Australian Commission on **Safety and Quality** in Health Care

Australian Guidelines for the Prevention and Control of Infection in Healthcare

3rd edition

Technical report: Systematic review of the effectiveness of waterless models of care

August 2026

safetyandquality.gov.au

The Australian Commission on Safety and Quality in Health Care pays respect to the Gadigal people as the Traditional Custodians of Country where the Commission's office is located. We extend that respect to all Aboriginal and Torres Strait Islander peoples, and their deep time connections to land, water and sky.

We recognise that knowledge about healthy Country, community and culture has been developed by Aboriginal and Torres Strait Islander peoples over tens of thousands of years and has been shared for generations. We are committed to partnering with and learning from Aboriginal and Torres Strait Islander peoples through the work that we do.

Published by the Australian Commission on Safety and Quality in Health Care

Level 5, 255 Elizabeth Street, Sydney NSW 2000
Phone: (02) 9126 3600
Email: mail@safetyandquality.gov.au
Website: safetyandquality.gov.au
ISBN: 978-1-923353-59-6

The Commission's preference is that you attribute this publication (and any material sourced from it) using the following citation:

Australian Commission on Safety and Quality in Health Care. Australian Guidelines for the Prevention and Control of Infection in Healthcare, third editions: Technical Report: Systematic Review of the Effectiveness of Waterless Models of Care Sydney: ACSQHC; 2026.

Disclaimer

The content of this document is published in good faith by the Commission for information purposes. The document is not intended to provide guidance on particular healthcare choices. You should contact your health care provider for information or advice on particular healthcare choices.

The Commission does not accept any legal liability for any injury, loss or damage incurred by the use of, or reliance on, this document.

Table of Contents

Background

The Australian Guidelines for the Prevention and Control of Infection in Healthcare (AICGs) are a key reference resource for healthcare services that implement the infection prevention and control actions of the National Safety and Quality Health Service Standards and Primary and community Healthcare standards and provides a basis to develop detailed protocols and processes for infection prevention and control specific to local settings.

These guidelines provide a nationally accepted approach to infection prevention and control, focusing on core principles and priority areas for action. They are underpinned by a risk-based approach which recognises that the level of infection risk may differ in different clinical settings, and for different patient populations. The recommendations in the AICGs provide the **minimum** standard for infection prevention and control interventions that should be used by healthcare workers and healthcare services

This revision addresses changes in evidence about the effectiveness of waterless models of care in healthcare. To support this work, the Australian Commission on Safety and Quality in Health Care (the Commission) commissioned a third party - Monash Sustainable Development Institute Evidence Review Service, BehaviourWorks Australia, Monash University to undertake a systematic literature review on the effectiveness of waterless models of care. Evidence from the systematic review will support the development of new good practice statements for the appropriate use of waterless models of care (the appropriate use of alcohol-based hand scrub for pre-procedure and pre-operative hand antisepsis and the appropriate placement of handwashing sinks) for the AICGs.

Rationale for review

The National Health and Medical Research Council (NHMRC) recommend that clinical practice guidelines be reviewed and updated at least every five years. The AICGs were last reviewed and updated in 2019. In recognition of the growth of infection prevention and control evidence in recent years, changes to the National Safety and Quality Health Service Standards, and the lessons learnt from the COVID-19 pandemic, an update of the AICGs is needed to ensure that this resource remains contemporaneous and applicable across the various settings that health care is provided in Australia.

Objectives of the review

A rapid systematic review on the effectiveness of waterless models of care in healthcare settings was completed to examine the state of waterless care research and its implications for policy, research and practice. The systematic review evaluated the evidence for one primary research question and one secondary narrative question:

Systematic review questions

What is the effectiveness of waterless models of care in reducing risk of healthcare-acquired infections and environmental colonisation/contamination?

Areas of interest included:

- Alcohol-based hand rub vs. soap and water
- Non-water based vs. water-based hygiene for pre-surgical scrubbing
- Sink removal / avoidance and associated alternatives to sink use

How could health service organisations measure the environmental impact of waterless models of care?

The systematic review on the effectiveness of waterless models of care is included in **Appendix 1.**

Systematic review methodology

Evidence included in the rapid review of waterless models of care implemented the following eligibility criteria:

- **Publication period:** Evidence published from 1 January 2015 until 31 August 2025.
- **Language:** Evidence published in English.
- **Population:** All inpatient healthcare populations were eligible, including admitted patients and healthcare workers involved in their care. The criteria were not limited by patient age, condition or clinical specialty.
- **Healthcare settings:** Inpatient healthcare settings, including acute care hospitals, intensive care units, neonatal intensive care units, general wards, surgical settings and operating rooms. Emergency departments were excluded.
- **Information sources:** Guideline portals, MEDLINE (Ovid), Embase (Ovid), Cochrane (Ovid), Scopus, Google Scholar (limited to the first 100 results sorted by relevance)
- **Included evidence types:** Clinical practice guidelines, systematic reviews, narrative reviews and primary research studies. Primary study designs included randomised controlled trials, comparative studies and case series.
- **Interventions:** Waterless models of care, including:
    - alcohol-based hand rub compared with soap and water
    - non-water-based compared with water-based pre-surgical hand preparation
    - sink removal or avoidance
    - sink removal combined with waterless patient care
    - waterless patient care without sink removal.
- **Outcomes:** Healthcare-associated infections, surgical site infections, patient colonisation, environmental colonisation or contamination, microbial load, skin health, hand hygiene compliance, antimicrobial resistance, resource use, costs and environmental impacts.
- **Excluded settings and populations:** Emergency departments, non-hospital settings, animal studies and laboratory studies, studies not involving patients or healthcare workers.
- **Excluded interventions:** Environmental cleaning interventions that did not involve waterless models of care.
- **Other exclusions:** Publications before 2015, non-English publications and grey literature.

Waterless models of care are defined as “the targeted avoidance of sinks and reduction of tap-water-related activities such as handwashing with disinfectant soap or solution prior to patient care”[1]. Waterless care is a relatively new concept, driven by the linkage of antimicrobial resistance (AMR) to wastewater systems[2]. Waterless care interventions therefore have considerable potential for addressing infection control, especially in critically ill and other vulnerable patient populations.

