Summary of literature identified for the National Policy Guidance and Evidence (NPGE) and Infection Control in the Built Environment and Decontamination (ICBED) literature reviews – October to December 2024

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 reviews

Literature review	Papers identified	Summary of Research and Impact on NIPCM Recommendations
SICPs and TBPs – Surgical Masks	Fan Y, Nishimura H, Sakata S et al. Minimal influenza virus transmission from touching contaminated face masks: a laboratory study.	This Japanese laboratory study aimed to determine transfer of live influenza virus and influenza viral RNA from contaminated surgical masks to human fingers after swiping the mask surface. This study adds to the evidence base for the NIPCM Surgical Masks literature review recommendations "**When should surgical masks be removed/changed?**" and "**How should surgical masks be removed?**". The study provides evidence that swiping influenza-contaminated masks does not

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	Sci Rep. 2024; 14: 20211.	contaminate fingers with viable virus or its RNA regardless of virus particle size or environmental conditions. However, findings should be interpreted with caution as the study may not represent real life scenarios. Notably, contact of hands with the surface of contaminated surgical masks in practice is likely to occur in a different and less controlled manner than in an experimental setting. No change to current recommendations.
SICPs and TBPs – Surgical Masks	Zhang C, Nielsen PV, Liu L et al. The source control effect of personal protection equipment and physical barrier on short-range airborne transmission. Build Environ. 2022; 1(211): 108751.	This simulation study aimed to determine the efficacy of different PPE items, including surgical masks, at source control of carbon dioxide “tracer gas” from a source to a target manikin. Control simulations were carried out, whereby the source manikin wore no PPE. This study adds to the evidence base for the NIPCM Surgical Masks literature review recommendations “**When should health care workers wear a surgical mask for SICPs?**” and “**When should patients wear a surgical mask for SICPs?**” by evidencing that the index of “tracer gas” exposure by the target manikin was reduced when the source manikin was wearing a surgical mask when compared to controls. However, findings cannot be relied upon as the study may not represent real life scenarios and did not compare outcomes statistically. Moreover, carbon dioxide “tracer gas” particle dimensions may not be comparable to all, or possibly any, airborne pathogens in a healthcare setting.

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		No change to current recommendations.
SICPs and TBPs – Surgical Masks	Park SY, Kim MC, Kim JY et al. Impacts of indoor masks wearing on air contamination during 10-minute speaking in patients with SARS-CoV-2 omicron variant infection. Infect Control Hosp Epidemiol. 2024; 14: 1-3.	This Korean laboratory study at a community treatment centre aimed to determine whether different mask types were effective as source control when worn by individuals with COVID-19 talking for 10 minutes in a space with "inadequate" ventilation. COVID-19-positive participants who had become symptomatic within 6 days spoke defined wording while wearing N95 respirators, surgical masks or no masks. Samples of inner and outer surfaces of masks, settle plates and the air were tested for COVID-19 contamination. This study adds to the evidence base for the NIPCM Surgical Masks literature review recommendations "**When should patients wear a surgical mask for TBPs?**" by providing evidence that N95 respirator or surgical mask use by COVID-19 infected patients for source control is important in preventing COVID-19 transmission via the air in poorly ventilated spaces. However, findings should be interpreted with caution as authors did not statistically compare patient characteristics between study groups, air contamination was confounded by viral load (p=0.08), and treatment centre rooms were not representative of healthcare rooms. No change to current recommendations.
SICPs - PPE - Headwear	Gumera A, Mil M, Fanshaw SR et al.	This systematic review with meta-analysis aimed to determine if surgical site infection (SSI) incidence differed significantly between studies where reusable or disposable surgical headwear was worn by operating theatre staff performing

