ARHAI Scotland

Antimicrobial Resistance and Healthcare Associated Infection

NHS National Services Scotland

Standard Infection Control Precautions and Transmission Based Precautions Literature Review:

Safe Management of the Care Environment (Environmental Decontamination):

Version: 1.0

December 2020

DOCUMENT CONTROL SHEET

Key Information:		
Title:	Safe management of the care environment (environmental decontamination): Standard Infection Control Precautions and Transmission Based Precautions Literature Review	
Date Published/Issued:	December 2020	
Date Effective From:	December 2020	
Version/Issue Number:	1.0	
Document Type:	Literature Review	
Document status:	Final	
Review date:	Financial year 2023/2024	
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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
1.0	November 2020	SICPs Routine cleaning of the environment and TBPs Environment Decontamination reviews were amalgamated and updated using a double reviewer methodology. The question sets were reviewed and the following objectives added: • How are patient zones defined in regards to cleaning? • What is the definition of decontamination? • What is the definition of contact time in relation to cleaning of equipment and the environment?

Approvals

Version	Date Approved	Name
1.0	December 2020	NPGO Steering Group

ARHAI Scotland Document Information Grid	
Purpose:	To inform the Standard Infection Control Precautions (SICPs) and Transmission Based Precautions (TBPs) sections on the Safe Management of the Care Environment (Environmental Decontamination) in the National Infection Prevention and Control Manual in order to facilitate the prevention and control of healthcare associated infections in NHS Scotland health and care settings.
Target audience:	All health and care staff involved in the prevention and control of infection in Scotland.
Circulation list:	Infection Control Managers, Infection Prevention and Control Teams, Public Health Teams
Description:	This literature review examines the available professional literature on routine cleaning of the environment.
Update/review schedule:	Updated as new evidence emerges with changes made to recommendations as required.
Cross reference:	National Infection Prevention and Control Manual (NIPCM) http://www.nipcm.hps.scot.nhs.uk NIPCM Literature Review: Management of Blood and Body Fluid Spillages in health and care settings NIPCM Literature Review: Gloves NIPCM Literature Review: The safe disposal of waste NIPCM: SBAR: Use of gloves for environmental cleaning Health Protection Scotland: Decontamination technologies literature review: Microfibre Health Protection Scotland: Decontamination technologies literature review: Steam Health Protection Scotland: Decontamination technologies literature review: Wipes

Update level:	Practice – No significant change to practice Research – No significant change

Contents

1 Objectives

The aim of this review is to examine the extant professional literature regarding the safe management of the care environment (environmental decontamination) in the care setting to form evidence based recommendations for practice.

The specific objectives of the review in terms of Standard Infection Control Precautions (SICPs) are to determine:

- What is the risk of Healthcare Associated Infection (HAI) from the care environment?
- How are patient zones defined in regards to cleaning?
- What is the definition of decontamination?
- What is the definition of routine environmental cleaning?
- What is the definition of the care environment for the purpose of routine environmental cleaning?
- What methods (technique) are recommended for cleaning the care environment?
- What is the correct use of detergent in the decontamination of the care environment?
- What is the correct use of disinfectant in the decontamination of the care environment?
- What is the definition of contact time in relation to cleaning of the environment?
- What is the recommended frequency of routine cleaning for the care environment?
- How should cleaning equipment e.g. cloths and bucket be managed and stored?
- Who is responsible for ensuring the care environment is clean?
- How should contamination of the care environment be monitored?
- When should new technologies be used for routine environmental cleaning?

The specific objectives of the review in terms of Transmission Based Precautions (TBPs) are to determine:

- How should an isolation room/cohort area be decontaminated?
- When should an isolation room/cohort area be decontaminated?
- What is a terminal clean and why is it required?

- When should terminal cleaning be carried out?
- What additional steps are required for a terminal clean?

NB. The evaluation of new technologies used for environmental cleaning such as UV light, hydrogen peroxide vapour and continuous room decontamination technology (high-intensity narrow-spectrum light, persistent disinfectants, self-disinfection surfaces e.g. copper) is not within the scope of this review.

Recommendations relating to the safe management of environmental contamination with blood and body fluids are outline in the Safe Management of Blood and Body Fluid Spillages literature review.

2 Methodology

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

3 Discussion

3.1 Implications for practice: SICPs

What is the risk of healthcare associated infection (HAI) from the care environment?

The care environment is associated with transmission of HAI via contact (direct or indirect) with contaminated surfaces.[1] The pathogens associated with HAI include, but are not limited to, vancomycin-resistant enterococci (VRE), *Clostridioides difficile* (*C. diff*), methicillin-resistant *Staphylococcus aureus* (MRSA), *Acinetobacter*, and norovirus [1-3] which can persist in the environment and contaminate various surfaces in care settings.[3, 4] Within the care environment, sites close to the patient (the patient zone) and "frequently touched" surfaces have been identified as areas of increased contamination.[1, 2, 4-9]

Frequently touched surfaces include, but are not limited to, bed rails, bed surface, supply carts, overbed tables and intravenous pumps[7] as well as door handles, computer keyboards, bedside commodes, soap dispensers and taps[4] and light switches.[6, 10] It has been suggested that cleaning specifications do not sufficiently address frequently touched surfaces, and should focus more on these areas.[5, 6, 11]

Findings from studies suggest an association between HAI acquisition and exposure to infected/colonised roommates and/or prior room occupants.[4, 12, 13] One study reported that patients admitted to a post-acute care facility were more likely to acquire new VRE infections when residing in VRE-contaminated rooms versus non-contaminated rooms (odds ratio [OR] 3.75, 95%CI 1.98-7.11) and rooms were more likely to be contaminated with VRE when hosting patients colonised with VRE versus non-colonised patients (OR 3.99, 95%CI 2.23-7.16).[14] Additionally, a recent meta-analysis suggested an association between exposure to infected/colonised roommates (OR 2.69, 95%CI 1.61-4.49) and prior room occupants (OR 1.96, 95%CI 1.36-2.68) with an increased risk of HAIs with the same organism.[15] These prior room occupant/roommate studies are only able to demonstrate correlations between risk of HAI acquisition and exposure to infected/colonised roommates or prior room occupants; most studies lack molecular typing therefore it could not be determined whether the infectious agents from patients and their roommates or prior room occupants were genetically the same, thus causation cannot at present be proven.