[1] Buvaneswarran S, Chua MCW, Amin Z, Wang X, Low JM. Knowledge, attitudes, practices, and perceived challenges for healthcare workers on waterless intensive care unit (ICU) care at a neonatal ICU in Singapore. J Hosp Infect. 2024 Apr;146:44-51

[2] Inkster T, Walker J, Weinbren M. Water-free patient care: a narrative review of the literature and discussion of the pressing need for a way forward. J Hosp Infect. 2024 Oct 1;152:36-41

Eligibility for the systematic review questions was defined using Population-Intervention-Comparator-Outcome criteria:

- **Population:** Patients admitted to acute care hospitals, including general acute care wards and intensive care units, and healthcare workers.
- **Intervention:** Waterless models of care, with a focus on:
    - Alcohol-based hand rub versus soap and water.
    - Non-water-based versus water-based hygiene for pre-surgical scrubbing.
    - Sink removal or avoidance and alternatives to sink use.
- **Comparators:** Routine patient care using tap water, conventional healthcare worker hand hygiene, traditional surgical scrubbing with tap water. Studies without a comparator group would also be included.
- **Outcomes:** No outcome restrictions were applied at the searching and screening stage. However, the protocol specified that the review would extract outcomes such as:
    - Healthcare-acquired infections.
    - Colonisation with multidrug-resistant organisms and waterborne pathogens.
    - Antimicrobial resistance.
    - Skin health outcomes.
    - Hand hygiene uptake and compliance.
    - Financial costs.
    - Environmental impacts and sustainability measures.

Literature search strategy

Systematic literature searches were completed in September 2025, using the following electronic databases:

The primary review question was searched through:

- MEDLINE via Ovid
- Embase via Ovid
- the Cochrane databases via Ovid
- Scopus
- Google Scholar, with screening limited to the first 100 results.

Grey literature searches covered:

- Australian Commission on Safety and Quality in Health Care
- Australian National Health and Medical Research Council
- United Kingdom National Institute for Health and Care Excellence
- World Health Organization
- Guidelines International Network
- United States Centers for Disease Control and Prevention
- Singapore Ministry of Health
- Provincial Infectious Diseases Advisory Committee, Ontario
- Royal Australian College of General Practitioners
- Victorian Department of Health
- Safer Care Victoria
- Western Australian Department of Health
- Society of American Gastrointestinal and Endoscopic Surgeons.

The secondary review question on the environmental-impact of waterless models of care was addressed through targeted searching, rather than using a full primary-question search. Searches focused on evidence published from 2021 onwards and examined how health service organisations could measure the environmental effects of waterless care.

The targeted search sought evidence relating to:

- Water consumption and water savings
- Waste generation and waste reduction
- Resource and material use
- Financial costs and cost savings
- Operating-room time and associated costs
- Other reported environmental or sustainability measures associated with waterless care.

Relevant Australian and international clinical practice guidelines were searched for recommendations and evidence concerning waterless care. Guideline reference lists were examined for relevant evidence, that may not have been identified through the database searches.

Google Scholar and Scopus AI were used to support targeted searching for the secondary review question. The report states that Scopus AI and Covidence assisted searching and screening, while evidence synthesis and report writing remained subject to human review and oversight. An example of the database filters is contained in **Appendix 2** of this report.

Search results were imported into Covidence for record management, deduplication and screening. Two reviewers independently screened the search results against the predefined eligibility criteria. The review screened 907 records at title and abstract stage and assessed 60 full-text publications.

Data extraction and synthesis methods

Data was extracted into standardised tables. The extracted information included:

- Publication details
- Study aims
- Study design
- Population and healthcare setting
- Sample size
- Intervention
- Comparator, where applicable
- Outcomes measured
- Study findings
- Information required for quality appraisal.

From the primary review question, extracted outcomes included healthcare-acquired infections, surgical site infections, patient colonisation, environmental colonisation or contamination, microbial outcomes, skin health, compliance and costs. For the secondary review question, extraction focused on reported measures of environmental impact, including water use, waste and costs.

The evidence was organised into the following intervention categories:

- Non-water-based compared with water-based pre-surgical hand preparation
- Sink removal combined with waterless care
- Sink removal without additional waterless care
- Waterless patient care without sink removal
- Alcohol-based hand rub compared with soap and water.

Outcomes were classified according to their importance:

- **Critical outcomes**, including healthcare-acquired infections and surgical site infections
- **Important but not critical outcomes**, including patient colonisation and other microbiological outcomes

- **Outcomes of limited importance**, including colony-forming units, skin integrity and hand hygiene compliance.

Evidence was synthesised narratively within each intervention category. The synthesis considered the study design, intervention, comparator, outcomes and direction of findings. Findings from reviews and primary studies were reported separately where appropriate.

Meta-analysis was not undertaken because the included studies differed in their interventions, study designs, populations and reported outcomes. The findings were presented through narrative summaries and supporting evidence tables.

Results of the search for evidence (PRISMA)

The search and study-selection process identified 1,746 records through databases and other searches.

- 839 records were removed before screening.
- 815 duplicates were identified and removed through Covidence
- 24 duplicates were removed manually.
- 907 records underwent title and abstract screening. Of these, 847 records were excluded because they did not meet the eligibility criteria.

60 full-text reports were assessed for eligibility. Sixteen reports were excluded for the following reasons:

- Wrong intervention: *n* = 7
- No effectiveness data: *n* = 2
- Wrong publication type: *n* = 2
- Superseded by a more recent review: *n* = 1
- Non-English publication: *n* = 1
- Wrong outcome: *n* = 1
- Wrong study design: *n* = 1
- Wrong healthcare setting: *n* = 1.

A further two studies were identified through the reference lists of relevant publications and added to the review. The final review included 46 studies that met the eligibility criteria and were included in the review. 40 studies addressed the primary review question on the effectiveness of waterless models of care in reducing healthcare-acquired infections and environmental colonisation or contamination. 6 studies addressed the secondary review question on measuring the environmental impact of waterless models of care.

The 40 studies addressing the primary review question were distributed across the review's areas of interest as follows:

- Non-water-based compared with water-based pre-surgical hand preparation: *n* = 17 studies
- Sink removal combined with waterless care: *n* = 10 studies
- Sink removal without additional waterless care: *n* = 5 studies
- Waterless patient care without sink removal: *n* = 7 studies
- Alcohol-based hand rub compared with soap and water: *n* = 1 review.

Appendix 3 includes a full list of included studies for the primary and secondary review questions, including study characteristics.

Risk of bias assessments

The waterless models of care review assessed the potential risk of bias as part of a broader methodological quality appraisal.

