NHS National Services Scotland

Hand Hygiene: Surgical hand antisepsis in the clinical setting

Literature Review

Version 6.2

18 October 2023

ARHAI Scotland

Antimicrobial Resistance and Healthcare Associated Infection

Contents

Key Information

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Document information	Description
Description:	This literature review examines the available professional literature on surgical hand antisepsis in the clinical setting.
Purpose:	To inform the hand hygiene section 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 2026.
Cross reference:	National Infection Prevention and Control Manual
Update level:	Practice – Changes include addition of sections covering the definition of surgical hand antisepsis and legislative requirements or standards relating to surgical hand antisepsis products. Change to recommendation that surgical scrubbing using an antimicrobial surgical scrub product should be used for the first surgical hand antisepsis of the day. Research – Further well conducted RCTs evaluating the efficacy of surgical hand antisepsis are required and further evidence is required regarding infection risk from fingernails and nail polish.

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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
6.2	October 2023	The following recommendation was expanded following stakeholder feedback. **Amended recommendation**: • Surgical scrubbing using an antimicrobial surgical scrub product should be used for the first surgical hand antisepsis of the day. **Additional wording added:** Or perform hand hygiene using water and a non-antimicrobial liquid soap prior to the first surgical antisepsis of the day; this can be carried out in an adjacent clinical area. Explanation of the stakeholder feedback was added to the discussion section of the research question 'When should surgical hand antisepsis be performed?'.
6.1	July 2023	Following stakeholder feedback, the following recommendation was clarified to align with the Association for Perioperative Practice (AfPP) and the National Institute for Health and Care Excellence (NICE) recommended practice. **Amended recommendation:** • Surgical scrubbing using an antimicrobial surgical scrub product should be used for the first surgical hand antisepsis of the day. A recommendation was removed from the section **'What is the correct process and technique for surgical hand antisepsis?'** as it does not form part of the surgical rubbing process.

Version	Date	Summary of changes
		Removed recommendation: • Hands should be washed with non-antimicrobial liquid soap and thoroughly dried after donning theatre clothing.
6.0	July 2023	Updated after review of current literature. **Additional research questions added:** • What is surgical antisepsis? • Are there any legislative requirements or standards relating surgical hand antisepsis products? **Alteration to wording of following research questions to ensure clarity of understanding:** • What is the available evidence regarding infection risk from fingernails (including gel overlays/artificial nails)? • What is the available evidence regarding infection risk from the wearing of hand and wrist jewellery in the clinical setting? **Amalgamation of objectives below into 'What is the correct process and technique for surgical hand antisepsis?':** • What is the correct technique to ensure that all surfaces of the hands are covered during surgical hand antisepsis? • How long should surgical hand antisepsis be carried out to ensure good technique? • What is the correct technique for surgical hand rubbing? • How long should surgical hand rubbing be carried out to ensure good technique? **Updated recommendation:** • Wash hands with an antibacterial hand wash product prior to the first operation of the day.

Version	Date	Summary of changes
5.1	May 2022	Following stakeholder feedback, an additional line was added to the recommendation **'What is the correct technique to ensure that all surfaces of the hands are covered during surgical hand antisepsis?**' - 'Repeat the procedure to the mid forearms only'. This is to align with the Association for Perioperative Practice (AfPP) recommended practice.
5.0	June 2020	**Additional research question added:** • Which products are suitable for surgical scrubbing/surgical rubbing? • Where should hand hygiene facilities be located for surgical hand antisepsis? **New recommendations:** **Which products are suitable for surgical scrubbing/surgical rubbing?** • Surgical rubbing with ABHR is a suitable alternative to surgical scrubbing with an antimicrobial scrub agent if the ABHR is licensed for this use. • Surgical scrubbing should be performed with an agent that has immediate and sustained antimicrobial effect (for example chlorhexidine gluconate, povidone-iodine). • Surgical rubbing should be performed with an agent that has immediate and sustained antimicrobial effect. **Where should hand hygiene facilities be located for surgical hand antisepsis?** • Scrub areas should be separate from the operating theatre (OR) or within a recessed area within the OR and located away from areas containing equipment and laid-up instrument trolleys in order to prevent water splashing and potential contamination.

Version	Date	Summary of changes
		Recommendations updated: **What is the recommendation relating to fingernails to enable effective surgical hand antisepsis?** Removal of the following • Nail products should not be worn as chips may harbour bacteria and thus represent an infection risk. **What are the hand hygiene facilities required for surgical hand antisepsis (including sink and tap design)?** The following recommendations should be adhered to when considering surgical hand antisepsis facility requirements **including sink and tap design:** • The sink and furniture should be at a height to facilitate hand and arm washing and prevent splashing of surgical attire/scrubs/uniform. • The design and drainage should ensure that the floor does not become wet during washing procedures. • The rim of the scrub sink should not have an internal lip, as contaminated water from the scrub procedure could collect beneath the rim and attract debris with a potential risk of infection. • For clinical wash hand basins used for invasive procedures, all basins should have curved sides with no plugs, have no overflows, and be fitted with infrared non touch taps which should not be placed over the waste outlet. • Foot pedals and/or elbow adjustments should be provided to operate taps and dispense hand hygiene solutions. • Provision of hot and cold water is essential and water should flow at a steady rate. When

Version	Date	Summary of changes
		specifying taps for scrub sinks, consideration should be given to the use of automatic mixer units providing water at a predetermined temperature. • The use of sonic accessories for instance non-touch, fixtures and fittings should be considered. • Where sensor taps are in operation they must allow a sufficient run-on-time for the hand hygiene/scrub protocol to be completed. The run on time should be a minimum of 20 seconds. • Foot operated disposal bins for waste paper should be provided. • Wall-mounted paper towel holders should also be provided. • The splash-back for scrub sinks and clinical wash hand sinks should be a single waterproof sheet or seal mounting with polyurethane or wall glaze.
4.0	December 2016	**Recommendations updated:** **What is the correct technique to ensure that all surfaces of the hands are covered during surgical hand antisepsis?** Removal of bullet point • At this point local policy may advise repeating the steps above but to the mid-arms only, rinsing as described above when complete. Inclusion of new bullet points 3 and 4 • Rinse hands by passing them through the water in one direction only, from fingertips to elbow. Do not move the arm back and forth through the water • Put antimicrobial soap into the palm of your left hand using the elbow of the right arm to operate the dispenser.

Version	Date	Summary of changes
		Discussion updated: **What is the correct technique to ensure that all surfaces of the hands are covered during surgical hand antisepsis?** Removal of text 'and this is current practice in NHSScotland' from bullet point 8.
3.0	November 2015	Updated after review of current literature
2.0	April 2014	Updated after review of current literature
1.0	January 2012	Defined as final

Approvals

Version	Date Approved	Name	Job Title	Division
6.0	June 2023	National Policies, Guidance and Evidence (NPGE) Working Group		
5.0	December 2019	National Infection Prevention and Control Group		
4.0	December 2016	National Policies, Guidance and Outbreaks Steering Group		
3.0	November 2015	Steering (Expert Advisory) Group for SICPs and TBPs		
2.0	April 2014	Steering (Expert Advisory) Group for SICPs and TBPs		
1.0	January 2012	Steering (Expert Advisory) Group		

Version	Date Approved	Name	Job Title	Division
		for SICPs and TBPs		

1 Objectives

The aim of this review is to examine the extant scientific literature regarding surgical hand antisepsis in health and care settings to inform evidence-based recommendations for practice.

For this literature review, the terms 'visibly soiled' and 'visible soiling' include, but are not limited to, blood and body fluids. Invasive procedures do not solely occur in operating theatre settings therefore the recommendations made in this review should be considered by any clinical setting where surgical hand antisepsis is required.

The specific objectives of the review are to determine:

- What is surgical hand antisepsis?
- Are there any legislative requirements or standards relating to surgical hand antisepsis products?
- When should surgical hand antisepsis be performed?
- Which products are suitable for surgical hand antisepsis?
- What is the recommended water temperature for surgical hand antisepsis?
- What is the available evidence regarding infection risk from fingernails (including gel overlays/artificial nails)?
- What is the available evidence regarding infection risk from the wearing of hand and wrist jewellery in the clinical setting?
- Should nail brushes, sponges and picks be used when performing surgical hand antisepsis?
- What is the correct process and technique for surgical hand antisepsis?
- How should hands be dried after surgical hand antisepsis?