The NHSScotland National Cleaning Services Specification (NCSS) patient accommodation categories refer to high-risk and very high-risk areas.[16] The areas within these categories are deemed high-risk or very high-risk settings as the patient is more vulnerable to infection.[16]

These categories are designed to inform the recommendations on the frequency and methods of cleaning, and to enable auditing.

High-risk in-patient areas include:

- Intensive care units, cardiac care units, renal, high dependency units, oncology, haematology, orthopaedics, cardiothoracic, neurosurgery, infectious disease units, A&E, admission units and neonatal and special care baby units.

Areas described as **very high-risk** include:

- Theatres, transplant and bone marrow units, day surgery.

An Audit Scotland report on hospital cleaning advises that any adjustment (increase) to the cleaning frequencies should be based on a formal risk assessment with reasons for variation documented.[17] The NHSScotland NCSS requires that all cleaning tasks outlined are subject to local risk assessments and provides risk assessment templates for each task.[16] Assessment of risk is based on infection risk versus public perception risk. Where higher risk is identified, deviation from recommendations is permitted.[16]

How are patient zones defined in regards to cleaning?

The World Health Organization (WHO) guidelines on hand hygiene in healthcare provide a definition of the environment immediately surrounding the patient, known as the 'patient zone'. The patient zone contains the patient and the patient's immediate surroundings.[18] This typically includes all inanimate surfaces that are touched by or in direct physical contact with the patient such as the bed rails, bedside table, bed linen, infusion tubing and other medical equipment" as well as "surfaces frequently touched by healthcare workers (HCWs) while caring for the patient such as monitors, knobs and buttons as well as other high frequency touch surfaces".[18]

What is the definition of decontamination?

Decontamination is a process which reduces, removes, inactivates, or destroys contamination to ensure that infectious agents or other contaminants cannot reach a susceptible site in sufficient quantities to cause infection or any other harmful response.[8, 19, 20] Decontamination have various levels and can involve cleaning, disinfection and/or sterilisation as required and according to the infection risk.[19]

What is the definition of routine environmental cleaning?

Cleaning is defined as a process which physically removes contamination from infectious agents and the organic matter on which they thrive but does not necessarily destroy infectious agents.[8, 19, 20] The reduction of microbial contamination depends upon many factors, including the effectiveness of the cleaning process and the initial bioburden. Cleaning is an essential prerequisite to ensure effective disinfection or sterilisation.[8, 19, 20] Routine cleaning is regular cleaning which is carried out on a scheduled basis, not on an ad hoc basis and not in response to an outbreak.[21]

What is the definition of the care environment for the purpose of routine environmental cleaning?

The NHSScotland National Cleaning Services Specification (NCSS) is intended to be followed wherever care is delivered in NHSScotland. The NHSScotland NCSS categorises all rooms and areas under an alphanumeric-coding system and these were split into Clinical and Non-Clinical due to high level of overlap.[16]

Clinical areas include e.g. ward bed area, single patient room, consult/treatment/clean utility room, dirty utility, day rooms/recreation, ward sanitary area, single room en-suite, ward pantry/kitchen (not production kitchen), ward store rooms, ward dining rooms, ward corridors, ward offices, Domestic Services Room (DSR), high risk in-patient, reception areas, staff sanitary facilities, staff changing rooms, therapy workshops i.e. plaster room/orthotics, waiting areas, Theatre/ICU/NICU/CCU/HDU/SCBU, laboratory/pharmacy including dispensary, aseptic wards, sterile services, isolation room, theatre lifts, ambulances and other patient transport vehicles.[16]

Non-clinical areas include e.g. offices, lecture rooms, corridors, stairs, lifts, fire escape stairs, staff rest room/pantry/kitchen, shops/banks, workshops, residential private areas (bedroom), public toilets/mother and baby rooms/residential bath/shower and WC, residential kitchen, on call rooms/relatives rooms, residential communal areas, cafeterias, sanctuary rooms, entrances to non-patient care area, foyers/public communal areas, DSR, waiting area.[16]

What methods (technique) are recommended for cleaning of the care environment?

The NHSScotland NCSS arranges routine environmental cleaning operations into a series of tasks to be carried out in particular patient accommodation categories; specific methods and minimum required frequencies are detailed for each task group.[16] Particular attention must be given to surfaces and areas that are frequently touched by patients and healthcare workers.[10, 16, 22]

Personal Protective Equipment (PPE) should be worn when carrying out environmental cleaning tasks as indicated in the NHSScotland NCSS.[16]

Single use-disposable gloves that meet the standard EN374-2 (and EN374-3 if exposure to chemical agents is anticipated) should be worn for environmental cleaning.[23] If household ('marigold'-type) gloves are worn for environmental cleaning these must be treated as single-use disposable items.[23] Single use gloves must never be decontaminated and re-used (see Standard Infection Control Precautions Literature Review: Personal Protective Equipment (PPE) Gloves and SBAR: Glove use for environmental cleaning).

Gloves should be changed:

- After each use.
- On completion of a task (e.g. when changing cloth to move on to next task)
- If a puncture is suspected or identified.
- After contact with cleaning chemicals that may compromise the integrity of the glove.