The review assessed the methodological quality of included evidence using appraisal tools appropriate to each study design:

- A Measurement Tool to Assess Systematic Reviews 2 (AMSTAR 2) for systematic reviews
- Scale for the Assessment of Narrative Review Articles (SANRA) for narrative reviews
- Joanna Briggs Institute critical appraisal tools for applicable primary study designs
- United States National Institutes of Health quality assessment tools where applicable.

The review also applied Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria where feasible, to identify critical methodological limitations in primary studies.

Studies were ranked by design using the National Health and Medical Research Council hierarchy of evidence. The appraisal identified substantial variation in methodological quality across the evidence base. Recurring limitations included:

- Weak study designs
- Absence of concurrent control groups
- Reliance on historical comparator periods
- Inadequate control of confounding
- Heterogeneous interventions and outcome measures
- Small study samples
- Limited reporting of clinical outcomes
- Use of surrogate microbiological outcomes
- Implementation of waterless care as one component of a broader intervention, which limited attribution of outcomes to the waterless component
- Limited applicability beyond the settings and circumstances in which the studies were conducted.

Critical methodological limitations were common in primary studies evaluating sink removal and waterless care. These studies frequently used interrupted time-series or historically controlled designs without concurrent control groups. The use of bundled infection prevention and control interventions also limited the ability to determine the independent effect of sink removal or waterless care.

Each included study was assigned a percentage quality score by reviewers as a measure of bias. The scores represented the proportion of applicable appraisal criteria met and were interpreted in the context of the study design, methodological limitations, and the relevance of the reported outcomes.

Study characteristics

The overall evidence base for sink removal or avoidance was heterogeneous, with relatively few randomised controlled trials and a substantial proportion of observational and interrupted time-series studies. Methodological quality varied considerably across studies and many studies evaluating sink removal interventions were undertaken in outbreak settings using historically controlled designs.

In contrast, studies evaluating non-water based versus water-based hygiene for pre-surgical scrubbing were undertaken across a range of perioperative settings and involved surgeons, nurses and other perioperative staff. These studies were not developed in response to outbreaks or increased incidences of healthcare-associated infections (HAIs) or surgical site infections (SSIs) but were based on the evaluation of processes (cost and time) or hand colonisation. Infection rates were often a secondary outcome due the difficulty of directly attributing clinical outcomes solely to hand hygiene.

Six studies addressed the environmental impact of waterless models of care. These studies examined water consumption, resource use, waste generation, sustainability measures and economic impacts associated with waterless care interventions and alcohol-based hand antisepsis. The evidence included systematic reviews, narrative reviews and case-series studies. Across the included studies, reductions in water use and potential cost savings were commonly reported. A summary of included studies is included in table 1.

Table 1 Summary of included studies by intervention category

Intervention category	Number of studies	Evidence types
Non-water based versus water-based hygiene for pre-surgical scrubbing	17	Systematic reviews, narrative reviews, randomised controlled trials, comparative studies and case series
Sink removal combined with waterless care	10	Systematic reviews, narrative review and interrupted time-series studies
Sink removal without additional waterless care interventions	5	Narrative reviews and interrupted time-series studies
Waterless care interventions without sink removal	7	Systematic reviews, narrative reviews, randomised controlled trial and interrupted time-series studies
Alcohol-based hand rub versus soap and water	1	Systematic review
Environmental sustainability of waterless care	6	Systematic review, narrative reviews and case series

Detailed study characteristics tables for waterless models of care are provided in **Appendix 3**. These tables summarise the included evidence by intervention category and report study design, setting, sample size, intervention and comparator details, outcomes, key findings and quality appraisal results for each included study.

Levels of evidence

The review evaluated evidence relating to the effectiveness of waterless models of care in reducing healthcare-acquired infections and environmental colonisation or contamination. The review also examined approaches for measuring environmental impacts. Outcomes were classified as:

- Critical outcomes
- Important but not critical outcomes
- Outcomes of limited importance.

Study outcomes with classifications are included in **Appendix 4**.

The waterless models of care review did not produce a complete set of standard GRADE Summary of Findings tables for all intervention categories for the primary review question. This is due to the limited number of studies, substantial heterogeneity or critical methodological limitations in the available evidence. The review instead combined outcome importance ratings, methodological appraisal findings and GRADE considerations where appropriate.

For the secondary review question, water savings, waste reduction and cost reductions were consistently reported. The review concluded that evidence on broader environmental impacts remains limited and should not be relied upon alone for decision-making. An overall evidence profile is provided in table 2.

Table 2 Overall evidence profile

Intervention category	Overall assessment reported by the review
Non-water-based versus water-based pre-surgical hand preparation	Weak evidence
Sink removal combined with waterless care	Weak evidence
Sink removal without additional waterless care	Weak evidence
Waterless patient care without sink removal	Inconclusive evidence
Environmental impacts of waterless care	Limited evidence base, but findings consistently favour reduced water use, waste and costs

Across intervention categories, evidence was heterogeneous and generally low quality. The strongest evidence related to alcohol-based hand scrub (surgical hand antisepsis). Evidence showed comparable effectiveness to traditional water-based scrubbing for prevention of surgical site infection, while offering advantages in skin tolerance, compliance and resource use. Evidence supporting sink removal and broader waterless care was largely derived from outbreak investigations and interrupted time-series studies conducted in intensive care settings. Although several studies reported reductions in colonisation or infection transmission following sink removal and waterless care interventions, the nature of the interventions together in the studies limited the certainty that a specific intervention could be attributed to a specific outcome. Overall, the evidence suggests potential benefit in selected high-risk circumstances but remains insufficient to support routine implementation across all healthcare settings.

Developing recommendations

The commission convened a Guideline Development Group to assess the evidence from the systematic review and develop the clinical practice recommendations as per the Procedures and requirements for meeting the NHMRC's Standards for Clinical Practice Guidelines.

The Guideline Development Group (GDG) consisted of multidisciplinary Members including representatives from relevant clinical disciplines, clinical experts, end users, and consumers. The GDG was representative of different geographic areas, professions and genders. A list of GDG membership is included in **Appendix 5**.

The GDG was responsible for reviewing the findings of the systematic review on the effectiveness of waterless models of care in healthcare. This was to determine if clinical practice recommendations could be developed to support the appropriate use of alcohol-based hand scrub and the appropriate placement of handwashing basins in the clinical environment.

All evidence was assessed against GRADE criteria. The GDG voted on the criteria that should be considered for the development of the clinical practice recommendations, using a Microsoft Teams polling tool. The GDG determined that, based on the quality of the evidence, good practice statements for the appropriate use of alcohol-based hand scrub and the appropriate placement of sinks would be appropriate for inclusion in the AICGs.