- What are the hand hygiene facility requirements for surgical hand antisepsis including sink and tap design?
- Where should hand hygiene facilities be located for surgical hand antisepsis?

2 Methodology

This targeted literature review was produced using a defined two-person systematic methodology as described in the National Infection Prevention and Control Manual: Development Process. Database searches were performed on 31 October 2022.

In total, 721 individual pieces of evidence were retrieved using the search strategy described in Appendix 5 of the **NIPCM methodology**. Details regarding the screening process are summarised in a PRISMA flowchart presented in **Appendix 2** (adapted from: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097).

3 Discussion

3.1 Implications for practice

What is surgical hand antisepsis?

Three pieces of evidence were identified from the literature defining surgical hand antisepsis, two guidelines from the Association for Perioperative Practice (AfPP) and the World Health Organization (WHO) were graded 'Recommend' using the AGREE methodology,[1, 2] and one (published by the Association of periOperative Registered Nurses (AORN) was graded level 4 - expert opinion according to SIGN50 methodology.[3] No evidence was included from the previous version of this literature review (Version 5.0) as this is a novel research question created for this update.

According to guidance from the AORN, the WHO and AfPP, while routine hand washing removes visible soiling and transient microbial skin flora, the additional steps and use of an antimicrobial surgical product or alcohol based hand rub (ABHR) during surgical hand antisepsis prevents the growth of resident microbial skin flora.[1-3]

Surgical hand antisepsis is routinely undertaken before performing an invasive procedure to minimise the number of microorganisms present on the skin thus reducing the risk of surgical site infection (SSI) and bloodstream infection (BSI). Surgical hand antisepsis is performed by the surgical team preoperatively.[2] Some invasive procedures may take place in care settings out with traditional operating theatres.

Are there any legislative requirements or standards relating to surgical hand antisepsis products?

Five pieces of evidence were included for this update. As this is a novel research question for this iteration there was no evidence included from the previous review (Version 5.0). Three British/European standards were graded SIGN50 level 4 evidence;[4-6] a guidance document produced by the European Chemicals Agency, published in Finland, was also graded SIGN50 level 4 evidence;[7] and one guideline document produced by the WHO was graded as AGREE 'Recommend'.[2] No primary scientific studies were identified to answer this research question, and the extant guidance are considered expert opinion as they are not evidence-based (no primary evidence referenced). British/European (BS EN) standards are summarised in **Appendix 3**. No legislative requirements were identified for hand hygiene products in Scottish health and care settings in the literature.

BS EN standards are produced from a technical committee formed of experts in their field to draw up standards outlining an agreed 'best practice' method. British Standards are obligated to adopt all European Standards. Those standards specific to this topic provide guidance outlining the minimum microbiological efficacy of products used in surgical hand antisepsis. Guidance from the European Chemicals Agency provides an overview of the standards, test conditions and pass criteria required for surgical hand disinfection products.[7] Three minimum standards exist for the assessment of surgical hand rubs and surgical handwash products which are suitable for hand disinfection use within healthcare settings. The standards refer to two steps: phase 2 step 1 refers to in vitro testing; whilst phase 2 step 2 refers to in vivo testing in a controlled setting. These are: BS EN 13727 for bacteria (phase 2,

step 1);[5] BS EN 12791 for bacteria (phase 2, step 2)[6] and BS EN 13624 for yeast (phase 2, step 1).[4] There are additional, optional standards for if a product is aiming to demonstrate virucidal, mycobacterial and fungicidal efficacy in surgical hand antisepsis. These are: BS EN 14348 for mycobacteria/tuberculosis (phase 2, step 1); BS EN 14476 for viruses (phase 2, step 1); and BS EN 13624 for fungicidal activity (phase 2, step 1).[7]

A surgical hand rub/surgical handwash product must demonstrate a minimum standard of efficacy to achieve the standard. The bactericidal in vitro standard BS EN 13727 (phase 2 step 1) requires the hand rub or handwash to demonstrate at least a five decimal log (lg) reduction within a maximum of five minutes against the following minimum spectrum of test organisms: *Pseudomonas aeruginosa (P. aeruginosa), Staphylococcus aureus (S. aureus), Enterococcus hirae (E. hirae)* and *Escherichia coli (E. coli)* K12.[5] The in vivo requirement for a product showing bactericidal activity BS EN 12791 (phase 2 step 2) is for the surgical hand rub/handwash to demonstrate an immediate and sustained (after three hours) mean bacterial log reduction at the same level or greater than that of propan-1-ol 60% (v/v), which is the reference for surgical hand rub. There is no requirement for specific test organisms as volunteers' resident microbial skin flora are used.[6] Finally, for yeast, the in vitro requirement BS EN 13624 (phase 2 step 1) is for the surgical hand rub/handwash to demonstrate at least a four decimal log reduction within five minutes against *Candida albicans*.[4] Optional standards for products used in surgical hand antisepsis are all in vitro tests and cover testing against the following microorganisms: viruses (poliovirus, adenovirus and murine norovirus) within BS EN 14476; fungal spores (*Candida albicans*) within BS EN 13624; and mycobacterial/tuberculosis (*Mycobacterium avium* and *Mycobacterium terrae*) within BS EN 14348. Efficacy against viruses is classified as an optional standard for products used in surgical hand antisepsis as viruses are not typically causative of an SSI, and therefore the standard is not a requirement for licensing in any country.[2] The standards do carry limitations; in vitro testing does not give any indication as to clinical effectiveness in real-life settings; sample sizes required in the phase 2 step 2 tests are small; no power calculation is included so conclusions regarding significance are unlikely to be able to be made as an effect may not be able to be detected; and the test organisms required to be used within the standards do not

cover a wide range of organisms. With these limitations in mind, additional evidence of a product's effectiveness demonstrated via a clinical trial would be beneficial.[2] However, the BS EN standards provide a consistent and transparent methodology in testing a surgical hand hygiene product. Use of the limits advocated by the standards within scientific studies enable accurate comparison of product efficacy; whilst also informing consumers of the antimicrobial properties of products. Manufacturers may choose to demonstrate efficacy of a product through the design and implementation of their own testing methods in addition to, or in place of, the standards. Manufacturers are not required to publish whether their products pass (or do not pass) the standards. Although the BS EN standards are not mandatory, international WHO guidelines state that antimicrobial preparations should abide by BS EN 12791 due to their rigorous methodology.[2]

When should surgical hand antisepsis be performed?

In this update, four publications were included that provide evidence relating to when surgical hand antisepsis should be performed which includes three guidelines graded 'Recommend' using the AGREE tool[1, 2, 8] and one expert opinion graded SIGN50 level 4 due to its lack of methodology.[3] Two guidelines are included from the previous review (Version 5.0), both of which are graded AGREE 'Recommend'.[9, 10]

There is consistency in the evidence base that the most appropriate time for surgical hand antisepsis to take place is before donning sterile PPE (for example gloves and gowns).[1-3, 8-10] Additionally the Association for Perioperative Practice (AfPP) states that in preparation for surgical hand antisepsis, surgical masks should be positioned and secured; and staff should be properly attired for the theatre (short-sleeved top tucked into trousers to help prevent splashing onto garments and all hair covered by a surgical hat).[3]

The AfPP and UK National Institute for Health and Care Excellence (NICE) state that surgical scrubbing using an antimicrobial surgical scrub product should be used for the first surgical hand antisepsis of the day.[3, 8] For subsequent procedures, surgical rubbing using an ABHR can be used to complete surgical hand antisepsis unless hands are visibly soiled.[2, 3, 8] It is worth noting that the AfPP recommendation

(updated in 2022) references the 2008 NICE recommendation with no additional primary literature referenced. Scottish stakeholder feedback received following publication of version 6.1 of this literature review highlighted that some settings have designed out scrub sinks to reduce the risk of water-associated infection, and consequently only use surgical hand rub products. Additionally, skin sensitivities and allergies may require avoidance of surgical hand scrub products. In these scenarios where surgical hand rubbing is the preferred option, it is expert opinion that hand hygiene using water and a non-antimicrobial liquid soap should be performed prior to entering the theatre or care area. The rationale for this is to remove physical contamination (which hand rub products are unable to do).