This review has also identified other general guidelines related to routine or daily cleaning of the environment close to the patient. Previous studies have shown that surfaces are regularly missed during cleaning[24, 25] therefore It is recommended to clean areas in a systematic way to establish a routine so that items or areas are not missed during the cleaning process.[26, 27]

Dancer[27] proposed a 4-step system for daily cleaning of an occupied bed space comprising of '(1) LOOK, (2) PLAN, (3) CLEAN and (4) DRY':

1. Look: visual inspection and assessment[26] of the area to be cleaned and consideration given to the overall conditions and degree of contamination paying attention to dirt, spillages and waste within the area.[27]
2. Plan: involves why and how the area needs to be prepared for cleaning. Hand hygiene should be performed and appropriate PPE should be worn prior to commencement of cleaning in accordance with local policy.[27]
3. Clean: involves the physical removal of dirt, smears, stains, grease and dust[4] achieved using detergents or combined detergent and disinfectant products according to local policy and following manufacturer's instructions regarding dilutions and contact time. Some general principles of cleaning include progressing from clean to dirty areas, from top to bottom areas, nearest to the patient first (e.g. bed head, locker, call button) then sites furthest from the patient (e.g. sink, bathroom), prioritising frequently touched areas, cleaning sites from least dirty to very dirty and floor cleaning as the last task.[26, 27]

4. Dry: encompasses time for physical drying of water and cleaning fluids (detergents and/or disinfectants) including contact time for disinfectants in accordance to manufacturer's instructions. Sanitary fixtures and fittings should be rinsed and dried after application of disinfectants.[16] The area should be assessed, cleaning equipment removed, waste disposed of appropriately including used PPE and hand hygiene should be performed.[27]

What is the correct use of detergent in the decontamination of the care environment?

A detergent is a cleaning agent that removes organic material, but does not have antimicrobial properties.[8] The NHSScotland NCSS states that a fresh solution of pH neutral detergent in hand hot water should be used for specific cleaning tasks.[16] The specific product used should be a local policy decision.

Cleaning solutions should be changed when dirty, at least every 15 minutes and prior to moving to a new location.[16] When using disposable cloths or paper towels the cloths or paper towels should be 'wrung' as dry as possible before application.[16]

Detergent wipes are currently in use within NHSScotland for general cleaning and it is advised that manufacturer's instructions are followed regarding their use including contact times. Where detergent wipes are used, an approach of one wipe, one surface and one direction is recommended. It is also recommended that surfaces are wiped more than once (using multiple wipes) to increase the removal of microbial contamination.[28]

Only cleaning products approved and supplied by the employer/healthcare facility or NHS National Procurement should be used. Cleaning products should be used in accordance with Control of Substances Hazardous to Health (COSHH) Regulations,[29] and manufacturer's instructions must be followed.[30]

What is the correct use of disinfectant in the decontamination of the care environment?

Disinfectants are chemical (or sometimes physical) agents that destroy pathogens or other harmful microorganisms but not necessarily all microbial forms (e.g. bacterial spores).[8] For disinfectants to be effective any organic material must first be removed by cleaning.[8]

The Centers for Disease Control and Prevention (CDC) recommends that disinfectants should be used routinely on sanitary fittings.[8] Sanitary fittings include toilets, sinks, basins, baths, taps and fixtures.[16] The importance of prior cleaning with detergent and rinsing and drying after application of the disinfectant/sanitiser is highlighted.[8] It is recommended that the product is used in accordance with local policy and following manufacturer's instructions.

The routine use of disinfectants is subject to debate, with some authors arguing for their routine use,[31] while others advocate the targeted use of disinfectants, for example only for cases of infection or for the environment of immunocompromised patients.[32] Routine, targeted use of disinfectant on high touch surfaces has been shown to reduce HAI rates in one study.[33] Other aspects of the debate centre on the potential for microorganisms to become resistant to disinfectants and the potentially hazardous nature of disinfectants to staff, patients and the environment.[34]

The National Patient Safety Agency (NPSA) Revised Healthcare Cleaning Manual (henceforth NPSA manual) does not recommend the use of dual function detergent/disinfectant products for routine cleaning, but recognises that they are in widespread use in UK healthcare premises, including being used for routine cleaning.[21] Centers for Disease Control and Prevention (CDC) guidelines acknowledge that the use of disinfectants in the routine cleaning of the patient (clinical) area of the hospital environment is controversial, but recommend using 'hospital' disinfectant for routine cleaning.[8] The CDC defines hospital disinfectant as disinfectant that has been registered for use by the Environmental Protection Agency (EPA). Note that this only applies in the USA. The epic3 guidelines do not recommend the routine use of disinfectants, except in the case of known or suspected infection and/or colonisation.[4]

See SICP Literature Review: Management of Blood and Body Fluid spillages for recommendations on the use of disinfectant in that context.

Only disinfectant products supplied by employers should be used. Cleaning products should be used in accordance with The Control of Substances Hazardous to Health (COSHH) Regulations,[29] and manufacturer's instructions should be followed.[21]

What is the definition of contact time in relation to cleaning of the environment?

Contact time is the specific length of time a disinfectant must remain in direct contact with microorganisms on the surface or item to be disinfected to achieve complete disinfection/inactivation. Contact times will be clearly stated by the manufacturer on the product label and generally range from 30 seconds to 10 minutes depending on the target microorganisms.[8, 35-37] As a general rule in healthcare, contact time refers to "wet contact time" i.e. length of time the disinfectant needs to stay wet on a surface in order to achieve claimed efficacy.[35] Indeed this definition is used by several studies[28, 35, 37-39] and a CDC guideline states that the period for surface disinfection is "framed by the application to the surface until complete drying has occurred".[8] A review by Health Protection Scotland on Existing and emerging technologies used for decontamination of the healthcare environment – Wipes recommended to

use enough wipes for disinfection to ensure that the surface remains visibly wet for the allocated contact time.[28] Additionally, the Environmental Protection Agency (EPA) requires surfaces to remain wet when evaluating the efficacy of wipes to disinfect *Clostridioides difficile (C. difficile)* spores and *Candida auris*.[35, 40]

Disinfectant wipes are being used with increasing frequency for surface disinfection in health and care settings due to their convenience;[40] but wipes may be too dry or have rapid drying time therefore it has been suggested to use enough wipes or reapply if necessary to ensure surface remains visibly wet during for the required contact time.[28] However, there is recent controversy with respect to wipes on whether or not surfaces need to stay wet for the duration of the label contact time or if they are effective if left "undisturbed" after the surface is no longer wet.[35, 36, 40, 41] A number of authors argue that the surface does not need to stay wet for the full contact time but should be allowed to remain "undisturbed" for the remainder of the time which is referred to as "treatment time".[36] Treatment time is the combination of wet time plus wiping as well as undisturbed time. It is also proposed that when applying disinfectant wipes, a wet time of at least 1 minute should be achieved to ensure disinfection.[3] An experimental study evaluating 6 disinfectant wipes demonstrated that bacterial efficacy remained unchanged after the product was dry on the surface or after label contact time was reached; no additional bactericidal effect was observed after a disinfectant dried indicating that there was no microbial reduction benefit for wet times beyond label contact time.[42] Until this controversy is settled, it is recommended that manufacturer instructions should be followed regarding contact times.[8, 28, 36, 37]

What is the recommended frequency for routine cleaning of the care environment?