GRADE Evidence to Decision frameworks

Development of the two new good practice statements was undertaken using the GRADE Evidence to Decision (EtD) framework. Evidence from the systematic reviews informed draft EtD frameworks prepared by the Commission. These frameworks were used by the GDG to systematically consider the balance of benefits and harms, certainty of evidence, values and preferences, acceptability, feasibility, resource implications, economic considerations and environmental sustainability considerations before formulating two new good practice statements.

The process was undertaken over multiple stages between March and July 2026 and incorporated evidence review, structured EtD assessment, two rounds of polling, deliberative discussion, revision of EtD frameworks, development of draft recommendations and good practice statements, and planned endorsement before public consultation.

Development of the draft Evidence to Decision frameworks

At Meeting 2 on 30 March 2026, Members were formally introduced to the EtD methodology that would be used throughout the recommendation development process. The Commission presented a two-part process consisting of review of evidence from the systematic review followed by structured consideration of key EtD criteria. Members were advised that the purpose of polling was to understand the group's assessment of the evidence across EtD domains, identify areas of agreement and uncertainty, and inform future discussions rather than determine final new good practice statements wording. Members were also informed that further polling could occur if areas of uncertainty or disagreement were identified.

Members reviewed evidence relating to alcohol-based hand scrub, waterless models of care interventions and environmental contamination associated with water systems. Members also considered proposals for the development of new good practice statements intended to provide practical guidance in areas where evidence was limited but implementation guidance was considered important. Reflective questions from Meeting 2 are included in **Appendix 6**.

Initial Evidence to Decision assessment

Following Meeting 2 of the GDG, Members completed an anonymous out-of-session polling process. The polling process used reflective questions developed around key EtD domains to support the EtD framework including:

- Benefits and harms;
- Certainty of evidence;
- Generalisability and applicability;
- Values and preferences;
- Acceptability;
- Resource implications;
- Economic sustainability; and
- Environmental sustainability.

Members were encouraged to identify any uncertainty where appropriate and provide explanatory comments regarding concerns for implementation challenges, unintended consequences and other contextual considerations. Polling responses were collated by the Commission and used to identify domains for the EtD framework requiring further deliberation. Results of reflective questions for waterless models of care are included in **Appendix 7.**

Review of the polling outcomes demonstrated agreement across many EtD domains but also identified several concerns requiring further discussion before recommendations could be drafted. Uncertainty related primarily to:

- the strength of evidence supporting alcohol-based hand scrub;
- the role of sinks as potential environmental reservoirs;
- the distinction between sink placement, sink avoidance and sink removal;
- the applicability of waterless approaches beyond outbreak settings;
- resource and infrastructure implications;
- environmental sustainability considerations; and
- potential risks arising from inappropriate interpretation of waterless care concepts.

Deliberation and repeated polling

The Commission synthesised the polling results and prepared discussion papers identifying EtD domains in which uncertainty remained. These papers were presented at Meeting 3 of the GDG in May 2026 and formed the basis of targeted discussion by the GDG.

The purpose of Meeting 3 was to consider how evidence should be translated into practical guidance and to determine whether the identified concerns could be addressed through refinement of narrative text or good practice statements. The co-Chairs emphasised that polling was intended to test alignment on concepts and identify direction rather than finalise wording.

The discussion focused on appropriate use of alcohol-based surgical hand scrub, the role of sinks within healthcare environments and the limited certainty of the available evidence. Members agreed that the available evidence was insufficient to support development of formal recommendations but considered that good practice statements supported by expert consensus and explanatory guidance would be appropriate. Members emphasised that any guidance should clearly distinguish alcohol-based surgical hand scrub from routine hand hygiene products and should not be interpreted as supporting routine sink removal. Members also recognised that additional practical guidance or narrative text would be necessary to address infection prevention and control considerations associated with alcohol-based hand scrub and sink placement.

Following this discussion, members participated in a second round of anonymous polling focused on the unresolved EtD criteria. Polling demonstrated increased alignment across the group and agreement on the importance of incorporating clinical context, local risk

assessment, implementation guidance, resource considerations, economic considerations and environmental sustainability considerations within the draft good practice statements and EtD frameworks. Meeting 3 notes are included in **Appendix 8**

Development of two new good practice statements

Good practice statements were considered the most appropriate mechanism for providing nationally consistent guidance, acknowledging limitations in the evidence included in the systematic review.

The drafting process ultimately focused on:

- appropriate use of alcohol-based hand scrub for preoperative and pre-procedure hand antisepsis; and
- risk-based placement of handwashing basins within healthcare facilities.

The evolution of these statements reflects member feedback received throughout the EtD process. Early concerns regarding misinterpretation of sink removal, inappropriate extension of waterless models of care beyond intended contexts, and confusion between alcohol-based surgical hand scrub and routine hand hygiene products informed subsequent refinement of the statements and associated rationale.

Consistent with feedback from the GDG, the final drafts emphasised risk assessment, clinical context, facility design considerations and safe implementation rather than routine adoption of waterless interventions.

Consideration of evidence limitations and implementation issues

Throughout recommendation development process, members considered the strengths and limitations of the available evidence together with the potential impact of the clinical practice recommendations on the delivery of healthcare. Common limitations included:

- weak or low-certainty evidence
- reliance on observational and historically controlled study designs
- concentration of studies in intensive care settings
- limited generalisability beyond outbreak or high-risk settings
- use of bundles of interventions that limited the certainty that a specific intervention resulted in a specific outcome
- uncertainty regarding economic and environmental outcomes.

The GDG consistently recognised that implementation would depend not only on evidence of effectiveness but also on practicality, workforce behaviour, infrastructure constraints, local resources and healthcare context. Consequently, explanatory narrative text, implementation guidance and risk-based approaches were considered important complementary elements of the revised recommendations and good practice statements.

Endorsement process

The draft wording of the revised new good practice statement and revision of the EtD frameworks were presented to the GDG at Meeting 4 on 28 July 2026. Members were asked to review the wording of the good practice statements and the supporting EtD frameworks, consider the draft rationale supporting each good practice statement and determine whether the materials should proceed to public consultation.

Members discussed the proposed wording of the draft good practice statements. Amendments to the wording of the draft new good practice statement were made, re circulated to the members and final feedback on the EtD was provided out of session.

Public and independent expert consultation

Public and independent expert consultation is planned for 31 August to 29 September 2026.

