

Summary of literature identified for the National Policy Guidance & Evidence (NPGE) and Infection Control in the Built Environment and Decontamination (ICBED) literature reviews literature reviews – July to September 2025

Titles and abstracts are reviewed for subject relevance. Additional exclusion criteria are also applied i.e. exclusion of laboratory focussed studies such as molecular typing etc.

Evidence Table – National Policy Guidance and Evidence (NPGE) - literature identified

Literature review	Papers identified	Summary of Findings and Impact on ARHAI Recommendations
Hand Hygiene: Surgical hand antisepsis in the clinical setting	Zhang T, Qin Q, Cao R, Lu R, Li D. Is sterility essential for hand-drying products in surgical hand antisepsis? A controlled before-and-after study. Am J Infect Control. Published online July 9, 2025. doi:10.1016/j.ajic.2025.07.002	This before-and-after controlled study compared bacterial cultures on hands after drying with different products (clean paper towels, sterile cloth towels, sterile paper towels) and using a rinse-free hand disinfectant. The study involved medical volunteers from a Second Affiliated Hospital of a Medical University. This study adds to the evidence base for the NIPCM Hand Hygiene: Surgical hand antisepsis in the clinical setting literature review research question “How should hands be dried after

Literature review	Papers identified	Summary of Findings and Impact on ARHAI Recommendations
		surgical hand antisepsis?”. The study provides evidence that all drying products evaluated (clean paper towels, sterile cloth towels and sterile paper towels) met the Chinese surgical hand antisepsis standard (WS/ T313-2019) of below 5 CFU/cm² on the hand surface after washing and drying. The study adds to the evidence base of the research question: “Which products are suitable for surgical hand antisepsis?”, by demonstrating that after using a rinse-free hand disinfectant (either a water-based product containing 0.20% ± 0.02% trichlorohydroxydiphenyl ether or a gel product containing chlorhexidine gluconate 1.0% ± 0.1% and ethanol 60.00% ± 6.00%), counts were 0.00 CFU/m² for all methods, with no significant difference. The study was sufficiently powered; however, it may not be fully applicable to Scottish health and care settings, for example, products used may not conform to British Standards. Furthermore, only one brand/type of paper towel and sterile paper towel was used, which may limit generalisability of the findings. No change to current recommendations.
Personal Protective Equipment (PPE): Gloves	Singh KV, Walia K, Farooque K, Mathur, P.	This systematic review and meta-analysis analysed outcomes relating to single versus double gloving, including use of indicator gloves. Meta-analysis of 18 randomised control studies performed between 1999 and 2023.

Literature review	Papers identified	Summary of Findings and Impact on ARHAI Recommendations
	Double gloving for self-protection in high-risk surgeries: a systematic review and meta-analysis Systematic Reviews. 2025; doi: 10.1186/s13643-025-02760-z.	Meta-analysis of four randomised control trials (RCTs) demonstrated that intraoperative detection of glove perforations was significantly higher when indicator double gloving was adopted versus single gloving (pooled odds ratio (OR) 8.64 [95% confidence interval (CI) 4.78 – 15.61, $p < 0.00001$). A significant association was not observed when comparing single gloving to double gloving without indicator gloves. These findings therefore provide evidence to suggest that double gloving using an indicator glove is more effective than double gloving using standard gloves. This study therefore adds to the evidence base for PPE: Gloves literature review research question “When should double gloving be adopted?”. No change to current recommendations.
SICPS – Safe Management of the Care Environment (Environmental Decontamination)	Norville P, Dangleben S and Hardy S. Biofilms and antimicrobial resistance in healthcare: evaluating chlorine dioxide as a candidate to protect patient safety. J Hosp Infect. 2025;162:121-126. doi: 10.1016/j.jhin.2025.04.034.	This experimental study applied European Standard and Minimum Biofilm Eradication Concentration tests to assess the efficacy of chlorine-based disinfectants against ‘clinically relevant’ multidrug-resistant organisms and biofilms. This study adds to the evidence base for the NIPCM Safe Management of the Care Environment (Environmental Decontamination) literature review. This paper adds to the research question “What is the correct use of disinfectant in the decontamination of the care environment?”, by demonstrating wide microbiological efficacy of chlorine dioxide products as disinfectants Biofilm preparations were immersed in liquid chlorine dioxide products for specified contact times, then