The AfPP state that surgical hand antisepsis (either surgical hand rubbing or surgical hand scrubbing) should occur between each procedure to reduce the risk of cross-infection.[3] There is consensus from the WHO regarding the use of ABHRs between surgical procedures if hands are not visibly soiled or contaminated with blood, other body fluids or excretions.[10]

Which products are suitable for surgical hand antisepsis?

In this update, eight pieces of literature were included, comprising three primary studies: a meta-analysis graded SIGN50 level 1+;[11] a randomised controlled trial (RCT) also graded SIGN50 level 1+;[12] and a crossover trial graded SIGN50 level 3.[13] Five guidelines are included, two graded SIGN50 level 4 expert opinion;[3, 14] and three graded 'Recommend' using the AGREE tool.[1, 2, 8] Seventeen papers were carried over from the previous update (Version 5.0). Of the 15 primary studies graded using SIGN50 methodology; there are three RCTs (two graded SIGN50 level 1+, one level 3),[15-17] one cohort study (level 2+),[18] seven experimental comparative studies (six graded level 3, one level 4),[19-25] three crossover trials (graded SIGN50 level 3),[26-28] and an observational study graded SIGN50 level 3.[29] Also included is an expert opinion piece graded SIGN50 level 4[9] and a guideline document graded 'Recommend' using the AGREE framework;[10] totalling 25 pieces of evidence.

In the literature identified, surgical hand antisepsis products are evaluated for their ability to reduce the number of bacteria on hands immediately after

scrubbing/rubbing, and after the conclusion of surgery (or a comparable time in experimental studies meaning following three or six hours of glove wear), which provides assessment of the sustained effect. The vast majority of studies adhere to BS EN 12791, the minimum standard to be used to assess efficacy against bacteria for surgical hand rubs/handwashes.[2]

Scrubbing versus rubbing

Studies assessing immediate and sustained antimicrobial efficacy indicate that ABHR is as effective[18] or superior[11, 13, 15, 17] to antimicrobial scrub agents.
A crossover trial directly compared a hand scrubbing technique with a hand rubbing technique, both using propan-1-ol 60% (v/v) as per the BS EN 12791 methodology.[13] The hand rub technique resulted in a significantly greater reduction in colony forming units (CFU) when compared to the scrub brush method both immediately after surgical hand antisepsis and 3 hours after application.[13] However limited applicability can be drawn from this as the scrub method used a brush (**see section on use of nail brushes**). There are limited comparisons to be made between scrubbing and rubbing products as all primary studies adhered to manufacturer's instructions and subsequently used a scrub brush with the scrub product which is a confounding factor. Nevertheless, primary studies adhering to EN 12791 evidenced the required log reduction according to the standard, when using the hand rub product. This reduction was not achieved with the hand scrub product.[12, 13] Conversely, a RCT that did not adhere to the British Standard as it did not investigate sustained effect (3 hours post application) or use the reference product 60% propan-1-ol (v/v) found no statistically significant difference between a chlorhexidine scrub and a 70% alcohol with 0.55% chlorhexidine rub.[18] Guidance from the AORN, the WHO, the US Centers for Disease Control and Prevention (CDC) and Infection Prevention and Control Canada (IPAC) state that ABHR is an appropriate alternative to surgical scrubbing with an antimicrobial scrub product.[1, 2, 9, 10, 14] The WHO states that surgical hand antisepsis should be performed using either a suitable antimicrobial scrub product or ABHR demonstrating sustained activity, but never in sequence, as the antimicrobial activity of the ABHR can become impaired if in the presence of water.[2]

Active ingredients

Surgical rubbing products typically contain ethanol, isopropanol or n-propanol, or a combination of any of these, and at different concentrations.[3] Additional ingredients are often added to enhance the antimicrobial efficacy (for example chlorhexidine gluconate) or to improve user tolerance (for example emollients). There is little evidence to recommend one surgical rubbing agent over another, partly due to the identified studies having incomparable rubbing agents and methodologies, and being carried out under experimental conditions that may not be representative of real-life conditions in healthcare settings.[20-22, 27, 28] Many studies utilised the BS EN 12791 standard methodology, whereby a product is considered suitable for surgical hand antisepsis if immediate (post disinfection) and sustained (following 3 hours in sterile glove) antimicrobial efficacy is at least as effective as that of the reference product propan-1-ol 60% (v/v), see **section on legislative requirements** for further details.

There is limited evidence to suggest that surgical scrubbing products that contain chlorhexidine gluconate have greater immediate antimicrobial efficacy than povidone-iodine containing scrubbing agents.[15] Studies comparing the antimicrobial efficacy of various scrub products did not reveal a superior agent.[24, 26]

A RCT has demonstrated that scrubbing with triclosan 0.5% did not meet the BS EN 12791 criteria as it did not show a sustained antimicrobial effect.[12] This study is limited by its small sample size and the triclosan scrub intervention was used a brush which is an additional confounder (see **section on nail brushes** for more information). The AORN recommends that soaps containing triclosan are not used in healthcare settings due to the potential contamination of the environment through bioaccumulation, potential for bacterial resistance, and lack of clear evidence as to its clinical benefits when compared with equivalent products.[1]

Guidance published by the CDC, WHO, IPAC and the AfPP do not recommend a specific surgical rubbing product or active ingredient, instead stating that the rubbing agent should have a sustained/persistent/residual activity[1-3, 9, 10, 14] against a broad spectrum of microorganisms and, when used persistently should inhibit bacterial growth for a number of days.[3]

Alcohol concentration

There is limited evidence to recommend a specific alcohol concentration in ABHR products for surgical antisepsis. A comparative study has graded the antimicrobial efficacy of various alcohol concentrations in ABHR products for surgical rubbing (in this case ethanol, at 75%, 85%, and 95% concentration).[25] A rub of ≥ 85% was found to be most effective when tested against the reference product propan-1-ol 60% (v/v), however, a power calculation was not carried out to determine sample size, therefore the validity of the results is questionable.[25] Results from another comparative study suggest that product formulation may have a greater effect on efficacy than alcohol concentration alone.[19] Indeed, the impact of adding glycerol to an ABHR can negatively affect antimicrobial efficacy when compared to an EN 12791 reference product propan-1-ol 60% (v/v).[23] The WHO Guidelines on Hand Hygiene in Healthcare state that alcohol solutions containing 60-80% alcohol are most effective, with higher concentrations being less effective as proteins are not easily denatured in the absence of water.[10] The evidence base for this comes from two books and a narrative review, published 1991, 1939 and 1903 respectively. Although the use of alcohol as a germicide is a widely accepted practice, the evidence underpinning this may be out of date. AfPP guidance states that the most efficacious alcohol concentrations are between 60-95% (alcohol only formulations) or 50-95% for ABHRs containing additional active ingredients (chlorhexidine gluconate or hexachlorophene).[3] This guidance is based on low quality studies containing small sample sizes and unclear methodologies.

The AfPP and the WHO state that while ABHR solutions may provide the most rapid reduction in microbial count, they are not as effective at removing visible soiling and debris as hand washing therefore, a hand wash solution is advised for the first wash of the day and also if hands are visibly soiled.[2, 3] A hand wash with plain soap and water may be appropriate in some settings for instance low income settings, as evidenced by Nthumba *et al*,[16] however the AfPP suggest that an antimicrobial scrub product is more effective at removing resident flora.[3] If plain soap is used, it should be followed with an application of ABHR.[3]

Side effects such as allergic reaction and skin sensitivity can occur with the use of any hand hygiene product. The CDC recommends that products are chosen based

on low irritancy potential, employee preferences (in terms of feel, fragrance, skin tolerance) and should not be chosen primarily based on cost.[9] The WHO acknowledges that frequent surgical hand antisepsis increases the likelihood of adverse skin events however these events occur less frequently in users of ABHR compared with iodophors.[2] This is based on expert opinion and no primary literature was used for this recommendation by the WHO.

What is the recommended water temperature for surgical hand antisepsis?

The temperature of water used for surgical hand antisepsis is described in a limited volume of evidence. Four pieces of evidence are included; three graded SIGN50 level 4 – expert opinion (AfPP, CDC and the Society for Healthcare Epidemiology of America (SHEA)),[3, 9, 30] and one publication from the WHO graded AGREE 'Recommend'.[10] No primary scientific studies were identified to inform this research question. All extant guidance and expert opinion literature recommend that warm water with a steady flow be used as this is both comfortable for the person undertaking the procedure, and is less likely than hot water to increase the risk of dermatitis.[3, 9, 10, 30] The AfPP recommend a specific temperature range of between 21.1 and 26.7ºC.[3]

What is the available evidence regarding infection risk from fingernails (including gel overlays/artificial nails)?