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	Reusable surgical headwear has a reduced carbon footprint and matches disposables regarding surgical site infection: a systematic review and meta-analysis. Journal of Hospital Infection. 2024; 152: 164-172.	surgeries. Another focus of the review was environmental sustainability of headwear options. This study adds to the evidence base for the NIPCM Headwear literature review recommendations "**What type(s) of headwear should be used?**". The meta-analysis found no significant difference (p=0.13) in SSI rates between the use of reusable and disposable surgical headwear across those studies directly comparing headwear types. Findings should be interpreted with caution due to the small number of studies evaluated through meta-analysis, particularly with regards to the influence of headwear types (n=2). The authors found moderate but insignificant heterogeneity in this sample, and publication bias assessment could not be completed. No change to current recommendations.
Hand Hygiene Indications and Techniques	Chen N, Li Y, He W, et al. Clinical Effectiveness of a 3-Step Versus a 6-Step Hand Hygiene Technique: A Randomized Controlled Cross-over Study.	Randomised crossover trial carried out university hospital in Wuhan, China. This study compared the application of a 6-step (as per WHO guidance) and a modified 3-step hand hygiene technique with alcohol-based hand rub (ABHR). Two-hundred and forty HCWs were randomly allocated into the 3-step intervention and the 6-step control group, followed by a 2-week washout period, and groups swapped over. This study adds to the evidence base for the NIPCM Hand Hygiene Indications and Techniques literature review within the research question "**What is the**

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	Open Forum Infectious Diseases. 2024; 11(10) doi:10.1093/ofid/ofae534	**correct process and technique when using hand rub, hand wipe and alternative products to ensure effective hand hygiene?**". The study demonstrated that the 3-step and 6-step techniques were both effective at microbial reduction of HCW hands; the average reduction factor for bacterial colony-forming unit (CFU) counts did not differ and the CFU counts were not significantly different ($p>0.05$). The 3-step technique had significantly higher compliance rates amongst HCWs compared to the 6-steps. However, findings must be interpreted with caution as this study was conducted in China so may have limited generalisability. No change to current recommendations.

Evidence table: Healthcare Infection Incidents, Outbreaks and Data Exceedance literature reviews

Literature review	Papers identified	Summary of Research and Impact on ARHAI Recommendations
Healthcare Infection Incidents and Outbreaks	Kelemen J, Sztermen M, Dakos EK, et al. Complex Infection-Control Measures with Disinfectant Switch Help the Successful Early Control of Carbapenem-Resistant *Acinetobacter baumannii* Outbreak in Intensive Care Unit. Antibiotics. 2024; 13(9):869. doi:10.3390/antibiotics13090869	This retrospective cohort study reports on the investigation and control of a carbapenem-resistant *Acinetobacter baumannii* outbreak in a neurosurgical intensive care unit of a Hungarian university hospital. This study adds to the evidence base for the NIPCM Healthcare Infection Incidents and Outbreaks literature review within the research question **"How should healthcare infection incidents/outbreaks be investigated and managed?"**. The study detailed methods for outbreak investigation involving epidemiological and environmental investigations. Furthermore, whole genome sequencing analysis allowed for the identification of the clone responsible for the outbreak which was found to have genes present that conferred resistance to quaternary ammonium compounds (QACs) disinfectants. Along with enhanced infection control measures, including a switch to alcohol-based disinfectants, no further cases were identified. However, the findings of this study must be interpreted with caution as bundled measures were applied to control the outbreak and applicability to Scottish health and care settings may be limited.

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		Furthermore, healthcare workers were not screened and the relatively small sample size precluded statistical analysis on patient risk factors. No change to current recommendations.
Healthcare Infection Incidents and Outbreaks	Mhango M, Sheehan F, Marmor A, et al. An outbreak of double carbapenemase-producing *Klebsiella pneumoniae*, harbouring NDM-5 and OXA-48 genes, at a tertiary hospital in Canberra, Australia Commun Dis Intell (2018). 2024; 48:10.33321/cdi.2024.48.50. doi:10.33321/cdi.2024.48.50	This descriptive outbreak study reports on the investigation and control of a carbapenemase-producing *Klebsiella pneumoniae* outbreak in a tertiary hospital in Australia. This study adds to the evidence base for the NIPCM Healthcare Infection Incidents and Outbreaks literature review within the research question **"How should healthcare infection incidents/outbreaks be investigated and managed?"**. The study detailed methods for outbreak investigation involving epidemiological and environmental investigations, microbiological analyses, whole genome sequencing (WGS) demonstrating high relatedness of patient isolates, and enhanced infection control measures to stop the outbreak. However, the findings of this study must be interpreted with caution as bundled measures were applied to control the outbreak and applicability to Scottish health and care settings may be limited. Despite isolate matching by WGS, the transmission route was not proven due to a lack of healthcare worker screening and limited environmental sampling. No change to current recommendations.