Literature review	Papers identified	Summary of Findings and Impact on ARHAI Recommendations
		neutralised, resulting in a sufficient log₁₀ reduction of a range of test organisms (Gram-negative and Gram-positive bacteria, and <i>Candidozyma auris</i>). No change to current recommendations.
Indications and Techniques for Hand Hygiene	Tano M, Kohta M, Yano Y, Sugama J. Reducing the frequency of hand hygiene to maintain skin integrity among nurses in the growing care unit: A pilot study. Fujita Medical Journal. 2025:2024-029.	This Japanese pilot before-and-after study assessed the residual microbial contamination and skin barrier impairment associated with two hand hygiene protocols in a 'growing care unit' - described in the study as 'level 2 neonatal intensive care units providing convalescent care after intensive care'. Under the current workflow, there would be six indications for hand hygiene, and this study trialled a modified workflow with fewer hand hygiene indications (four times). The main distinction being whether hand hygiene was performed before donning gloves and before removing gowns. Three female nurses participated in the study. There was no significant difference between the pre- and post-intervention rates of bacterial contamination at each time point of the day ($p = 0.99$). Similarly, there was no difference in skin impairment, measured by trans epidermal water loss (TEWL) and skin pH, at any time point between the two periods. This study therefore adds to the evidence base for the NIPCM Indications and Techniques for Hand Hygiene literature review research question: "When should hand hygiene be performed?".

Literature review	Papers identified	Summary of Findings and Impact on ARHAI Recommendations
		No change to current recommendations.

Evidence table – Healthcare Infection Incidents, Outbreaks and Data Exceedance - literature identified

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
Healthcare infection incidents and outbreaks in Scotland	Rathod SN, Barajas G, Mitchell BI, et al. Candida auris outbreak in a cardiothoracic transplant intensive care unit: implications for infection prevention practices and keeping pace with an evolving landscape. Infect Control Hosp Epidemiol. Published online June 23, 2025. doi:10.1017/ice.2025.10217	This study reports on an outbreak of <i>Candida auris</i> within a cardiothoracic transplant intensive care unit (CTICU) at an academic medical centre in the USA from July 2023 to February 2024. This study adds to the evidence base for the NIPCM Healthcare Infection Incidents and Outbreaks literature review research question “What is the definition of a healthcare infection incident/outbreak?”. An outbreak of <i>C. auris</i> is defined within this study as the finding of three or more patients with <i>C. auris</i> isolated from clinical or screening samples that are linked by time, space, and/or clinical care providers within one month. The study adds to the evidence base of the research question “How can healthcare infection incidents/outbreaks be recognised/detected?”. The study states that identification of a hospital onset case of <i>C. auris</i> (isolation of <i>C. auris</i> on day four of hospital admission or later) triggers a point prevalence survey (PPS) on the affected unit(s) – which is carried out weekly until no additional positive cases are identified. Patients previously positive for <i>C. auris</i> are not further screened. The study adds to the evidence base of the research question “How should healthcare infection incidents/ outbreaks be investigated and managed?”. The outbreak was investigated