The NHSScotland NCSS details the minimum required frequencies for the cleaning tasks in particular room types and patient accommodation categories.[16] Compliance with the cleaning frequencies outlined in the NHSScotland NCSS is a requirement of the NHSScotland Healthcare Improvement Scotland HAI standards (2015).[30]

The frequency of cleaning should reflect the risk of HAI. High risk areas, frequently touched surfaces and the near patient zone have been identified as providing a greater potential risk of HAI and it has been proposed that cleaning efforts should be reinforced in these areas.[6, 43, 44]

Recommended cleaning frequencies can be altered in response to local risk assessment. Deviation from the recommended frequency on the basis of risk assessment must be documented.[16]

During the ongoing COVID-19 pandemic, guidance specific for NHS Scotland from the National Infection Prevention and Control Manual's addendum for COVID-19 IPC for Acute Settings[45]

recommended that the cleaning frequency of the care environment should be increased to at least twice daily, focusing on frequently-touched areas. A minimum of 4 hours should have elapsed between the first daily clean and the second daily clean. Where a room has not been occupied by any staff or patients since the first daily clean was undertaken, a second daily clean is not required.[45]

How should cleaning equipment e.g. cloths and buckets, be managed and stored?

The NHSScotland NCSS[16] and Health Facilities Scotland (HFS)[46] recommend that the colour coding of reusable cleaning materials and equipment should follow the National Patient Safety Agency (PSA) Colour Coding Scheme.[47] This stipulates that cleaning items should be used exclusively in one area to reduce cross infection and that equipment should be coded to comply with the following recommendations:

Red: Bathrooms, washrooms, showers, toilets, basins and bathroom floors

Blue: General areas including wards, departments, offices and basins in public areas

Green: Catering departments, ward kitchen areas and patient food service at ward level

Yellow: Isolation areas[16, 46, 47]

All materials and equipment (re-useable and disposable) e.g. cloths including microfibre, mops, buckets, aprons and gloves should be colour coded and the method used to colour code items should be clear, permanent and in accordance with existing local practice.[46, 47]

Colour coding is not required for cleaning products such as detergents and disinfectants nor in main catering departments or catering equipment where there is a well-established procedure in place. Paper towels used as cloths do not require colour coding as long as their use is strictly controlled to single use.[46]

After use, disposable cleaning equipment should be dealt with in accordance with local waste management policy[21] (see SICP Literature Review: The safe management of waste).

Non-disposable cleaning equipment which is no longer fit for purpose should be disposed of in accordance with local waste management policy.[21]

The Domestic Service Room (DSR.) is used to deliver cleaning services for a defined area. Scottish Health Facilities Note (SHFN) 30 Part A states that cleaning materials and equipment in daily use should be stored in a fit for purpose, dedicated DSR with sufficient space and facilities to allow non-disposable cleaning equipment to be cleaned after use and for the disposal of cleaning solutions. Space should be provided for segregation of mops, buckets and

other cleaning equipment, vacuum cleaner and scrubbing/polishing machine (for hard floors) and for a lockable COSHH cupboard for cleaning supplies.[48] Detailed requirements are outlined in SHFN 30 Part A and detailed cleaning requirements for DSRs are outlined in the NHSScotland NCSS.[16]

Who is responsible for ensuring the care environment is clean?

HDL(2005)07 establishes that Senior Charge Nurses (SCNs) are responsible for ensuring safe working conditions within their clinical area, including all aspects of environmental cleanliness. This includes authority to require local cleaning services to act on any problems identified.[49]

Local cleaning specifications should outline the allocation of cleaning duties.[30] Staff should be clear on their specific responsibilities in line with the local cleaning specification and should be trained accordingly.[16]

The NPSA Manual for NHS England has generic advice on work schedules for domestic and nursing staff.[21] As a generalisation, domestic staff are responsible for the built environment and fixtures and fittings, and nursing staff are responsible for patient care equipment. The National Infection Prevention and Control Manual (NIPCM) emphasises that this is general advice, this division of responsibility for cleaning tasks is not absolute, and is subject to local policy.

How should contamination of the care environment be monitored?

NHSScotland Health Boards are audited on their compliance with the tasks outlined in the NHSScotland NCSS; with individual wards, facilities and Boards collecting statistics that are collated quarterly by Health Facilities Scotland (HFS). Guidance on the monitoring process is outlined in the National Facilities Monitoring Framework Manual[50] (SHFN 01-01, updated April 2020 (previously Monitoring Framework) for NHS Scotland NCSS. The Monitoring Framework Manual states that monitoring is the on-going assessment of the outcome of cleaning processes, and outlines a framework for assessment.[50] Visual inspection is the method advocated in the NHSScotland NCSS, and this is supported by the Monitoring Framework Manual, which requires observational assessment monitoring.[16, 50]

Visual inspections should be carried out as part of the physical monitoring of the care environment to identify damage to surfaces and accumulations of dust. Surfaces should be free from dust, soil, spots, film and sticky residue.[16, 50]

Visual inspection is the most commonly used method for evaluating and monitoring effectiveness of environmental cleaning and disinfection however it is a poor indicator of microbial contamination because of the subjective nature of assessing what is “clean” or “dirty”

and inspectors/assessors tend to emphasise areas such as floors and walls that have limited roles in HAI transmission.[3, 24, 25, 51]