Six pieces of literature were included regarding recommendations relating to fingernails; two from the previous review (Version 5.0) which includes a guideline document from the CDC[9] and a guideline produced by the WHO[10]; both graded AGREE 'Recommend'. In this current update, four additional documents were added; two guidelines graded AGREE 'Recommend' (WHO and AORN)[1, 2] and two pieces graded SIGN50 level 4 (IPAC and AfPP).[3, 14]

There is a lack of primary scientific evidence focusing on fingernails and their impact on effective surgical hand antisepsis. The included guidelines and expert opinion literature are consistent in their recommendations that fingernails should be kept short and clean and be healthy and natural. However, there remains a lack of strong evidence that artificial nails or nail polish are associated with increased rates of SSI as many of the guidelines are based on low to moderate quality studies. Guidance from IPAC and CDC are not specific to surgical operating staff.[9, 14] There is conflicting guidance on the maximum length that fingernails should be: the AfPP recommend[3] a maximum length of 2mm whilst the WHO recommends a 5mm maximum length.[10] There is consensus that long fingernails may prevent effective microorganism removal [1, 3] as well as posing an increased risk of glove perforations and patient injury.[3]

All literature recommend that those providing direct care to patients should not wear nail polish, including shellac[1-3, 14] due to the possibilities of harbouring more microorganisms than clean fingernails and fragments of the nail polish becoming displaced from the nail and entering the wound.[1, 3] IPAC states that chipped nail polish or nail polish worn longer than four days can result in microorganisms remaining after hand washing, even surgical hand antisepsis.[14] This guidance is based on a provincial review by Public Health Ontario that references three studies of small sample size as evidence. There is no conclusive evidence that fresh nail polish increases SSI rate or indeed increases the number of microorganisms present.[3] The AfPP state that nail polish applied with ultraviolet (UV) light may result in damage to the nail which in turn may result in increased growth of microorganisms, however there is no evidence quoted to support this and therefore further research is required.[3]

The AORN, AfPP, CDC and IPAC describe an association between artificial nails and increased glove perforations and outbreaks of Gram-negative bacteria and yeasts.[1, 3, 9, 14] However, these findings are based on evidence from a systematic review of low quality and a local state rapid review. There is also cross-referencing of sources as the AfPP references the AORN as their source for this association. Nevertheless this has led to the WHO, AfPP, AORN and CDC recommending that artificial nails or extenders should not be worn;[2, 3, 9, 10] including nail art, acrylic gel

nails and wraps.[1] The AfPP and CDC further suggest that surgical hand antisepsis is not effective at removing microorganisms from artificial nails.[3, 9]

What is the available evidence regarding infection risk from the wearing of hand and wrist jewellery in the clinical setting?

Seven pieces of evidence were included for this research question. From the previous review (Version 5.0), two guidelines graded AGREE 'Recommend' by the WHO and CDC,[9, 10] and one expert opinion graded SIGN50 level 4 were included.[31] In this current update, four additional resources were identified. Two guideline documents graded AGREE 'Recommend', from the AORN and the WHO[1, 2] and a further two pieces of evidence from AfPP in the UK and IPAC in Canada, graded level 4 evidence according to SIGN50 methodology.[3, 14] No primary evidence was identified for this question.

There is consensus within the literature that hand and wrist jewellery should be removed prior to surgical hand antisepsis[1-3, 9, 10, 14] as the wearing of hand and wrist jewellery contributes to an increased number of microorganisms on the skin.[1, 9, 10, 14] However, all aforementioned guidelines have used 'The WHO Guidelines on Hand Hygiene in Health Care and their consensus recommendations' as evidence for their recommendations and so despite their consensus this should be interpreted with caution. The AORN guidance states that the wearing of jewellery is associated with less effective removal of microorganisms during surgical hand antisepsis.[1]

A report examining infection control in operating theatres suggests that wedding bands (with no stones) may be worn but that surgeons may be advised to remove them.[31] However, the majority of more recently published guidance do not recommend the wearing of rings[1] or at the very least strongly discourage them.[14] Additionally the AfPP, WHO and IPAC all state that the wearing of rings has been associated with a contamination risk through increased incidence of glove tears, particularly with rings containing stones.[3, 10, 14] However, the WHO guideline is used as the only reference for this statement within the AfPP and IPAC. The WHO

evidence base consists of five primary studies, three of which were published before 2000 and all of which were of low to medium quality and therefore excluded from this literature review.

Should nail brushes, sponges and picks be used when performing surgical hand antisepsis?

A total of 12 publications were included that provide evidence relating to whether nail brushes, sponges and picks should be used in surgical hand antisepsis. Seven pieces of evidence were included from the previous iteration (Version 5.0); comprising of two guidelines graded AGREE 'Recommend' (SHEA and WHO guidelines),[9, 10] a guidance document published by SHEA graded level 4 evidence,[30] two RCTs (both of which are graded SIGN50 level 1+[32, 33]), a before-after study graded as level 3,[17] and a UK controlled trial graded SIGN50 level 1+.[34] Within this current update, five pieces of evidence were added including a RCT graded SIGN50 level 1+,[35] three guidelines graded AGREE 'Recommend' (AORN, WHO and NICE),[1, 2, 8] and an expert opinion publication from the AfPP graded SIGN50 level 4[3].

Three RCTs, a before-after study and a controlled trial provide evidence regarding brushes, sponges and picks.[17, 32-35] One RCT found no difference between the control group (scrub with 4% chlorhexidine gluconate liquid soap only) and the investigatory groups (additional use of a nail pick, or nail brush in the scrubbing process) in bacterial load (colony forming units (CFU/ml)) on nurses hands one hour after surgical hand antisepsis.[33] There was no mention as to whether dirt was visible under the nails before commencing the scrub. Another RCT determined that the use of a nail brush increased the bacterial count on hands possibly due to increasing abrasion and subsequent shedding of skin.[35] Although the methodology was robust the sample size was small and this study was carried out in only one operating room department in Turkey therefore affecting applicability to Scottish health and care settings. The final RCT concluded that traditional scrubbing using a brush was associated with significantly greater skin damage than rubbing with an alcohol-based product.[32] A limitation of this RCT was that no comparison was made between the scrub product and no nail brush and the scrub product with a nail brush; therefore

the findings could be attributed to the different antisepsis product used rather than the use of a nail brush. The before-after study found that a waterless, scrubless antisepsis product of 1% chlorhexidine gluconate (CHG)/ethanol hand preparation had a significantly greater bactericidal effect than the methods using a scrub and sponge.[17] This study was described as an RCT within the paper however it has been graded level 3 according to SIGN50 methodology due to its lack of description regarding blinding and randomisation and lack of a suitable control as the scrub method is compared to a waterless rub; therefore, findings should be interpreted alongside other, more robust, primary evidence. Additionally, a controlled trial found that there was no significant difference in the number of post-intervention colony forming units (CFU) when testing three different scrubbing methods (first chlorhexidine gluconate only, second chlorhexidine plus a nail pick, and the third chlorhexidine plus a nail brush). Results indicate no additional benefit of decontamination from the use of a nail brush or nail pick.[34] Despite the limited evidence, guidance documents from the WHO, AORN AfPP, SHEA and the CDC all recommend that professionals do not perform surgical hand antisepsis with a scrub brush.[1-3, 9, 10, 30] The use of a nail cleaner (a single-use nail pick) whilst washing is recommended by NICE, the WHO and AfPP when hands are visibly soiled.[2, 3, 8] NICE additionally state that a nail brush can be used before the first operating procedure of the day when washing hands however this guidance was published in 2008 and does not align with more current literature.[8]

The use of sponge applicators to assist with the surgical hand antisepsis procedure is not widely discussed in the literature. These applicators are typically either plain sponges (used to apply the antimicrobial scrub product) or sponges impregnated with antimicrobial products which may also have soft, flexible bristles (often called a ‘brush sponge’). No primary evidence was identified regarding the use of sponges. However, the CDC stated within its 2002 guidance that a reduction in bacterial counts on hands was associated with scrubbing with a disposable sponge or combination sponge-brush.[9] They cite moderate evidence from eight studies for the use of sponges or brushes (six of which were published pre-2000 and the remaining two were already included within this review)[17, 32] to suggest that neither a brush or sponge is necessary to reduce bacterial counts on hands, particularly when ABHRs are used.[9]

What is the correct process and technique for surgical hand antisepsis?