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		using whole genome sequencing and single nucleotide polymorphism (WGS-SNP) analyses, WGS-SNP analysis revealed two distinct outbreak strain types. To manage the outbreak, <i>C. auris</i> cases were placed on 'contact plus' isolation precautions (gown and gloves donned in the room and the room is cleaned daily with a bleach-containing solution) once identified via surveillance or clinical sample. A bundle of IPC measures were implemented which included: including screening new admissions weekly; universal contact isolation precautions and centralised cleaning and disinfection of shared equipment in the CTICU; sampling of the environment for sources of transmission; and hand hygiene and personal protective equipment audits. The outbreak was declared as resolved after four consecutive weeks with no new identification of <i>C. auris</i> cases in the CTICU. Findings of this study should be interpreted with caution as a bundle of measures were applied to control the outbreak, therefore it was not possible to determine the effectiveness of any one measure in isolation. Furthermore, applicability to Scottish health and care settings may be limited. No change to current recommendations
Management of incidents and outbreaks in a	Minotti C, Robinson E, Schlaepfer P, et al.	This study retrospectively analysed blood and faecal samples collected during an outbreak of <i>Klebsiella oxytoca</i> in a Swiss neonatal intensive care unit (NICU).

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
neonatal unit (NNU)	Interpreting whole-genome sequencing data during neonatal <i>Klebsiella oxytoca</i> complex outbreak management. Antimicrob Resist Infect Control. 2025; 14(76). Doi:10.1186/s13756-025-01595-6.	83 of 152 isolates collected during the outbreak period November 2021 – June 2023 were analysed using WGS, which found that the outbreak occurred in two waves, November 2021 – February 2022, and July 2022 – June 2023. Sampling of the equipment and environment (including water sampling, sinks, incubators, shared equipment) and targeted screening of patients was introduced in response to the outbreak. Following identification of wildtype ST18 <i>K. oxytoca</i> from the bathtub syphon and water from the associated hose, additional targeted environmental sampling was performed, and the bath was replaced with a model that did not have a drain or overflow system. No additional cases were detected until July 2022, where WGS linked a set of twins to the previous wave. Case analysis confirmed that a patient that was hospitalised during the first wave remained hospitalised until June 2022, therefore was hypothesised to be the source of the second outbreak wave. Additional screening at birth and one week of life were subsequently introduced. Monitoring of hand hygiene was introduced in the summer of 2023; average hand hygiene compliance was 35% across 105 staff from August – December 2023. The outbreak ended in June 2023. A single-point prevalence survey performed in February 2024 identified <i>K. oxytoca</i> in four rectal swab samples, with strains not related to the outbreak.

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		This study adds to the evidence base the following research questions, “How should NNU incidents/outbreaks be investigated and managed?” as WGS was effectively used to investigate whether patient samples were related to the outbreak to aid in decision making relating to outbreak management. A bundle of IPC measures were applied to control the outbreak waves, therefore it was not possible to determine the effectiveness of any one measure in isolation. Additionally, it is unclear if the intervention relating to hand hygiene improved compliance. No change to current recommendations.

Evidence Table – Infection Control in the Built Environment and Decontamination (ICBED) - literature identified

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Jasuja, JK, Klupp, EM, Aepfelbacher, M et al. Hidden transmissions of <i>Pseudomonas aeruginosa</i> ST111 –the importance of continuous molecular surveillance. Antimicrob Resist Infect Control. 2025;14(99). doi: 10.1186/s13756-025-01619-1	This German outbreak report discusses a genetic and epidemiological investigation of eleven patient cases of carbapenemase-resistant <i>Pseudomonas aeruginosa</i> at a tertiary care hospital. This study adds to the evidence base for the NIPCM Infection Prevention and Control (IPC) for safe healthcare water systems literature review. This paper adds to the following research questions: “Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?”, and “What are the causes/sources of environmental contamination with healthcare water system-associated organisms?” as it provides genetic and epidemiological evidence of an association between clinical cases of VIM-producing <i>P. aeruginosa</i> and the wastewater system; specifically sinks within patient rooms and bedpan flushing devices. This paper also adds to the research question “What are the environmental testing requirements when investigating healthcare water system-associated outbreaks?” by evidencing that where water-associated clinical pathogens are implicated in infection, environmental sampling of sinks and rinse water within shared clinical spaces, followed by core