Objective monitoring methods are available to monitor and provide feedback on cleaning and disinfection; they include fluorescent markers, adenosine triphosphate (ATP) bioluminescence and microbiological cultures.[3, 24, 25, 51, 52] Fluorescent markers, an invisible gel covertly applied to surfaces prior to cleaning, is removed with friction and absence of marker when shone with ultraviolet light indicates that a surface has been wiped.[25, 51] This method is used to provide immediate feedback on thoroughness of cleaning. ATP bioluminescence assay, which provides rapid assessment of cleaning effectiveness, is used to detect ATP on surfaces indicating presence of organic material (e.g. bacteria, human secretion/excretions, food) and is expressed in relative light units (RLU).[3, 25, 51] In microbiological culture method, environmental surfaces are sampled, grown in a medium and the resulting microorganisms expressed as colony forming units (CFU) are counted.[3, 25, 51]

However, each method has important limitations. Microbial culture method is costly, has limited utility as results are not available for 1 to 3 days therefore it cannot be used for real-time feedback and there is no accepted benchmark definition of “clean” in terms of CFU cut-off values.[3, 25, 51] Similarly, there is no established benchmark for ATP bioluminescence to indicate the surface is clean, benchmark varies considerably by assay brand and model and correlation between ATP levels and microbial contamination is inconsistent.[3, 4, 25, 51] Additionally, ATP readings are affected by presence of residual detergents or disinfectants such as sodium hypochlorite.[3, 25, 51] While fluorescent markers can assess thoroughness of cleaning and provide immediate feedback, it generally lacks specificity and are more likely to generate false positives than false negatives.[52] Staff may focus efforts on removal of near visible marks rather than improving cleaning practices.[25] A review by Health Protection Scotland on Monitoring the effectiveness of decontamination of the healthcare environment ATP Bioluminescence and Fluorescent Markers recommended that ATP bioluminescence and fluorescent marker monitoring systems can be used for the purpose of staff training and monitoring of the healthcare environment however there was insufficient evidence to support the use of either methods to infer microbiological cleanliness of a surface.[52]

When should new technologies be used for routine environmental cleaning?

There is some low level evidence indicating that microfibre cloths,[53-55] steam cleaners,[56] hydrogen peroxide vapour/fumigation/mist,[4, 21, 57] persistent disinfectants,[3, 58] and antimicrobial environmental surfaces (e.g. coating of metallic copper and/or its alloys)[3, 4, 54] decontaminate or

provide resistance against contamination but this does not prove that they are effective in the prevention and control of healthcare associated infection.

The use of microfibre systems is permitted by the NHSScotland NCSS.[16] The task definition/quality standards section gives the option of using a microfibre system for various aspects of cleaning as a decision to be made locally.[16] This is mirrored in the NPSA Manual which recommends that NHS organisations in England consider adoption of these technologies as part of a managed cleaning regimen.[21] For more information on microfibre, see Health Protection Scotland's Decontamination technologies literature review – Microfibre.

The situation with steam cleaning is similar. The NPSA recommend that it can be adopted as part of a managed cleaning regimen and suggest that correct use of the machines is at least as effective as conventional cleaning at removing soiling from surfaces and will be better than conventional cleaning at cleaning crevices and other difficult to reach surfaces.[21] In 2009, Scottish Government funding was made available to NHSScotland to support the purchase of steam cleaners for use on beds and curtains. The NPSA manual states that steam cleaning, in combination with microfibre cloths is effective against *C. difficile* and may take place in accordance with local requirements.[21] The NHS NCSS mentions that steam cleaners may be used for cleaning of surfaces, floors and patient care equipment in ambulances and patient transport vehicles if available however they are only to be used by staff who have received appropriate training[16] and should not be used on electrical appliances.[56]

However, some authors have argued that further research is needed before steam cleaning can be advocated for routine cleaning of the care environment[59] while a review by Health Protection Scotland on Decontamination technologies - Steam found insufficient and inconsistent evidence to support the use of steam decontamination for routine and terminal cleaning procedures in the healthcare environment.[56]

The CDC guidelines (USA) specifically recommend that hydrogen peroxide vapour fumigation (disinfectant fogging) is not used for routine cleaning in patient care areas.[8] The NPSA manual states that it may be appropriate against specific pathogens but that there is insufficient evidence for use in routine cleaning.[21]

The use of new technologies is discussed in the NPSA manual.[21] The general recommendation is that new technologies require a robust evidence base before introduction to routine cleaning in the care environment. The NPSA Manual highlights that, although new technologies may be effective, routine cleaning is also effective at reducing contamination, and re-contamination of the care environment will occur as the environment is used regardless of the effectiveness of the cleaning.[21] The NPSA Manual suggests that new technologies may have a role in outbreak

response or to remove a particular pathogens (MRSA or *C. difficile*) from the care environment and that this should only be considered in consultation with local infection prevention and control teams.[21] Any technologies that are adopted for routine cleaning of the care environment should be used in accordance with manufacturer's instructions, after risk assessment and appropriate training for users.[21]

3.2 Implications for practice: TBPs

How should an isolation room/cohort area be decontaminated?

The NHSScotland National Cleaning Services Specification (NCSS) outlines the tasks required for decontamination of an isolation room/cohort area and should be followed.[16] All domestic staff undertaking isolation/cohort cleaning should be instructed appropriately and supplied with sufficient and appropriate cleaning equipment to carry out tasks effectively. Appropriate PPE should be worn and local policies followed when disposing waste including used PPE into appropriate waste streams.[16]

The room should be decontaminated from the highest to the lowest point (e.g. curtain rails to floors) and from the least contaminated to the most contaminated (i.e. from infrequently touched surfaces to surfaces such as shower and toilet areas), changing cleaning equipment/solutions when they become soiled.[21]

When the environment is potentially contaminated with transmissible pathogens, disinfectants such as chlorine-releasing agents should be used.[4, 10, 16, 21, 22, 60-62] For disinfectants to work effectively, the surface being decontaminated must be free from organic soil and matter[8, 63], a neutral detergent solution should be used to clean the environment prior to disinfection or a combined detergent/disinfectant may be used.[21, 26]

There is substantial evidence to support the effectiveness of hypochlorite solutions at 1000ppm[2, 10, 64-68] or 5000ppm[62, 65, 68, 69] and sodium dichloroisocyanurate (NaDCC)[67, 70] for the disinfection of surfaces contaminated with norovirus or *C. difficile* It is recommended by epic3[4] and CDC[22] guidelines that chlorine-based disinfectants, such as sodium hypochlorite solution or sodium dichloroisocyanurate (NaDCC) solution at the manufacturer's recommended concentration of 1000 parts per million (ppm) available chlorine (av cl), are used for the disinfection of surfaces contaminated with norovirus or *C. difficile*.