Literature review	Papers identified	Summary of Research and Impact on ARHAI Recommendations
Healthcare Infection Incidents and Outbreaks	Jiang YL, Lyu YY, Liu LL, et al. Carbapenem-resistant *Klebsiella oxytoca* transmission linked to preoperative shaving in emergency neurosurgery, tracked by rapid detection via chromogenic medium and whole genome sequencing. Front. Cell. Infect. Microbiol. 2024; 14:1464411. doi: 10.3389/fcimb.2024.1464411	This descriptive outbreak study reports on the investigation and control of a carbapenem-resistant *Klebsiella oxytoca* (CRKO) outbreak in a neurosurgical intensive care unit of a tertiary hospital in China. This study adds to the evidence base for the NIPCM Healthcare Infection Incidents and Outbreaks literature review within the research question **"How should healthcare infection incidents/outbreaks be investigated and managed?"**. The study detailed methods for outbreak investigation involving epidemiological and environmental investigation, active surveillance sampling of patients and healthcare workers, whole genome sequencing for isolate matching of patient and preoperative shaving razors samples, and enhanced infection control measures were used to stop the outbreak. However, the findings of this study must be interpreted with caution as bundled measures were applied to control the outbreak and applicability to Scottish health and care settings may be limited. No change to current recommendations.
Management of incidents and Outbreaks in neonatal units	Shaik Ismail B, Toh Hui X, Seah Jia H, et al. *Serratia marcescens* outbreak at a neonatal intensive care unit in an	This study investigates an outbreak of *Serratia marcescens* in five neonates within a NICU in Singapore from 17 March 2022 to 20 July 2022 causing conjunctivitis and pneumonia. This study adds to the evidence base for the NIPCM Management of Incidents and Outbreaks in neonatal units literature review within the

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	acute care tertiary hospital in Singapore. J Hosp Infect. Published online October 22, 2024. doi:10.1016/j.jhin.2024.10.002	research question "**How should NNU incidents/outbreaks be investigated and managed?**" The study describes enhanced screening procedures for environment, patient group and contacts; whole genome sequencing (WGS); enhanced infection control measures; isolation of cases; cohorting staff and replacement of equipment. However, no conclusive source for the outbreak was found. Its successful management was thought to be as a result of the outbreak management practices put into practice. Care should be taken when interpreting these findings as the sample size of this study is small and staff screening was not undertaken. In addition the findings of this study have limited applicability to Scottish health and care settings. No change to current recommendations.
Management of incidents and Outbreaks in neonatal units	Guo Q, Zhao X, Ma J, et al. *Serratia marcescens* outbreak in a neonatal intensive care unit associated with contaminated handwashing sinks. Indian J Med Microbiol. Published online October 15, 2024. doi:10.1016/j.ijmmb.2024.100741	This case-control study describes an outbreak of *Serratia marcescens* in a NICU in China, resulting in 12 neonates testing *Serratia marcescens* positive. Three significant risk factors were investigated as possible sources: proximity of handwashing sink to patient bed unit (<0.8m), large number of rotating nurses within a week, and use of humidification water in the incubator. This study adds to the evidence base for the NIPCM Management of Incidents and Outbreaks in neonatal units literature review within the research question **"How should NNU incidents/outbreaks be**

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		investigated and managed?" The study carried out repeated environmental and patient screening as well as WGS and the construction of phylogenetic trees. In addition, a retrospective case-control analysis was performed to identify potential risk factors; three factors were found to be significant following multivariable logistic regression analysis. The results of this study should be interpreted with caution as a definitive source was not determined. Other possible sources of *S. marcescens* were not followed up and the three risk factors were merely hypothesised to be sources. Applicability to Scottish health and care settings may be limited. No change to current recommendations.