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		genome multi-locus sequence typing, can be successful in identifying environmental reservoirs. Limitations to this study include failure to screen all infected patients on admission and delayed environmental sampling in relation to first clinical cases, which reduced the comprehensiveness of findings. No change to current recommendations.
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Querin B, Danjean M, Jolivet S et al. Protracted outbreaks of VIM-producing <i>Pseudomonas aeruginosa</i> in a surgical intensive care unit in France, January 2018 to June 2024. Antimicrob Resist Infect Control. 2025;14(1):95. doi: 10.1186/s13756-025-01599-2	This study at a French surgical intensive care unit (SICU) investigated the incidence of Verona integron-encoded metallo-β-lactamase-producing <i>P. aeruginosa</i> (PA-VIM) via an outbreak investigation, and a matched case-control study of risk factors. This study adds to the evidence base for the NIPCM Infection Prevention and Control (IPC) for safe healthcare water systems literature review. This paper adds to the research questions “Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?” and “Which healthcare procedures present an increased risk of transmission of healthcare water system-associated organisms?” Case-control study findings demonstrated that enteral nutrition had a close to significant association ($p=0.05$), and placement of a nasogastric tube was significantly associated ($p=0.02$) with PA-VIM. Moreover, antifungal

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		administration ($p=0.02$) and duration ($p=0.03$) and antibiotic administration (0.01) were significant risk factors for PA-VIM. This paper also adds to the research questions “What are the environmental testing requirements when investigating healthcare water system-associated outbreaks?” and “What are the causes/sources of environmental contamination with healthcare water system-associated organisms?” by demonstrating that sinks can be considered a potential reservoir of infection and colonisation of the affected patients. Sink drains were sampled throughout, with the later addition of enteral nutrition equipment as per identified practice deficiencies. All sampling sites yielded PAV-VIM-positive results indicating that sink drains, sites associated with increased patient risk and/or sites associated with compliance issues may be appropriate to sample. Positive environmental samples from sinks were genetically related, and in some cases temporally related, to patient cases. Finally, this paper adds to the research question “Are there any recommended methods for the removal of healthcare water system contamination?” by indicating that replacement of contaminated sink drains may be an effective method to reduce PA-VIM contamination by PA-VIM, although may not prevent future recontamination. Intermittent PA-VIM-positive clinical and environmental samples were identified up to the study end date,

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		but following replacement of sink drains there was a nine-month period during which there were no new positive samples Limitations to this study included non-comprehensive sequencing of PA-VIM isolates and a change in sampling site and frequency. These factors may have prevented a more comprehensive assessment of sources, reservoirs and potential transmission routes. No change to current recommendations.
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Edman-Wallér J, Andersson J, Nelson M et al. A hospital-wide outbreak of extended-spectrum β-lactamase-producing <i>Klebsiella oxytoca</i> associated with contaminated sinks and associated plumbing: outbreak report, risk factor analysis and plasmid mapping. J Hosp Infect. 2025;162:1-8. doi: 10.1016/j.jhin.2025.05.002.	This Swedish outbreak report outlines risk analysis, genetic analysis and investigation of an extended-spectrum β-lactamase (ESBL) producing <i>Klebsiella oxytoca</i> outbreak at a secondary care hospital. This study adds to the evidence base for the NIPCM Infection Prevention and Control (IPC) for safe healthcare water systems literature review. This paper adds to the research question “Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?”. In addition, the paper adds to the research questions “What are the causes/sources of environmental contamination with healthcare water system-associated organisms?”, and “What are the environmental testing requirements when investigating healthcare water system-associated incidents/outbreaks?” Following the identification of clinical