Therefore, neutral detergent followed by a disinfectant containing 1000 ppm av cl (or a combined detergent/disinfectant (1000 ppm av cl)) should be used for decontamination of isolation rooms/cohort areas, including sanitary fittings (e.g. sinks).[8, 10, 21, 64]

Only cleaning products supplied by employers should be used and the solution should be prepared in accordance to manufacturer instructions and local policy.[16] Manufacturer instructions should be followed with regard to the preparation of disinfectants and contact time required for effective disinfection.

Cleaning products are covered by Control of Substances Hazardous to Health (COSHH) Regulations and are subject to risk assessment before use.[29]

Staff should ensure adequate ventilation is in place when using chlorine releasing agents during and after cleaning.[21]

Several studies indicate that domestics may miss or fail to adequately clean certain frequently touched objects in the patient environment such as door handles, toilet handles and light switches.[24, 25] This is thought to reflect a ritualistic rather than a risk based approach to cleaning. The risks of HAI resulting from inadequate cleaning have been widely discussed.[24, 71-73] It is important to ensure that environmental decontamination is thorough and includes all frequently touched surfaces to reduce the risk of acquiring infections from the environment.[22]

There is emerging evidence to support novel technologies as a supplement to the use of a chlorine-based disinfectant (e.g. hydrogen peroxide vapour (HPV) [74-79] and ultraviolet (UV) light[80-88]) or new disinfectant formulations (e.g. chlorine dioxide solution[89, 90] and peracetic acid[91, 92]). to replace the use of a standard chlorine-based disinfectant However, several practical and safety concerns are relevant to the use of novel disinfection methods, such as: the additional time required; a requirement for rooms to be cleaned with detergent prior to use of the technology; and, in the case of hazardous cleaning solutions, the necessity for rooms to be vacated before the decontamination process. Additionally, findings from a study suggest that in settings with low *C. difficile* infection (CDI) rates and high compliance in standard daily and discharge room disinfection protocols, the use of UV technology had no significant effect in CDI rates compared to manual cleaning alone.[93] Regarding novel technologies, further research is required to adequately assess their efficacy, cost, potential hazards, and user safety. In addition, a range of studies demonstrate that audit and feedback programmes using either fluorescent marker or ATP bioluminescence may be used to improve the effectiveness of terminal cleaning.[94-99] Any new products/technologies should be formally assessed (e.g. cost,

benefit, potential hazards and user safety) before they are adopted for application in NHSScotland (e.g. via the Health Innovation Procurement Portal or HAI Commodities Group).

HPV may be considered as an additional measure following disinfection of vacated isolation rooms for patients colonised or infected with multidrug-resistant organisms (e.g. carbapenemase-producing organisms) or high consequence pathogens (e.g. viral haemorrhagic fever), or where environmental contamination is contributing to an outbreak with ongoing transmission. HPV is not recommended for routine use.[74-79]

When should isolation room/cohort areas be decontaminated?

The NHSScotland NCSS outlines the frequency required for decontamination of isolation rooms in NHSScotland hospitals.[16] It mandates that decontamination should take place regularly (at least daily) and following patient discharge. Local Infection Prevention and Control Teams (IPCTs) will advise if increased cleaning frequencies are required, in relation to any aspect of environmental cleaning.[16]

Cleaning frequency should be increased at times of potentially high environmental and equipment contamination (e.g. HAI incidents/outbreaks of infection/colonisation) and should be particularly targeted at frequently touched surfaces e.g. bed rails, door handles toilets used by patients with gastrointestinal symptoms.[4, 22]

What is a terminal clean and why is it required?

Terminal cleaning is defined in the NHSScotland NCSS, which is applicable throughout Scotland wherever healthcare is delivered (i.e. NHS) and is considered good practice in private independent and voluntary sectors.[16]

A terminal clean is defined as: a procedure required to ensure that an area has been cleaned/decontaminated following transfer or discharge of a patient suspected or known to be infected or colonised with and infectious pathogen (i.e. alert organism or communicable disease) in order to ensure a safe environment for the next patient.[4, 16]

When should terminal cleaning be carried out?

The NHSScotland NCSS states that a terminal clean is required “following discharge of a patient with an infection (i.e. alert organism or communicable disease), in order to ensure a safe environment for the next patient”.[16]

What additional steps are required for a terminal clean?

The NHSScotland NCSS states that items such as patients' belongings, bed screens, curtains and bedding should be removed prior to the room being decontaminated.[16]

4 Implications for research

Much of the evidence base on the safe management of the environment in the care setting is composed of experimental microbiological investigations, the results of which may not be readily extrapolated; and reports of in response to outbreaks, where isolating the effect of cleaning is challenging, and is often based on expert opinion.

There remains a need for high quality primary studies on many aspects of the safe management of the care environment. Well designed primary research studies that can isolate the effect of routine cleaning on HAIs would be a valuable contribution to the evidence-base.

Despite the recognised difficulties associated with conducting such research, there is a need to research the routine use of disinfectants in cleaning of the care environment. The use of dual function detergent/disinfectant products should be considered alongside research on the use of detergents alone or detergents followed by disinfectants. This would address the reality of the clinical environment where these products are already in use.

The use of new technologies for routine cleaning of the healthcare environment is also an area where further research is required. These include the "no-touch" methods for room decontamination of which UV light and hydrogen peroxide systems (vapour, dry mist) are the most common. Further research is required to determine their efficacy, safety and other considerations e.g. cost and staff training.