In total, 14 papers were included, six sources were identified in this current update comprising of two AGREE 'Recommend' guidelines published by AORN and the WHO[1, 2], two expert opinion pieces graded SIGN50 level 4 evidence;[3, 6] one RCT graded SIGN50 level 1+[35] and one experimental study graded SIGN50 level 3 evidence.[36] These evidence join eight sources identified in the previous update (Version 5.0); containing two guidelines graded AGREE 'Recommend' published by the CDC and the WHO[9, 10], two expert opinion pieces of evidence (graded SIGN50 level 4)[30, 37], and four experimental studies (graded SIGN50 level 3).[38-41]

The effective decontamination of hands and forearms is paramount to reducing SSIs; the AfPP suggest that the creation and implementation of a clear hospital policy regarding antisepsis procedure increases staff compliance and understanding.[3]

Surgical scrubbing

There is consensus in extant guidance and expert opinion literature (WHO, AORN, AfPP and BS EN 12791) regarding basic procedural concepts for surgical scrubbing. Hands and arms must be wet before application of the antimicrobial surgical product.[3, 10] In order to avoid contamination the wash should not go above the elbows,[3, 10] and hands should stay raised above the elbows to allow water to run off.[1, 3, 10] Splashing of water onto surgical attire should be avoided.[3] All expert opinion pieces and guidelines identified for this review state that the product manufacturer's instructions for use must be followed.[1, 3, 6, 10] BS EN 12791 and the AORN additionally state that manufacturer's instructions should be consulted regarding the volume of product to be used, frequency of application and timing of adding water.[1, 6]

There is slight variation concerning the recommended step by step process for surgical scrubbing in the clinical setting. Similar to the British Standard procedure for testing scrub products, the AfPP suggests the following steps:[3, 6]

- Wet hands and forearms and, according to the manufacturer's instructions regarding amount, apply the solution from a dispenser. Rub solution into the

hands palm to palm and then work upwards until all areas to just below the elbow are covered in solution.

- Using the right palm spread product over the back of the left hand with interlaced fingers. Repeat with the left palm on the back of the right hand.
- With fingers interlaced, rub palm to palm.
- Clasp the fingers of the right hand into the left palm and rotate hands. Repeat with the opposite hand.
- Hold the right thumb in the left hand and rotate to cover in scrub solution. Repeat with the opposing thumb.
- For both hands, rub the fingertips on the palm.
- Working only in the direction towards the elbows, use a rotating action to move one hand around the arm to just below the elbow. Repeat on the other arm.
- Rinse. Repeat above steps. Ensure hands are kept higher than elbows throughout the process.
- Where possible use elbows to turn off taps and allow water to run off skin. Open the gown pack and take a sterile single-use hand towel. Pat dry the left hand down to the elbow, discard the towel and repeat with the right hand. For further information on drying hands see section on **how hands should be dried**.

There are discrepancies between the above process and those published by the AORN and the WHO. The AORN suggests the use of a soft, non-abrasive sponge to apply the scrub solution.[1] There is additional instructional guidance offered concerning the step by step process such as washing each side of each finger as though each finger has four sides;[1] timing for 2 minutes to scrub each finger and front and back of one hand;[10] and washing each side of the arm from wrist to elbow for a further minute.[10] However, there is agreement that if hands are visibly soiled then it is recommended to wash hands with non-antimicrobial soap and running

water.[1, 10] The primary aim of these literature sources are similar; that is to cover all surfaces of the hand and arm as thoroughly and effectively as possible.

A low quality experimental study conducted in China found that an enhanced washing technique with the addition of focusing on blind areas within the traditional washing technique (outer edge of palm, inner edge of palm, and nail groove and nail root) was associated with a reduction in the number of bacteria (CFU/cm^2) and a significant reduction in the SSI rate.[36] However, there is no clear description regarding the process of the traditional handwashing technique. There is also a risk of bias towards the 'enhanced' technique as the study was unblinded due to its method and focus. The level of compliance by subjects is not graded and British Standard regulations were not adhered to as the scrubbing product used was not identified to be the reference product propan-1-ol 60% (v/v).

Whilst the length of time required to perform surgical hand scrubbing is well studied in the literature, results are often difficult to interpret due to the wide variation in scrubbing protocols. Historically, there was consensus that in practice the scrub technique should take a minimum of four minutes to complete[9, 10, 30, 37] However, more recently the WHO and the AfPP suggest a time range of between two and five minutes as being equally as effective.[2, 3]

Indeed, a recent RCT investigating scrub times found there was no significant difference in bacterial counts between a one-minute and two-minute scrub with no nail brush, both immediately after surgical hand scrubbing and after completion of surgery.[35] These scrub times were repeated with the use of a nail brush, and bacterial count immediately after surgical hand scrub was significantly higher in the two-minute duration group. For more information on the use of nail brushes in surgical hand antisepsis please see **section on nail brush use** of this review. Limitations of this RCT include its generalisability to Scottish healthcare settings as it was carried out in one operating room department in Turkey, potential risk of bias as the study's use of a method of measuring microorganisms left residual media on the hands which could inadvertently increase the number of microorganisms by providing a nutrient source.[35] The WHO suggests that manufacturer's guidance on the specific time deemed effective for their product's use should be adhered to.[2]

Surgical hand rubbing

If water quality cannot be guaranteed, the WHO recommend that surgical hand antisepsis using ABHR should be performed in lieu of surgical scrubbing.[2] Evidence shows that ABHR can be superior to, or as effective as, a traditional surgical scrub (**see section on products**).[3]

There is consensus in the literature that surgical hand rub should be applied according to manufacturer's instructions for use to ensure effectiveness[1, 9, 10, 30] with sufficient product being used to wet the hands and arms for the duration of the rubbing process (meaning the product should not be allowed to fully evaporate until the surgical hand rubbing process is complete).[3, 10]

The 2018 WHO guidelines for the prevention of SSI recommends the following steps for undertaking surgical hand rub with ABHR. This process aligns with guidance from the AfPP.[2, 3]

- Put approximately 5ml (3 doses) of ABHR in the palm of your left hand, using the elbow of your other arm to operate the dispenser.
- Dip the fingertips of your right hand in the hand rub to decontaminate under the nails (5 seconds).
- Smear the hand rub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the hand rub has fully evaporated (10-15 seconds).
- Repeat above steps for the left hand and forearm.
- Put approximately 5ml (3 doses) of ABHR in the palm of your left hand, to rub both hands at the same time up to the wrists (20 – 30 seconds). Using a rotating movement, and rubbing palm against palm, ensure the whole surface of the hands are covered up to the wrist.
- With fingers interlaced, rub palms back and forth.
- Moving the right palm back and forth, rub the back of the left hand and wrist and repeat with opposite hand.

- Hold the back of the fingers in the palm of the other hand and rub them using a sideways back and forth movement.
- Clasp each thumb in the opposite hand and rotate.
- When hands are dry, sterile surgical clothing and gloves can be donned.[9, 30]
- The above sequence (average 60 seconds duration) should be undertaken until the ABHR manufacturer's instructions for duration is reached.

Guidance from the WHO states that once all surgical procedures are finished, routine hand hygiene (meaning non-antimicrobial liquid soap and water, or ABHR if hands are not visibly soiled) should be performed after surgical gloves are removed and before any other activities are undertaken.[2, 10]

Several studies have evaluated the efficacy of various rubbing durations using a number of different rubbing agents, with conflicting results.[38-41] There is consensus in the literature that manufacturer's instructions should be adhered to with regards to application time.[2, 3, 9, 10, 30, 38] Additionally the WHO guidelines for prevention of SSI state that the ABHR procedure should typically last for 1.5 minutes and hands and forearms should be wet with ABHR for the length of the process so sufficient product is required for this.[2]

The AfPP note that ABHR should only be applied to completely dry hands; hands and arms should also be completely dry before donning sterile gloves to reduce dermatitis risk.[3] Surgical hand scrubbing and surgical hand rubbing should never be combined in sequence due to the possible impairment of ABHR antimicrobial activity when in presence with water.[2, 3]

How should hands be dried after surgical hand antisepsis?