Evidence Table: Infection Control in the Built Environment and Decontamination (ICBED) literature reviews

Literature review	Papers identified	Summary of Research and Impact on NIPCM Recommendations
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Moretti M, Vanstokstraeten R, Crombé F, et al. Five-year VIM-producing Pseudomonas aeruginosa outbreak in four Belgian ICUs, an investigation report (2019-2023). Am J Infect Control. 2024;52(12):1425-1431. doi:10.1016/j.ajic.2024.08.022	This outbreak study investigates a verona integron-encoded metallo-β-lactamase-producing *Pseudomonas aeruginosa* (VIM-PA) outbreak across four ICUs in a Belgian university centre. This outbreak was sustained across five years and caused by 2 VIM-PA clones, both of which were linked to sink drains. This paper 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 within the review: • **"Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?"** By identifying VIM-PA cases that were associated with sink drains from WGS. Only four samples were taken from the drains during the outbreak, nevertheless this paper demonstrates a risk of transmission from environmental sources. • **"What are the causes/sources of environmental contamination with healthcare water system-associated organisms?"** By showing that VIM-PA was present within sink

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		drain samples and, through WGS, linked to VIM-PA patient isolates throughout the outbreak this study identified sink drains as a reservoir and source of ongoing transmission. Due to the bundled nature of outbreak studies any conclusions drawn regarding the risk of infection cannot be fully relied upon. This study did not prove direction of transmission between the sink drain samples and patient isolates and therefore caution must be taken when interpreting the results. No change to current recommendations.
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Kim UJ, Choi SM, Kim MJ, et al. Hospital water environment and antibiotic use: key factors in a nosocomial outbreak of carbapenemase-producing *Serratia marcescens.* J Hosp Infect. 2024;151:69-78. doi:10.1016/j.jhin.2024.04.021	This outbreak investigation spans two years affecting a total of 30 patients over two ICUs of a tertiary hospital in South Korea. *Klebsiella pneumoniae* carbapenemase-producing *Serratia marcescens* (KPC-SM) was identified in a sink, dirty utility room, a communal bathroom and the waste bucket of a continuous renal-replacement therapy system (CRRT); its genetic similarity to patient isolates was confirmed through pulsed-field gel electrophoresis (PFGE). A retrospective review found a significant link between KPC-SM patient isolates and the use of CRRT and antibiotics (*P<0.05)*. This paper adds to the evidence base for the NIPCM Infection prevention and control (IPC) for safe healthcare water systems

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		literature review. This paper adds to the following research questions within the review: • **"Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?"** By identifying a genetic link between the strain of KPC-SM present in the healthcare water environment with the strains isolated from the affected patients through PFGE. • **"What are the causes/sources of environmental contamination with healthcare water system-associated organisms?"** By demonstrating that carbapenem-resistant Enterobacterales (CRE) were present in hospital water environments such as sinks, CRRT systems and wastewater sinks. This study describes contamination of these water environments, for example through the misuse of handwashing sinks by using them to dispose of wastewater therefore allowing biofilm-producing Enterobacterales to form reservoirs. • **"Which healthcare procedures present an increased risk of transmission of healthcare water system-associated organisms?"** This study demonstrated an association between a history of CRRT and a higher chance of contracting KPC-SM. The study hypothesised that inadequate CRRT management