Another area of research is the evaluation of alternative methods to visual inspection method for monitoring and assessing cleanliness of the healthcare environment. There is some evidence that alternative methods such as aerobic colony counts (ACC) and other microbiological evaluation, adenosine tri-phosphate (ATP) bioluminescence methodology and fluorescence are more accurate indicators of cleanliness than visual inspection. However, such methods require a standardised level of microbial contamination that correlates with acceptable cleaning performance, and this has yet to be established. There is scope for developing monitoring tools and standards to work in tandem with visual inspection.

5 Recommendations

5.1 Recommendations for standard infection control precautions (SICPs)

What is the risk of Healthcare Associated Infection (HAI) from the care environment?

The risk of HAI from the care environment is ever-present.

Within the clinical area of the care environment, sites close to the patient (the patient zone) and frequently touched surfaces have been identified as areas of increased contamination. Environmental cleaning should focus on these areas.
(Category B recommendation)

High risk and very high risk areas have been identified in the NHSScotland National Cleaning Services Specification. These are areas where the patient is particularly vulnerable to Healthcare Associated Infection (HAI).

Local risk assessments should identify increased risk of HAI and local cleaning schedules should be adapted accordingly. This must be documented.
(Mandatory)

How are the patient zones defined in regards to cleaning?

According to WHO guidelines, the patient zone contains the patient and the patient's immediate surroundings. This typically includes all inanimate surfaces that are touched by or in direct physical contact with the patient such as the bed rails, bedside table, bed linen, infusion tubing and other medical equipment" as well as "surfaces frequently touched by healthcare workers (HCWs) while caring for the patient such as monitors, knobs and buttons as well as other high frequency touch surfaces.
(Category B recommendation)

What is the definition of decontamination?

Decontamination is a process which reduces, removes, inactivates or destroys contamination to ensure that infectious agents or other contaminants cannot reach a susceptible site in sufficient quantities to cause infection or any other harmful response. Decontamination can involve cleaning, disinfection and/or sterilisation as required and according to the infection risk.
(Category B recommendation)

What is the definition of routine environmental cleaning?

Routine environmental cleaning is regular cleaning which is carried out on a scheduled basis, not on an ad hoc basis and not in response to an outbreak. The NHSScotland National Cleaning Services Specification details cleaning tasks to be carried out routinely in identified areas. Cleaning performance is audited against the NHSScotland National Cleaning Services Specification.
(Mandatory)

What is the definition of the care environment for the purpose of routine environmental cleaning?

The NHSScotland National Cleaning Services Specification categorises routine environmental cleaning operations into a series of tasks to be carried out in particular areas and broadly split into Clinical and Non-Clinical.

Clinical areas may include: In-patient Acute and Continuing Care e.g. wards, bed areas, continuing care, day room, clinical clean and dirty utility area, corridor, stairs, etc.

High risk and Very High risk areas e.g. A&E, transplant and bone marrow Units, day surgery, Theatres/ICU/NICU/CCU/HDU/SCBU, Oncology, Neurosurgery, Renal, Neonatal, etc.

Departments, Clinics and Health Centres e.g. treatment rooms, consulting rooms, utility rooms, Domestic Service Rooms, corridors, waiting areas, lifts, stairs, etc.

Non-Clinical areas may include: Departments e.g. offices, computer services, etc.

Residential Accommodation e.g. bedrooms, bed sitting rooms, private sitting rooms and offices, sanitary areas, utility areas, etc.
(Mandatory)

What methods (technique) are recommended for cleaning of the care environment?

The NHSScotland National Cleaning Services Specification outlines specific cleaning methods for each task group in each patient area in the care environment.
(Mandatory)

Personal Protective Equipment (PPE) should be worn for carrying out environmental cleaning tasks as indicated in the NHSScotland National Cleaning Services Specification.
(Mandatory)

Particular attention must be given to surfaces and areas that are frequently touched (high-touch) by patients and healthcare workers.
(Category B recommendation)

What is the correct use of detergent in the decontamination of the care environment?

A fresh solution of neutral pH detergent in hand hot water should be used for routine cleaning tasks. Cleaning solutions should be changed: when dirty; at least every 15 minutes; and prior to moving to a new location. Paper or disposable cloths should be wrung as dry as possible before use.
(Mandatory)

Where detergent wipes are used, it is advised that manufacturer's instructions are followed regarding their use including contact times. An approach of one wipe, one surface and one direction is recommended. Surfaces may be wiped more than once (using multiple wipes) to increase the removal of microbial contamination.
(Category C recommendation)

Only cleaning products supplied by employers should be used. Cleaning products should be used in accordance with Control of Substances Hazardous to Health (COSHH) Regulations and manufacturer's instructions.
(Mandatory)

What is the correct use of disinfectant in the decontamination of the care environment?

Disinfectants should be used routinely on all sanitary fittings. Sanitary fittings include toilets, sinks, basins, baths, taps and fixtures. Sanitary fittings should be cleaned with detergent prior to disinfection; alternatively, a combined detergent/disinfectant may be used. Sanitary fittings should be rinsed and dried after the application of disinfectant.

(Mandatory)

Only disinfectant products supplied by employers should be used. Disinfectant products should be used in accordance with Control of Substances Hazardous to Health (COSHH) Regulations and manufacturer's instructions.

(Mandatory)

Ensure adequate ventilation is in place when using chlorine releasing agents during and after cleaning.

(Category C recommendation)

What is the correct use of disinfectant in the decontamination of the care environment?

Disinfectants should be used routinely on all sanitary fittings. Sanitary fittings include toilets, sinks, basins, baths, taps and fixtures. Sanitary fittings should be cleaned with detergent prior to disinfection; alternatively, a combined detergent/disinfectant may be used. Sanitary fittings should be rinsed and dried after the application of disinfectant.

(Mandatory)

Only disinfectant products supplied by employers should be used. Disinfectant products should be used in accordance with Control of Substances Hazardous to Health (COSHH) Regulations and manufacturer's instructions.

(Mandatory)

Ensure adequate ventilation is in place when using chlorine releasing agents during and after cleaning.

(Category C recommendation)

What is the definition of contact time in relation to cleaning of the environment?

Contact time is the specific length of time a disinfectant must remain in direct contact with microorganisms on the surface or item to be disinfected to achieve complete disinfection/inactivation. The contact time of a disinfectant as stated by the manufacturer on the product label should be followed and may vary depending on the target microorganisms.
(Category B recommendation)

What is the recommended frequency for routine cleaning of the care environment?