The final drafts of the new good practice statements for the appropriate use of alcohol-based hand scrub for pre-operative and pre-procedure hand hygiene and the appropriate placement of handwashing basins in clinical settings will be available on the Commission's website for public consultation. The Commission will collate feedback from the consultation and present the outcomes of the public consultation to the GDG at Meeting 5, to be held in November 2026 prior to submitting the third edition of the AICGs to the NHMRC for endorsement.

Appendices

Appendix 1: Effectiveness of waterless models of care in reducing risk of healthcare-acquired infections and environmental colonisation / contamination: a rapid evidence review

Professor Peter Bragge1

Professor Allen C Cheng2

Associate Professor Andrew J Stewardson3

Ms Stephanie J Curtis3

Ms Veronica Delafosse1

Ms Danni Teychenne1

Ms Diki Tsering1

1. Monash Sustainable Development Institute Evidence Review Service, Monash University, Clayton, Melbourne, Australia

2. Infectious Diseases, Monash Health and School of Clinical Sciences, Monash University

3. Department of Infectious Diseases, The Alfred and School of Translational Medicine, Monash University

The Monash Sustainable Development Evidence Review Service (ERS) has a strong track record in providing robust research reviews to decision-makers in government, industry, philanthropic and other organisations to optimise policy and practice. ERS employs established methodologies and has published extensively on methods and empirical reviews in high-quality peer-reviewed journals. Access a list of academic and report publications here.

Citation

Bragge P, Cheng AC, Stewardson AJ, Curtis SJ, Delafosse V, Tsering D. Effectiveness of waterless models of care in reducing risk of healthcare-acquired infections and environmental colonisation / contamination: a rapid evidence review. Monash Sustainable Development Institute Evidence Review Service, BehaviourWorks Australia, Monash University, December 2025.

Funding sources/sponsors

This project is funded by the Australian Commission on Safety and Quality in Healthcare [RfQ D25 17664]

Conflicts of interest

- Professor Cheng is on the Infection Prevention and Control (IPC) Advisory Committee for the Australian Commission on Safety and Quality in Healthcare
- Associate Professor Stewardson was a member of the Healthcare Associated Infection (HAI) Advisory Committee for the Australian Commission on Safety and Quality in Healthcare from 2014 until 2021

Table of Contents

Summary

Background, scope and context

Waterless or water-free care is “the targeted avoidance of sinks and reduction of tap-water-related activities such as handwashing with disinfectant soap or solution prior to patient care.” [p. 45] (1). Waterless care is a relatively new concept, driven by the linkage of antimicrobial resistance (AMR) to wastewater systems (2). Waterless care interventions therefore have considerable potential for addressing infection control, especially in critically ill and other vulnerable patient populations.

This rapid systematic review was commissioned in the context of a wider updating of the Australian Guidelines for the Prevention and Control of Infection in Healthcare to examine the state of waterless care research and its implications for policy, research and practice. The primary review question was:

What is the effectiveness of waterless models of care in reducing risk of healthcare-acquired infections and environmental colonisation / contamination?

Areas of particular interest were:

- Alcohol-based hand rub vs. soap and water [review of clinical practice guidelines and reviews due to the extensive primary evidence base]
- Non-water based vs. water-based hygiene for pre-surgical scrubbing [review of clinical practice guidelines, reviews and primary studies]
- Sink removal / avoidance and associated alternatives to sink use [review of clinical practice guidelines, reviews and primary studies]

A secondary area of interest was:

How could health service organisations measure the environmental impact of waterless models of care?