Seven pieces of evidence were included to assess how hands should be dried after surgical hand antisepsis. This consists of three guidance documents from the previous review (Version 5.0) (WHO, CDC and SHEA)[9, 10, 30] and a clinical trial;[42] and an additional three guidance documents identified for this current update (AORN,

AfPP and WHO).[1-3] Three guidelines are graded 'Recommend' using the AGREE tool,[1, 2, 10] three guidance documents are graded expert opinion level 4 using the SIGN50 methodology;[3, 9, 30] and the clinical trial is graded level 2+ using the SIGN50 methodology.[42]

Several methods of hand drying exist including paper towels, warm forced air and evaporation. These methods were evaluated in a clinical trial which found no significant difference or change in the number of CFUs from pre-wash to post-dry across all methods.[42] Warm air dryers are not indicated for use in health care settings in Scotland due to the potential for environmental contamination. Evaporative air drying is impractical; therefore, the use of disposable paper towels is the preferred option. Although the trial followed a robust methodology and used a sample size calculation, these findings would benefit from further evidence collected in clinical settings as the paper was written over 20 years ago under experimental controlled conditions.

The AfPP state that it is important that hands are dried well before donning sterile surgical gloves to reduce the transfer of bacteria (the risk of which is increased with wet surfaces).[3] When using alcohol for surgical hand antisepsis it is also important that hands and forearms are completely dry before donning sterile gloves[2, 3] to reduce risk of dermatitis.[3] Furthermore, as the antimicrobial activity of ABHRs may be impaired if hands are wet, hands should be completely dried before an ABHR is applied.[2, 3]

The procedure for drying hands, as recommended by AfPP, is:[3]

- After rinsing, turn off the taps using elbows and allow water to run off the hands.
- Open a gown pack on a clean surface and take a sterile hand towel.
- The skin should be blotted dry with sterile single-use towels[3, 9, 10, 30] (rubbing will disturb skin cells).
- Using one towel per hand work from fingertips to elbows.

- Hands are dried firstly by placing the opposite hand behind the towel and blotting the skin – then using a corkscrew movement to dry from the hand to the elbow.
- The towel must not be returned to the hand once the arm has been dried and must be discarded immediately.
- The process is then repeated for the opposite hand.

What are the hand hygiene facility requirements for surgical hand antisepsis including sink and tap design?

Eight pieces of guidance were included for this research question. Four sources of evidence were added in this update, consisting of guidance published by the AORN[1], AfPP[3], Health Facilities Scotland[43] and the WHO;[2] two guidelines are graded AGREE 'Recommend'[1, 2] and a further two sources are graded expert opinion level 4 evidence according to SIGN50 methodology.[3, 43] Literature included from the previous review (Version 5.0) includes two US guidance documents from CDC[9] and SHEA[30] (graded AGREE 'Recommend'[9] and level 4 evidence[30] according to SIGN50); a guideline from the WHO graded 'Recommend' using the AGREE tool;[10] and guidance produced by Health Facilities Scotland graded level 4 expert opinion using SIGN50 methodology.[44] There were no primary scientific studies identified for this research question.

Guidelines from the AORN state that paper towel dispensers located at hand washing stations should be enclosed to allow for towel removal without dispenser contact and protection of the towels from contamination with sink water.[1] However, there is ambiguity as it is not specified whether this recommendation is solely for settings undertaking surgical hand antisepsis or for all hand hygiene moments involving water. For specific details about sink design and operational management, see guidance on water safety produced by **Health Facilities Scotland (SHTM 04-01)**[43] and guidance on specification and design produced by **Health Facilities Scotland (SHTM 64)**.[45] The recommendations by Health Facilities Scotland are consistent with the other included literature sources regarding the facility

requirements for surgical hand antisepsis.[1-3, 9, 10, 30, 44] Further to SHTM 04-01 and SHTM 64 the following key points are recommended from the literature:

- The sink should be at a height to facilitate hand and arm washing and prevent splashing of uniforms.[2, 3, 44]
- The sink design and drainage should be such that it reduces the risk of splashing[2, 3, 44] for example ensuring sinks are deep enough;[1] sink taps should not be positioned directly above the drain to reduce splashing from the drain hole;[1] and water pressure into the sink should be modified to reduce splashing.[1]
- The rim of the sink should not have an internal lip, as contaminated water from the scrub procedure could collect beneath the rim and act as an environmental source of contamination.[44]
- Hot and cold water should flow at a steady rate. When specifying taps for scrub sinks, consideration should be given to the use of automatic mixer units providing water at a predetermined temperature.[44] These facilities should be maintained as part of a routine maintenance programme.[3]
- The use of sonic taps and dispensers for instance non-touch fixtures and fittings should be considered and taps should not be placed over the waste outlet[3, 44] to reduce the risk of hand contamination and help to ensure sterility during surgical hand antisepsis.[1] Alternatively foot pedals and/or elbow adjustments to operate taps and dispense hand hygiene products, including ABHR,[2, 46] are advised.[3, 10, 44]
- Where sensor taps are in operation they must allow a sufficient run-on-time for the hand hygiene/scrub protocol to be completed. The run on time should be a minimum of 20 seconds.[44]
- Disposal bins for waste paper should be foot-operated or open-topped.[3]
- Paper towel holders should be wall-mounted.[44]
- Splash-back should be a single waterproof sheet or seal mounting with polyurethane or wall glaze.[1, 44]

- The surface area in contact with water should be reduced where possible.[1]
- There should be sufficient space between preparation and sterile areas, sinks and patients.[1]
- Product dispensers should be regularly maintained to ensure they deliver the correct amount of product (according to the manufacturer).[3]
- Dispensers should not be reused or filled when partially empty.[3]

Where should hand hygiene facilities be located for surgical hand antisepsis?

Six papers were included for this research question. Three pieces of evidence were identified in this iteration; two of which are graded AGREE 'Recommend', published by the AORN[1] and the WHO,[2] and a publication by the AfPP in the UK, graded level 4 using SIGN 50 methodology.[3] These join three guidelines previously included in Version 5.0 that are all graded level 4 expert opinion and are published by SHEA[30, 46] and Health Facilities Scotland.[44]

Health Facilities Scotland and the AfPP state that the scrub area should be separate from the operating theatre (OR). If an OR has a recessed scrub area, this must be located away from the area containing laid-up instrument trolleys, to prevent water and potential microbial contamination.[3, 44] Health Facilities Scotland further states that a scrub room can be shared between two ORs but the room must be large enough to enable three people scrubbing back to back with space between (minimum size 16m^2).[44] The AfPP guidelines are consistent with HFS recommendations however they do not recommend a specific area size, just that there must be enough space to prevent risk of contamination against others.[3]

Two guidance documents (AORN and SHEA) indicate that ABHR dispensers should be placed at the entrance to, or inside, the OR[1] and near anaesthesia providers to promote adherence with hand hygiene indications.[46] Additionally, there should be a hand scrub sink in the semi-restricted area close to the entrance to the OR.[1] It should be noted that the frequency of hand hygiene does not equate to appropriate hand hygiene for instance it must be carried out at the appropriate moments to be

effective. Another consideration is to allow staff workflow patterns to determine the location of hand hygiene product dispensers, as suggested by SHEA.[30]

ABHRs should be located in accordance with applicable national and local fire safety standards and codes.[30, 44, 46]

3.2 Implications for research

There is an extensive body of literature which examines the efficacy of surgical hand antisepsis however there is a lack of well conducted RCTs in practice. Evidence for the infection risk from fingernails and nail polish has primarily been synthesised from expert opinion rather than evidence-based guidance and therefore, additional high quality studies are warranted to investigate the infection risk more thoroughly and provide greater clarity in recommendations. Further study and consideration of water usage in surgical hand antisepsis may be warranted as sustainability in healthcare is an essential consideration in decision-making.

4 Recommendations

This review makes the following recommendations based on an assessment of the extant scientific literature on surgical hand antisepsis in the health and care setting.

What is surgical hand antisepsis?

Surgical hand antisepsis is more thorough than routine hand hygiene; in addition to the removal of visible soiling and transient bacteria, it prevents the growth of resident microbial skin flora before performing an invasive procedure.