The NHSScotland National Cleaning Services Specification outlines the minimum required frequencies for the cleaning tasks in particular areas and patient accommodation categories.
(Mandatory)

Sites of increased contamination such as high risk sites, frequently touched surfaces and the near patient zone require more frequent cleaning than other sites in the healthcare setting.
(Category B recommendation)

Recommended cleaning frequencies can be altered in response to local risk assessment. Deviation from the recommended frequency on the basis of risk assessment must be documented.
(Mandatory)

During the ongoing COVID-19 pandemic, cleaning frequency of the care environment should be increased to at least twice daily. A minimum of 4 hours should have elapsed between the first daily clean and the second daily clean. Where a room has not been occupied by any staff or patients since the first daily clean was undertaken, a second daily clean is not required.
(Mandatory)

How should cleaning equipment e.g. cloths and buckets be managed and stored?

Re-usable cleaning materials and equipment should be colour coded in accordance with the coding scheme outlined in the NHSScotland National Cleaning Services Specification. Cleaning equipment should only be used in the area indicated by the colour scheme. The colour scheme is:

Red: Bathrooms, washrooms, showers, toilets, basins and bathroom floors.

Blue: General areas including wards, departments, offices and basins in public areas

Green: Catering departments, ward kitchen areas and patient food service at ward level

Yellow: Isolation areas

Colour coding is not required for cleaning products such as detergents and disinfectants. Paper towels used as cloths do not require colour coding as long as their use is strictly controlled to single use.
(Mandatory)

Disposable cleaning equipment should be disposed of in accordance with local waste management policy. Non-disposable cleaning equipment which is no longer fit for purpose should be disposed of in accordance with local waste management policy.
(Category C recommendation)

Separate purpose built Domestic Services Rooms (DSRs) should be used for storage of cleaning equipment. These areas should have sufficient space and facilities to enable cleaning equipment to be thoroughly cleaned following use and for the disposal of cleaning solutions.
(Mandatory)

Who is responsible for ensuring the care environment is clean?

A named person or persons e.g. Charge Nurses should be responsible for ensuring safe working conditions within their clinical area. This includes all aspects of environmental cleanliness. Charge Nurses have the authority to require local cleaning services to act on any problems identified.
(Mandatory)

Staff groups must be aware of their local environmental cleaning schedules and be clear on their specific responsibilities and should be trained accordingly.
(Mandatory)

In general, cleaning staff are responsible for cleaning the built environment and fixtures and fittings, while nursing staff are responsible for cleaning patient care equipment. Note, this is division of cleaning responsibilities is not absolute, and is subject to local/organisational policy.
(Category C recommendation)

How should contamination of the care environment be monitored?

The NHS Scotland National Cleaning Services Specification states that cleanliness of the care environment should be monitored by visual inspection.
(Mandatory)

ATP bioluminescence and Fluorescent markers may be useful for training and monitoring purposes provided appropriate benchmarking and methodology is implemented prior to use.
(Category C recommendation)

When should new technologies be used for routine environmental cleaning?

The decision to adopt new technologies locally for routine environmental cleaning should be based on an assessment of the evidence for effectiveness.
(Category C recommendation)

Any technologies that are adopted for routine cleaning of the care environment should be used in accordance with manufacturer's instructions, after risk assessment and after appropriate training for users.
(Category C recommendation)

5.2 Recommendations for transmission based precautions (TBPs)

How should an isolation room/cohort area be decontaminated?

The NHSScotland National Cleaning Services Specification should be followed with respect to the decontamination of isolation rooms/cohort areas.
(Mandatory)

Isolation rooms/cohort areas should be decontaminated by starting from the highest to the lowest point, and from the least contaminated to the most contaminated, changing cleaning equipment/solutions when they become soiled.
(Category C recommendation)

Neutral detergent followed by a disinfectant containing 1000 parts per million (ppm) available chlorine (av cl) (or a combined detergent/disinfectant (1000 ppm av cl)) should be used for decontamination of isolation rooms/cohort areas, including sanitary fittings (e.g. sinks).
(Category B recommendation)

Hydrogen peroxide vapour may be considered as an additional measure following disinfection of vacated isolation rooms for patients colonised or infected with multidrug-resistant organisms (e.g. carbapenemase-producing organisms) or high consequence pathogens (e.g. Ebola virus), or where environmental contamination is contributing to an outbreak with ongoing transmission. Hydrogen peroxide vapour is not recommended for routine use.
(Category B recommendation)

When should an isolation room/cohort area be decontaminated?

The NHSScotland National Cleaning Services Specification should be followed with regard to cleaning frequency of isolation rooms within NHSScotland, i.e. at least once a day.
(Mandatory)

Cleaning frequency should be increased at times of potentially high environmental and equipment contamination (e.g. HAI incidents/outbreaks of infection/colonisation) and should be particularly targeted at frequently touched surfaces e.g. bed rails, door handles, toilets.
(Category B recommendation)

What is a terminal clean and why is it required?

A terminal clean is defined as a procedure required to ensure that an areas has been cleaned/decontaminated following discharge or transfer of a patient suspected or known to be infected or colonised with an infectious pathogen (i.e alert organism or communicable disease) in order to ensure a safe environment for the next patient.
(Mandatory)

When should terminal cleaning be carried out?

Terminal cleaning should be carried out after a patient with an infection/colonisation (i.e. alert organism or communicable disease) has been discharged or transferred in order to ensure a safe environment for the next patient.
(Mandatory)

What additional steps are required for a terminal clean?

The NHSScotland National Cleaning Services Specification should be followed with respect to terminal cleaning.

(Mandatory)

Patients belongings, bed screens, curtains and bedding should be removed prior to the room/area being decontaminated.

(Mandatory)

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Appendix 1: Grades of Recommendation

Final recommendations are given a grade to highlight the strength of evidence underpinning them, the NIPCM grades of recommendations are as follows:

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 NICP group
No recommendation	Insufficient evidence to recommend one way or another	N/A