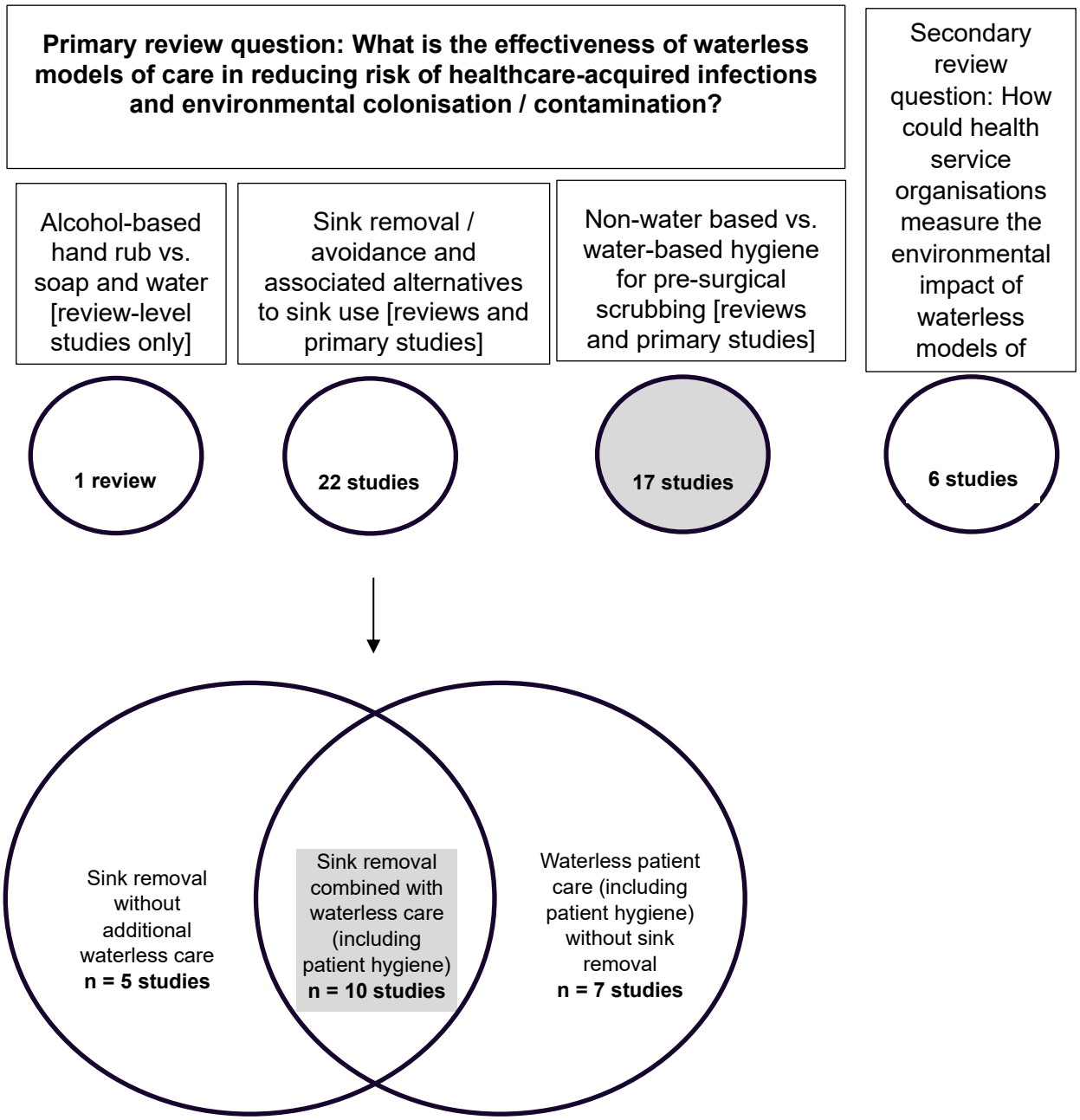
Method

The rapid review adhered to best principles of rapid research reviews and focused on research published since 2015. A review protocol was co-developed with the Australian Commission on Safety and Quality in Healthcare (hereafter referred to as ‘the Commission’) and pre-registered on the Open Science Framework on August 22, 2025.

Included studies

A total of 46 studies were identified following database searching. Although the search and selection criteria encompassed all areas of inpatient healthcare settings except emergency departments, all primary studies involving sink removal / avoidance were conducted in intensive care units. Figure 1 maps the included studies to the review questions and areas of interest.

Figure 1: number of included studies by review questions and areas of interest



Quality appraisal and GRADE analysis was undertaken for these two categories, collectively representing 27 studies. This involved defining the quality of the evidence through ranking study design; assessing quality of evidence for critical outcomes (defined as clinical outcomes – hospital acquired infection, surgical site infection) and other (non-clinical) outcomes; and producing evidence summaries. Determining recommendations was not within scope of this rapid review as this requires a guideline panel and deliberation process.

For the remaining studies, study ranking and quality appraisal was undertaken, but GRADE analysis was not valid due to low number of included studies and heterogeneity of outcomes.

Table 1presents an evidence map showing all included studies ranked by study design and indicating their methodological quality (where ‘low’ was defined as meeting ≤ 50% of eligible

quality criteria; 'medium' 50 to ≤75% and 'high' was > 75%).**Table 1:** Studies by NHMRC rank, quality (% in cells) and topic

Rank	Study	ABHR surgery	Sink removal + waterless care	Sink removal	Waterless care	ABHR (reviews)
I: SR	Fucini (2024)		73% (M)			
	Gök (2016)	38% (L)				
	Groven (2017)				69% (M)	
	Ho (2019)	**88% (H)**				
	Liu (2016)	**77% (H)**				
	Low (2024)		69% (M)			
	Tanner (2016)	**92% (H)**				
	Widodo (2019)	23% (L)				
	Zanichelli (2021)				69% (M)	
	Kuti (2021)					**100% (H)**
I: NR	Boyce (2023)				58% (M)	
	Fry (2019)	58% (M)				
	Inkster (2024)		50% (L)			
	Kearney (2021)			50% (L)		
	Khodabakhshi (2020)	50% (L)				
	Mallinckrodt (2023)				67% (M)	
	Nthumba (2020)	33% (L)				
	Parkes (2018)			33% (L)		
II: RCT	Akita (2022)	60% (M)				
	Martin (2017)				60% (M)	
	Santé (2023)	60% (M)				
	Tsai (2017)	**100% (H)**				
III-2	Forer (2017)	56% (M)				
	Olivia (2025)	**89% (H)**				
	Shen (2015)	**89% (H)**				
III-3	Baker (2021)				75% (M)	
	Cantero (2018)		50% (L)			
	Catho (2021)		63% (M)			
	De-Las-Casas-Cámara (2022)			56% (M)		
	De-Las-Casas-Cámara (2019)			56% (M)		
	Debast (2025)			38% (L)		
	Hopman (2017)		**89% (H)**			
	Martischang (2025)		44% (L)			
	Moulin (2024)				50% (L)	
	Schärer (2023)		38% (L)			
	Shaw (2018)		56% (M)			
	Tracy (2020)		25% (L)			
IV	Gaspar (2017)	**90% (H)**				
	Iwakiri (2017)	60% (M)				
	Oriel (2017)	70% (M)				

Key findings: Non-water based vs. water-based hygiene for pre-surgical scrubbing (17 studies)

Key findings

There is weak evidence to support that alcohol-based hand rub (ABHR) is an effective or superior alternative to soap and water as a pre-surgical scrub. This is based mostly on studies assessing bacterial concentrations, with only two observational studies examining clinical outcomes in the last 10 years in the present review. Three high quality systematic reviews covering earlier studies identified only five studies measuring surgical site infections (SSI) (2002 – 2010); all found no difference for ABHR vs. water-based scrubbing.

Supporting evidence

The 17 relevant studies published since 2015 comprised eight review-level studies (NHMRC Level I - five systematic reviews, three narrative reviews); three RCTs (Level II), three quasi-experimental controlled studies (Level III-1) and three case series (Level IV).

Seven of the included studies were of relatively high methodological quality (three systematic reviews, one RCT, two quasi-experimental controlled studies and one case series). These studies reported:

- Uncertain findings from a review of 10 trials measuring non-clinical outcomes (colony forming units (CFU)) (Tanner 2016)
- Mixed findings on CFU and no difference on (SSI (two studies from 2002 and 2012) for waterless hand rub (WHR) vs. chlorhexidine gluconate (CHG) vs. povidone-iodine (PI) from a review of 11 studies (Ho 2016)
- ABHR associated with similar rates of SSI (pooled analysis of two trials from 2002 and 2009), but was better tolerated and was associated with less skin damage vs. traditional scrubbing in a review of 10 studies (Liu 2016)
- CFU count significantly lower with conventional chlorhexidine and ABHR vs. povidone–iodine (PI) scrub based on an RCT (N = 240). No comparison between chlorhexidine and ABHR (Tsai 2017)
- No difference in bacterial skin concentrations (CFU) for ABHR vs. antimicrobial soap from a quasi-experimental trial (N = 71) (Olivia (2025)
- ABHR superior to conventional surgical hand scrub on culture rate (coagulase-negative staphylococci) from a quasi-experimental trial (N = 128) (Shen 2015)
- No difference on SSI for ABHR vs. traditional scrub based on a case series (N = 56 surgeons and 231 patients) (Gaspar 2018)