(Category C recommendation)

Are there any legislative requirements or standards relating to surgical hand antisepsis products?

Surgical hand antisepsis products intended for use in health and care settings should meet the minimum and additional BS EN standards.

Minimum BS EN standards include BS EN 13727 and BS EN 12791 for activity against bacteria, and BS EN 13624 for activity against yeast.

Additional standards include BS EN 14348 for activity against mycobacteria/tuberculosis, BS EN 14476 for activity against viruses, and BS EN 13624 for activity against fungi.

(Category C recommendation)

When should surgical hand antisepsis be performed?

Surgical hand antisepsis should take place **before** donning sterile PPE (for instance gloves and gowns).

(Category A recommendation)

In preparation for surgical hand antisepsis surgical masks should be positioned and secured, and staff should be properly attired for theatre (short-sleeved top tucked into trousers and hair covered by a surgical hat).

(Category C recommendation)

Surgical scrubbing using an antimicrobial surgical scrub product should be used for the first surgical hand antisepsis of the day. Or perform hand hygiene using water and a non-antimicrobial liquid soap prior to the first surgical antisepsis of the day; this can be carried out in an adjacent clinical area.

(Category C recommendation)

Surgical hand antisepsis should be performed between each procedure; using either the surgical scrubbing technique or surgical rubbing (if hands are not visibly soiled).

(Category C recommendation)

Alcohol based hand rub (ABHR) may also be used for hand decontamination between glove changes if hands are not visibly soiled.

(Category C recommendation)

Which products are suitable for surgical hand antisepsis?

Surgical antisepsis products should have an immediate and sustained antimicrobial effect for instance by using products that meet the minimum British Standards for surgical hand antisepsis products.

(Category C recommendation)

Surgical rubbing with ABHR is a suitable alternative to surgical scrubbing with an antimicrobial scrub agent.

(Category A recommendation)

What is the recommended water temperature for surgical hand antisepsis?

Warm water with a steady flow should be used for carrying out surgical hand antisepsis.

(Category C recommendation)

What is the available evidence regarding infection risk from fingernails (including gel overlays/artificial nails)?

In line with standard hand hygiene practice recommendations, fingernails should be kept clean and short, not exceeding 5mm in length.

(Category C recommendation)

Those providing direct care to patients should not wear nail products, including shellac.

(Category C recommendation)

Artificial nails should not be worn as they inhibit effective hand hygiene and increase the likelihood of glove perforations.

(Category C recommendation)

What is the available evidence regarding infection risk from the wearing of hand and wrist jewellery in the clinical setting?

All hand and wrist jewellery should be removed prior to surgical hand antisepsis.

(Category C recommendation)

Local policies should be in place to direct members of staff to remove hand and wrist jewellery.

(Category C recommendation)

Should nail brushes, sponges and picks be used when performing surgical hand antisepsis?

Nail brushes **should not** be used for surgical hand antisepsis.

Nail cleaners (for example nail picks (single use)) can be used if nails are visibly dirty.

Soft, non-abrasive, sterile (single use) sponges may be used to apply antimicrobial liquid soap to the skin.

(Category A recommendation)

What is the correct process and technique for surgical hand antisepsis?

Scrubbing Process:

- Wet hands and forearms and, according to the manufacturer's instructions regarding amount, apply the solution from a dispenser. Rub solution into the hands palm to palm and then work upwards until all areas to just below the elbow are covered in solution.

- Using the right palm spread product over the back of the left hand with interlaced fingers. Repeat with the left palm on the back of the right hand.
- With fingers interlaced, rub palm to palm.
- Clasp the fingers of the right hand into the left palm and rotate hands. Repeat with the opposite hand.
- Hold the right thumb in the left hand and rotate to cover in scrub solution. Repeat with the opposing thumb.
- For both hands, rub the fingertips on the palm.
- Working only in the direction towards the elbows, use a rotating action to move one hand around the arm to just below the elbow. Repeat on the other arm.
- Rinse. Repeat above steps. Ensure hands are kept higher than elbows throughout the process.
- Allow water to run off skin. Take a sterile single-use towel and pat dry left hand down to the elbow, discard the towel and repeat with the right hand.

Rubbing Process:

- Put approximately 5ml (3 doses) of ABHR in the palm of your left hand, using the elbow of your other arm to operate the dispenser.
- Dip the fingertips of your right hand in the hand rub to decontaminate under the nails (5 seconds).
- Smear the hand rub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the hand rub has fully evaporated (10-15 seconds).
- Repeat above steps for the left hand and forearm.

- Put approximately 5ml (3 doses) of ABHR in the palm of your left hand, to rub both hands at the same time up to the wrists (20 – 30 seconds). Using a rotating movement, and rubbing palm against palm, ensure the whole surface of the hands are covered up to the wrist.
- With fingers interlaced, rub palms back and forth.
- Moving the right palm back and forth, rub the back of the left hand and wrist and repeat with opposite hand.
- Hold the back of the fingers in the palm of the other hand and rub them using a sideways back and forth movement.
- Clasp each thumb in the opposite hand and rotate.
- When hands are dry, sterile surgical clothing and gloves can be donned.[9, 30]
- The above sequence (average 60 seconds) should be undertaken until the ABHR manufacturer's instructions for duration is reached.

Manufacturer's guidance should be followed to ensure effectiveness of the product used.

Surgical scrubbing should not be combined with surgical hand rubbing in sequence.

(Category C recommendation)

How should hands be dried after surgical hand antisepsis?

- The skin should be blotted dry with sterile single-use towels (rubbing will disturb skin cells).
- Using one towel per hand and arm work from fingertips to elbows by placing the opposite hand behind the towel and blotting the skin using a corkscrew movement to dry from the hand to the elbow.

- Using a second towel repeat the process on the other hand and arm to the elbow.
- The towel must not be returned to the hand once the arm has been dried and must be disposed of immediately.

ABHR should not be applied on wet skin and hands should be fully dry before donning sterile gloves.

(Category C recommendation)

What are the hand hygiene facility requirements for surgical hand antisepsis including sink and tap design?

The following recommendations should be adhered to when considering surgical hand antisepsis facility requirements including sink and tap design:

- The sink should be at a height to facilitate hand and arm washing and prevent splashing of uniforms.
- The sink design and drainage should reduce the risk of splashing for example ensuring sinks are deep enough, sink taps should not be directly above the drain, reducing forceful flow into the sink by modifying the water pressure.
- The rim of the sink should not have an internal lip.
- Foot pedals and/or elbow adjustments should be provided to operate taps and dispense hand hygiene products.
- Hot and cold water should be provided and flow at a steady rate. When specifying taps for scrub sinks, consideration should be given to the use of automatic mixer units providing water at a predetermined temperature. These facilities should be maintained as part of a routine maintenance programme.
- The use of sonic taps and dispensers, for instance non-touch fixtures and fittings, should be considered, and taps should not be placed over the waste

outlet. Alternatively, foot pedals and/or elbow adjustments to operate taps and dispense hand hygiene products, including ABHR, are recommended.

- Where sensor taps are in operation they must allow a sufficient run-on-time for the hand hygiene/scrub protocol to be completed. The run-on time should be a minimum of 20 seconds.
- Foot-operated or open-topped bins for waste paper should be provided.
- Wall-mounted paper towel holders should also be provided.
- The splash-back for scrub sinks and clinical wash hand sinks should be a single waterproof sheet or seal mounting with polyurethane or wall glaze.
- The surface area in contact with water should be minimised.
- There should be sufficient space between preparation and sterile areas, sinks and patients.
- Product dispensers should be regularly maintained to ensure they deliver the correct amount of product (according to the manufacturer). Dispensers should not be reused or filled when partially empty.

(Category C recommendation)

Where should hand hygiene facilities be located for surgical hand antisepsis?

Within operating theatres scrub areas should be separate from the operating theatre (OR) or in a recess within the OR and located away from areas containing equipment and laid-up instrument trolleys.