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		and using a shared wastewater sink caused cross-contamination across the two ICUs and therefore contamination with KPC-SM. Implementation of a CRRT waste bag management protocol resulted in the end of the outbreak. However, staff also separated the dirty utility rooms for the ICUs so termination of the outbreak cannot be attributed solely to the introduction of the protocol. There were several limitations to this outbreak investigation. A bundled approach was implemented so effects of individual interventions cannot be assessed. Whole genome sequencing was not carried out which would have clarified the evolution of CPE and staff screening was not undertaken so transmission between healthcare workers cannot be ruled out. No change to current recommendations.
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Vazquez Deida AA, Spicer KB, McNamara KX, et al. *Burkholderia multivorans* Infections Associated with Use of Ice and Water from Ice Machines for Patient Care Activities - Four Hospitals,	This outbreak study identified a further 23 cases of *B. multivorans* ST659 between 2020 and 2024 across three hospital sites in California (15 cases) and Colorado (8 cases). *B. multivorans* was isolated from ice machines used within the hospitals and found to be highly genetically similar to patient isolates, as tested with WGS. This paper adds to the evidence base for the NIPCM Infection prevention and control (IPC) for safe healthcare water systems

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	California and Colorado, 2020-2024. MMWR Morb Mortal Wkly Rep. 2024;73(39):883-887. Published 2024 Oct 3. doi:10.15585/mmwr.mm7339a4	literature review. This paper adds to the following research questions within the review: • **"Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?"** By providing evidence of WGS identifying the same sequence type of *B. multivorans* present in patient and environmental isolates. • **"What are the causes/sources of environmental contamination with healthcare water system-associated organisms?"** Ice machines were found to be contaminated with *B. multivorans*. The source of this contamination was not investigated however the same sequence type *B. multivorans* was previously isolated from ice machines of the same manufacturer within two other southern Californian hospitals, both of which experienced outbreaks in *B. multivorans* spanning a similar time period as the outbreaks investigated in this paper. • **"What actions can be undertaken to reduce the risk of infection/colonisation associated with direct water usage?"** The study concluded that tertiary hospitals should consider avoiding using tap water, including water and ice available from

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		ice machines, during healthcare outbreaks of water-related organisms. Although the ice machines were confirmed to be a reservoir of *B. multivorans* it was only hypothesised that this was how the patients became colonised with the bacteria as no clinical exposure to the tap water and ice were documented in the patients medical records. Due to the previous outbreaks of this same bacteria in other Californian hospitals an assumption was made that the source would also be the ice machines, therefore no additional environmental or staff sampling was undertaken. No change to current recommendation.
Infection Prevention and Control (IPC) for Safe Healthcare Water Systems	Wei L, Feng Y, Lin J, et al. Handwashing sinks as reservoirs of carbapenem-resistant *Acinetobacter baumannii* in the intensive care unit: a prospective multicenter study. Front Public Health. 2024;12:1468521. Published 2024 Oct 9. doi:10.3389/fpubh.2024.1468521	This prospective study investigated carbapenem-resistant *Acinetobacter baumannii* (CRAB) infection of two patients in an ICU in China. Whole genome sequencing (WGS) identified a handwashing sink as the source of CRKP colonisation in both patients, direct transmission of a common clone between the patients did not occur. This paper 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 within the review:

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		• **"Which organisms associated with healthcare water systems are responsible for colonisation/infection of patients?"** By identifying the same sequence type CRAB colonisation in patients as in handwashing sinks present in the ICU through routine admission screening and further investigation by WGS. • **"What are the causes/sources of environmental contamination with healthcare water system-associated organisms?"** A reservoir of CRAB was found to be the handwashing sinks present in the ICU. However, further environmental or staff sampling was not undertaken so it is possible that greater number of reservoirs not discussed existed within the ICU environment. Within this study there was a very small sample size experiencing CRAB colonisation, and only one patient exhibited symptomatic CRAB infection. Whilst patients had undergone routine admission sampling for CRAB there was no routine sampling of sinks prior to the study and no samples were taken from the P traps of sinks so other sinks with contamination of CRAB acting as reservoirs may have been overlooked. Furthermore, staff screening and other environmental screening was not undertaken, these could have been additional

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		reservoirs of CRAB. Applicability to the Scottish healthcare setting is low due to the setting of this investigation. No change to current recommendations.