A further six studies were of relatively moderate quality (one narrative review, two RCTs, one quasi-experimental controlled study and two case series). Four studies were relatively poor quality (two systematic reviews, two narrative reviews)

Application of GRADE criteria

Of the nine included primary studies:

- Only two studies measured critical outcomes (SSI)
    - Both were weak study designs with no control group (NHMRC IV - case series)
    - Both studies did not contain critical methodological weaknesses based on GRADE criteria
    - Both found no difference on SSIs after introduction of ABHR

- One study measured an important but not critical outcome (pathogens in SSI)
    - This was a weak study design with no control group (NHMRC IV - case series)
    - It did not contain critical methodological weaknesses based on GRADE criteria
    - It found that *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and *Enterobacter* species were more common after introduction of ABHR
- Seven studies measured outcomes of limited importance
    - These comprised three RCTs (Level II), three quasi-experimental controlled studies (Level III-2) and one case series (Level IV)
    - Three of the studies had critical methodological weaknesses based on GRADE criteria including two of the three RCTs
    - The remaining four studies reported mixed (positive, neutral-non-significant) findings on ABHR for reducing CFU with one Level IV study reporting that ABHR improved hand hygiene compliance

Therefore, the overall evidence base for this intervention is classified as WEAK across all measured outcomes.

Table 2 presents a summary of key findings across included reviews and primary studies, highlighting overall quality and presence of critical methodological weaknesses based on GRADE criteria.

Table 2: Summary of included studies: Non-water based vs. water-based hygiene for pre-surgical scrubbing (17 studies)

•	• **Citation** • **Quality (%)**	• **Outcome**	• **Outcome criteria**	• **Conclusion relevant to relevant outcomes**
• **I: SR**	• Gök (2016) • 38%	• Antibacterial effect	• Limited importance	• ABHR causes less skin damage and has an antibacterial effect in a short time
		• Skin integrity	• Limited importance	
	• Ho (2019) • 88%	• **SSI**	• **Critical**	• No differences in CFU or SSI however waterless hand rubs had the highest compliance
		• CFU	• Limited importance	
		• Hand hygiene compliance	• Limited importance	
	• Liu (2016) • 77%	• **SSI**	• **Critical**	• No difference in SSI, however ABHR causes less skin damage
		• Skin damage	• Limited importance	
	• Widodo (2019) • 92%	• Microorganisms on hands	• Important not critical	• All surgical hand washing methods are effective at reducing microorganisms
	• Tanner (2016) • 23%	• **SSI**	• **Critical**	• No significant differences in SSI or CFU, however waterless hand rubs had the highest compliance
		• CFU	• Limited importance	
		• Hand hygiene compliance	• Limited importance	
• **I: NR**	• Fry (2019) • 58%	• **SSI**	• **Critical**	• Limited literature, however, no difference in SSI. ABHR has a greater reduction in CFU.
		• CFU	• Limited importance	
	• Khodabakhshi (2020) 50%	• CFU	• Limited importance	• ABHR have the fastest and strongest effect in reducing microbial load and may limit skin damage
		• Skin integrity	• Limited importance	
	• Nthumba (2020) 33%	• **SSI**	• **Critical**	• No difference in SSI
• **II: RCT**	• Akita (2022) • 60% #	• CFU	• Limited importance	• No difference for both outcomes
		• Staff skin moisture	• Limited importance	
	• Santé (2023) • 60% #	• CFU	• Limited importance	• Triclosan, triclosan + ethanol and propran-1-nol all reduced CFU immediately, but triclosan does not meet the European standard for sustained additional effect
	• Tsai (2017) • 100%	• CFU	• Limited importance	• Conventional chlorhexidine scrub and waterless hand rub were superior in bacterial inhibition pre-surgery, but not post-surgery
• **III-2: quasi-experimental controlled**	• Forer (2017) • 56% #	• CFU	• Limited importance	• Alcohol rub was more effective after application (no surgery performed)
	• Olivia (2025) 89%	• CFU	• Limited importance	• Both ABHR and antimicrobial soap (4% chlorhexidine reduced CFU, but were not significantly different to each other regarding magnitude of effect
	• Shen (2015) 89%	• Culture rate	• Limited importance	• Alcohol-based hand rub was more effective, pre- and post-surgery

IV: Case series	● Gaspar (2017) ● 90%	● **SSI**	● **Critical**	● Improved compliance but no difference in SSI
		● Hand hygiene compliance	● Limited importance	
	● Iwakiri (2017) 60%	● **SSI**	● **Critical**	● No difference in SSI
	● Oriel (2017) 70%	● Pathogens SSI	● Important but not critical	● After the introduction of an ABHR for surgical hand antisepsis, there was change in SSI pathogens identified

● *# - Critical study limitations according to GRADE criteria (Appendix 3)*

Key findings: Sink removal combined with waterless care (10 studies)

Key findings

There is weak evidence that sink removal and waterless care may be effective in reducing clinical infection and patient colonisation where clinical infections with gram-negative pathogens are also identified in the sink. All identified primary studies were historically controlled (NHMRC Level III-3). Five of the seven studies were performed in the context of a clear outbreak, with two addressing increasing endemic multi-drug-resistant gram-negative infections. All identified primary studies were conducted in intensive care units (ICU).

Supporting evidence

The 10 relevant studies published since 2015 comprised three reviews (NHMRC Level I - two systematic, one narrative), and seven interrupted time series without a parallel control group (Level III-3). All primary studies were ICU settings, including one Australian study in a paediatric ICU.

Only one of the included studies was of relatively high methodological quality. This interrupted time series reported:

- Sink removal combined with waterless patient care significantly reduced patient colonisation with gram-negative bacteria (GNB) in a sample of 2,490 patients, with a decrease in colonisation rate from 26.3 to 21.6 GNB/1000 ICU admission days reported (Hopman 2017)

Two moderate-quality systematic reviews (fulfilling 69 – 73% of relevant quality criteria) published in 2024 reported:

- Uncertain findings on GNB infection and colonisation due to heterogenous study design and low volume of studies in a review of 11 studies. The majority (10 / 11) of included studies focused on sink removal and modifications, with only one (Hopman 2017, included in the current review) combining sink removal with waterless care (Fucini 2024);
- Preliminary evidence from seven studies that replacing or reducing sink use in everyday ICU care appears to reduce the risk of GNB and pulmonary nontuberculous mycobacterium acquisition (Low 2024)

Two moderate-quality interrupted time series reported:

- Sink removal combined with waterless patient care terminated an outbreak of *Pseudomonas aeruginosa* in a sample of 21 ICU patients (131 environmental samples) (Catho 2021)
- Sink removal combined with waterless patient care significantly reduced incidence of multi-drug-resistant Gram-negative bacteria (MDR-GNB) in a sample of 202 ICU patients (Shaw 2018)

The remaining five studies were poor methodological quality, fulfilling only 25 – 50% of applicable quality criteria.