(Category C recommendation)

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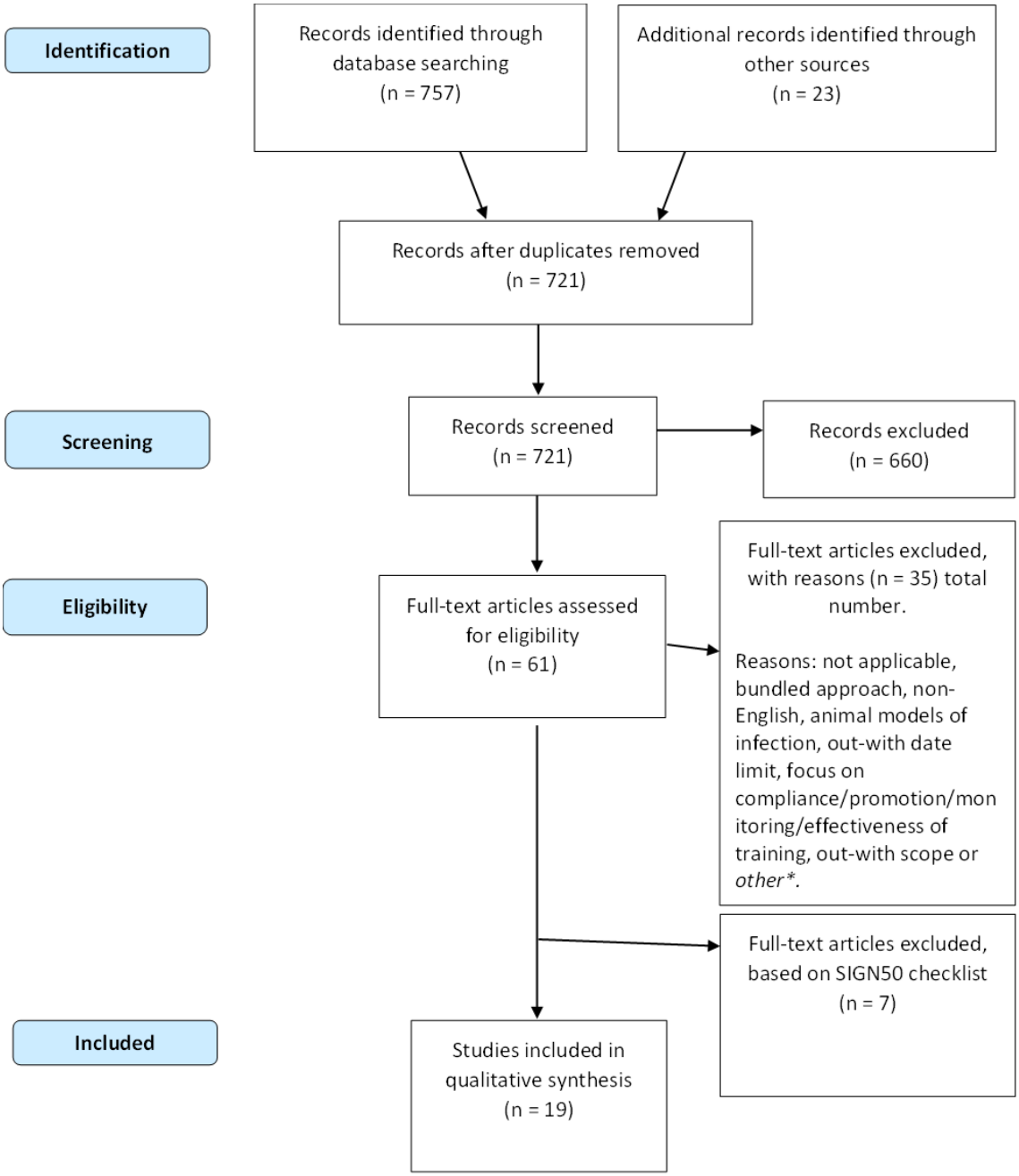
Appendix 1: Grades of recommendation

Grade	Descriptor	Levels of evidence
Mandatory	'Recommendations' that are directives from government policy, regulations or legislation	N/A
Category A	Based on high to moderate quality evidence	SIGN level 1++, 1+, 2++, 2+, AGREE strongly recommend
Category B	Based on low to moderate quality of evidence which suggest net clinical benefits over harm	SIGN level 2+, 3, 4, AGREE recommend
Category C	Expert opinion, these may be formed by the NIPC groups when there is no robust professional or scientific literature available to inform guidance.	SIGN level 4, or opinion of NIPC group
No recommendation	Insufficient evidence to recommend one way or another	N/A

Appendix 2: Prisma Flow Diagram

PRISMA Flow Diagram of the evidence identified during the three-year update between 1st June 2019 and 31st October 2022. For more details on the search strategy, see National Infection Prevention and Control Manual: Development Process.



Appendix 3: British Standards

Standard	Title	Description	Publication date
BS EN 1500:2013	Chemical disinfectants and antiseptics – Hygienic hand rub – Test method and requirements (phase 2, step 2)	This standard applies to products for hygienic hand rub for use in areas where disinfection is medically indicated. This standard suggests a method to ascertain whether a product for hygienic hand rub reduces transient microbial flora on hands. The method simulates practical conditions and requires volunteers with artificially contaminated hands.	May 2013
BS EN 12791:2016+ A1:2017	Chemical disinfectants and antiseptics – Surgical hand disinfection – Test method and requirements (phase 2, step 2)	This standard applies to products for surgical hand rub or handwash for use in areas where disinfection is medically indicated. This standard suggests a method to ascertain if a product for surgical hand rub / handwash reduces the release of resident and eventually present	September 2018

Standard	Title	Description	Publication date
		transient microbial flora on hands and wrists. The method simulates practical conditions and requires volunteers with clean hands.	
BS EN 13624:2013	Chemical disinfectants and antiseptics – Quantitative suspension test for the evaluation of fungicidal or yeasticidal activity in the medical area – Test method and requirements (phase 2, step 1)	This standard applies to products used in the medical area in areas where disinfection or antisepsis is medically indicated. This standard suggests a lab-based method and minimum requirements for fungicidal or yeasticidal activity of antiseptic products. Products must be tested at a concentration of ≤ 80% due to dilution factors within the lab testing method.	October 2013
BS EN 13727:2012+A2:2015	Chemical disinfectants and antiseptics – Quantitative suspension tests for the evaluation of bactericidal activity in the medical area –	This standard applies to products used in the medical area in areas where disinfection or antisepsis is medically indicated. This standard suggests a lab-based method and minimum requirements for	November 2015

Standard	Title	Description	Publication date
	Test method and requirements (phase 2, step 1)	bactericidal activity or antiseptic products. Products must be tested at a concentration of ≤ 80% due to dilution factors within the lab testing method.	

Appendix 4: Search Strategy

EMBASE and MEDLINE search 2000 to current

1. exp Hand Disinfection/
2. exp Hand Hygiene/
3. handwash$.mp.
4. (hand$ adj2 wash$).mp.
5. hand disinfection.mp.
6. hand hygiene.mp.
7. hand cleansing.mp.
8. hand saniti$.mp.
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10. exp Specialties, Surgical/
11. invasive procedure$.mp.
12. exp Operating Rooms/
13. operating theatre$.mp.
14. 10 or 11 or 12 or 13
15. surgical scrub$.mp.
16. (surg$ adj2 scrub$).mp.
17. jewelry.mp.
18. jewellery.mp.
19. technique$.mp.
20. method$.mp.
21. procedure$.mp.
22. dry$.mp.
23. (hygiene adj4 facilit$).mp.
24. exp Health Facility Environment/
25. 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24
26. 9 and 14 and 25

Limit 26 to English language

CINAHL 2000 to current

S29	S26 OR S27 (English language)
S28	S26 OR S27
S27	MH "Surgical Scrubbing"
S26	S8 AND S14 AND S24
S25	S8 AND S14 AND S24 149
S24	S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23
S23	MH "Health Facility Environment"
S22	(hygiene) N4 (facilit*)
S21	"dry*"
S20	"procedure*"
S19	"method*"
S18	"technique*"
S17	"jewellery"
S16	"jewelry"
S15	MH "Jewelry"
S14	S9 OR S10 OR S11 OR S12 OR S13
S13	"operating theatre*"
S12	MH "Operating Room Personnel+"
S11	MH "Operating Rooms"
S10	MH "Invasive Procedures+"
S9	MH "Specialties, Surgical+"
S8	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7
S7	"hand disinfection"
S6	"hand saniti*"
S5	"hand cleansing"
S4	(hand*) N2 (wash*)
S3	"handwash*"
S2	"hand hygiene"
S1	MH "Handwashing+"