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		cases, environmental contamination was identified within sink drains, pipes and a toilet bowl. The use of whole genome sequencing was used to further demonstrate that these sites were reservoirs of genetically similar strains of ESBL-producing <i>K. oxytoca</i> to clinical cases. Genetic similarity between ESBL-positive <i>K. oxytoca</i>-positive clinical isolates and environmental isolates from sinks and toilets is suggestive of a relationship between the healthcare water system and patient cases, but whether other sources or reservoirs existed was not explored further. Finally, this paper adds to the research question “Are there any recommended methods for the removal of healthcare water system contamination?”. A bundle of prevention measures were applied, which coincided with in a transient reduction in the number of clinical cases which was not sustained. Measures included: reinforcement correct sink use, urinary catheter care, cleaning and disinfection; replacement of sink strainers, traps, pipes and taps including those found to be contaminated; installation of splash-resistant taps and removable sink traps; and hot water flushing. Due to bundling, the efficacy of individual measures cannot be assessed. A key limitation of this study is that other potential reservoirs that may have contributed to this sustained outbreak were not explored. As a result, the source and transmission route of

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		ESBL-producing <i>K. oxytoca</i> in this outbreak cannot be determined. No change to current recommendations.
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Debast SB, van den Bos-Kromhout MI, de Vries-van Rossum SV et al. Aquatic reservoir-associated outbreaks of multi-drug-resistant bacteria: a hospital outbreak report of <i>Pseudomonas aeruginosa</i> in perspective from the Dutch national surveillance databases. J Hosp Infect. 2025;162:310-318. doi: 10.1016/j.jhin.2025.05.024.	This Dutch outbreak report outlines the investigation and control of a Verona integron-encoded metallo-β-lactamase type 2-producing carbapenem-resistant <i>Pseudomonas aeruginosa</i> (CRPA-VIM) outbreak of asymptomatic and infected patients in an intensive care unit (ICU). This study adds to the evidence base for the NIPCM Infection Prevention and Control (IPC) for safe healthcare water systems literature review. This paper adds to the following research questions: “Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?”, “What are the causes/sources of environmental contamination with healthcare water system-associated organisms?” and “What types of infection can healthcare water system-associated organisms cause?”. Within this outbreak, decolonisation and screening of admitted patients provided strong evidence that CRPA-VIM transmission resulted in urinary tract infections (n=2) and urosepsis (n=1) in patients following admission to the ICU. Moreover, findings of contact tracing, extensive environmental sampling, typing and successful

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		controls were highly suggestive that sinks were the source of patient infection and colonisation with CRPA-VIM in this setting. The paper adds to the research question “What actions can be undertaken to facilitate the earliest possible detection and preparedness for clinical cases of water-associated colonisation or infection?” by demonstrating that routine clinical surveillance may be beneficial for identifying some, but not all, patient cases of <i>P. aeruginosa</i> infection and colonisation. Clinical surveillance of patients – throat and rectal swabs, and urine and sputum sampling – was undertaken in line with national surveillance of carbapenemase-producing <i>P. aeruginosa</i> in the Netherlands. Prospective surveillance was successful in identifying the first positive isolate related to the outbreak in 2023, with earlier cases identified by retrospective review of national surveillance data. The paper adds to the research question “What are the environmental testing requirements when investigating healthcare water system-associated incidents/outbreaks?”. Environmental sampling conducted during the outbreak was successful in identifying intermittent contamination of sinks. Sink faucets, surroundings, inlets and their margins and syphons as well as neighbouring nursing trolleys were swabbed in the rooms of CRPA-VIM-positive patients. CRPA-VIM isolates obtained from these swabs were then compared to each other and clinical

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		samples by whole genome and core genome multi-locus sequence typing. Finally, the study adds to the research question “Are there any recommended methods for the removal of healthcare water system contamination?” by demonstrating that where there is extensive environmental contamination by waterborne organisms, complete removal of all water fixtures may be the best available measure to prevent further patient cases. Prior to this, extensive control measures throughout the course of the investigation failed to prevent intermittent detection of CRPA-VIM-positive environmental and clinical samples, indicating continued recontamination of the water system. Only after complete removal of all water fixtures were no further patient cases identified and was the outbreak declared over. A key limitation of this study is poor reporting of clinical sampling indications and timing during prospective surveillance. No change to current recommendations
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Petkar HM, Caseres-Chiuco I, Al-Shaddad A et al. Outbreak of <i>Pseudomonas aeruginosa</i> on a neonatal intensive care unit: Lessons from a Qatari setting. J Infect Prev. 2024;25(4):103-109.	This Qatari outbreak report describes the investigation and control of a <i>Pseudomonas aeruginosa</i> outbreak in a neonatal intensive care unit (NICU). This study adds to the evidence base for the NIPCM Infection Prevention and Control (IPC) for safe healthcare water systems literature review.

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
	doi: 10.1177/17571774241236248.	Firstly, this paper adds to the research questions: “Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?”, “What types of infection can healthcare water system-associated organisms cause?” and “What actions can be undertaken to facilitate the earliest possible detection and preparedness for clinical cases of water-associated colonisation or infection?”. <i>P. aeruginosa</i>-positive neonates involved in this outbreak were diagnosed with pneumonia (n=2) and bacteraemia (n=2). Active screening of neonates was successful at detecting data exceedance of <i>P. aeruginosa</i>-positive clinical samples within the TBU, triggering this outbreak investigation. In addition, this hospital undertook monthly sampling of tap water and annual <i>P. aeruginosa</i> culture, in line with NHS England’s 2021 publication of Health Technical Memorandum 04-01. The environmental sampling protocol was unsuccessful at detecting contamination of water prior to clinical cases. This study adds to the research question “What are the environmental testing requirements when investigating healthcare water system-associated incidents/outbreaks?” <i>P. aeruginosa</i> contamination was successfully identified during outbreak investigation, by the means of extensive environmental sampling. ‘Random’ swabbing of sinks taps, aerators, drains, medical equipment, cleaning products and the environment was conducted. In addition, this study adds to the research question “What are the water testing requirements during a water-

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		associated incident/outbreak?”. Sinks throughout the unit had tap water samples collected, including pre- and post-flush samples which were repeated upon positive results. Environmental and clinical isolates were compared by pulsed field gel electrophoresis (PFGE) to infer relatedness, and pre-flush samples were later used to infer efficacy of tap disinfection during outbreak control. This study also adds to the research question “What are the causes/sources of environmental contamination with healthcare water system-associated organisms?”, No environmental isolates were found to be identical to clinical samples from cases. Authors defined the outbreak as polyclonal, with shared clonal origins of <i>P. aeruginosa</i> isolates. Notably, there was 92% homology between a clinical isolate and a tap water isolate from the milk preparation room sink. In addition, audits demonstrated deficiencies in practice during the outbreak period, many of which were water systems-associated practices. These findings combined indicate that the water system may have acted as a reservoir of <i>P. aeruginosa</i>. The study also adds to the research question “How and by whom should water-associated incidents be investigated?”, by reporting the formation and specialities of the multidisciplinary outbreak investigation team. Authors also reported additional staff members and teams to which findings were regularly communicated via scheduled meetings, reports and emails.

Literature review	Papers identified	Summary of scientific findings and Impact on ARHAI Recommendations
		Finally, this study adds to the research question “Are there any recommended methods for the removal of healthcare water system contamination?”. A bundle of prevention measures were implemented, which included hand hygiene, dismantling and disinfection of taps, increased frequency of cleaning, and repeated audits to ensure correction of practice deficiencies. Control efforts were seemingly effective as the outbreak was inevitably closed following a month without emergence new cases. The efficacy of individual control measures cannot be assessed. Limitations of this study include the poor reporting of water sample processing. Moreover, findings on relatedness of environmental and clinical samples were explored via PFGE, which has less discriminatory power than whole genome sequencing. No change to current recommendations.