Application of GRADE criteria

Of the seven included primary studies:

- Five studies measured critical outcomes (Infection)
    - All were relatively weak study designs with no control group (NHMRC III-3 - interrupted time series with no control group)
    - All had critical methodological weaknesses based on GRADE criteria
    - Four of the five studies reported that sink removal combined with waterless care ceased the outbreak (three studies) or reduced incidence in an endemic setting
- Two studies measured an important but not critical outcome (colonisation)
    - Both were relatively weak study designs with no control group (NHMRC III-3 - interrupted time series with no control group)
    - One had critical methodological weaknesses based on GRADE criteria; one did not
    - As reported above, the study with no critical weaknesses reported a significant reduction in colonisation
    - The other study reported that only cessation of routine bathing reduced incidence of colonisation

Therefore, the overall evidence base for this intervention is classified as WEAK across all measured outcomes.

Table 3 presents a summary of key findings across included reviews and primary studies, highlighting overall quality and presence of critical methodological weaknesses based on GRADE criteria.

Table 3: Sink removal combined with waterless care (10 studies)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
NHMRC I: SR			
Fucini (2024) 73%	**HAIs**	**Critical**	Sink rooms had significant higher incidence of HAI
Low (2024) 69%	**HAIs**	**Critical**	Preliminary, limited,= evidence that sink removal and water-free interventions terminate outbreaks
NHMRC I: NR			
Inkster (2024) 50%	Gram-negative infections/colonisation	Important but not critical	Limited literature however there is value in waterless care in reducing infection rates.
NHMRC III-3: Interrupted time series with no control			
Cantero (2018) 50% #	***C. indologenes* cases**	**Critical**	No cases after 3 stage bundled sink outbreak response including closing patient care handwashing station and implementing waterless patient care
Catho (2021) ^ 63% #	**Verona Integron-encoded metallo-β-lactamase *P. aeruginosa* cases**	**Critical**	Bundled response including sink removal and waterless patient care ceased the outbreak
Hopman (2017) 89%	Patient colonisation with GNB	Important but not critical	Sink removal and waterless patient care reduced patient colonisation with GNB
Martischang (2025) ^ 44% #	***S. marcescens* cases**	**Critical**	The outbreak was not controlled by interventions likely due to active pressure by selective oral decontamination (SOD) or the maintenance of ventilatory circuits.
Schärer (2023) 38% #	**MDR *P. aeruginosa* infection or colonisation**	**Critical**	Outbreak ceased after final stage of interventions, including waterless patient care and sink removal
Shaw (2018) 56% #	**MDR-GNB colonisation or infection**	**Critical**	Sink removal and water avoidance, including patient wipes, reduced incidence of MDR-GNB in endemic setting.
Tracy (2020) 25% #	Neonate colonisation with multidrug-resistant organism	Important but not critical	Only cessation of routine bathing of neonates decreased the incidence of colonisation

 # - Critical study limitations according to GRADE criteria (Appendix 3)

^ Catho (2021) and Martischang (2025) assess the same intervention, however, different organism and timeframe

Sink removal without additional waterless care interventions (5 studies)

Key findings

There is weak evidence that sink removal alone, without waterless care, is an effective intervention for managing infection outbreaks in ICU and critical care settings. The three identified primary studies were historically controlled (NHMRC Level III-3) and contained critical study limitations. The two narrative reviews were also low-moderate quality. All of the primary studies and the majority of studies within the two included reviews were in intensive care unit and critical care settings.

Supporting evidence

The five relevant studies published since 2015 comprised two narrative reviews (Level I) and three interrupted time series without a parallel control group (Level III-3). All studies were low-medium quality fulfilling only 38 - 56% of applicable criteria. One narrative review (Kearney 2021) and one low quality primary study (Debast 2025) reported that sink removal was the most effective of a series of infection control strategies implemented sequentially. These included workflow modification and education, use of drain / waste disposal covers and physical barriers or room modification to protect patients from sinks. These strategies do not decolonise sinks. (Parkes 2018) GRADE analysis was not valid due to low number of included studies and heterogeneity between included studies.

Table 4: Sink removal without additional waterless care interventions (5 studies)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
NHMRC I: NR			
Kearney (2021) 50%	Carbapenemase-producing bacteria (CPB)	Important but not critical	There are limited prospective studies available however studies confirm sinks serve as reservoirs of CPB
Parkes (2018) 33%	Organism isolated	Important but not critical	Sink cleaning, disinfection and replacement often cease outbreaks but fail to decolonise sinks
NHMRC III-3: Interrupted time series with no control			
De-Las-Casas-Cámara (2022) * 56% #	Antibiotic consumption	Important but not critical	Significant reduction in antibiotic consumption and MDR cases (including water-free patient care)
	Multidrug-resistant organism cases	Important but not critical	
De-Las-Casas-Cámara (2019) * 56% #	Nonfermenting gram-negative bacilli (NFGNB) in bronchial aspirate invasive mechanical ventilation cases	Critical	Significant case reduction after removing sinks (including water-free patient care); NFGNB detected in faucets
Debast (2025) 38% #	Verona Integron-encoded Metallo-β-lactamase P. aeruginosa cases	Critical	A bundle of infection prevention measures did not terminate the outbreak, only sink removal did.

**De-Las-Casas-Cámara (2019) and De-Las-Casas-Cámara (2022) assess the same intervention, however the antibiotic consumption and MDR cases analyses include an additional year of data.*
 # - Critical study limitations according to GRADE criteria (Appendix 3)

Waterless patient care (including patient hygiene) without sink removal (7 studies)

Key findings

Evidence is inconclusive regarding the effect of waterless care, without sink removal, on HAI and SSI rates. Review-level studies are inconclusive and one moderate-quality large RCT reported no difference between traditional bathing and waterless care on HAIs. All three primary studies had critical study limitations.

Supporting evidence

The seven relevant studies published since 2015 comprised of two systematic reviews (Level I), two narrative reviews (Level I), one RCT (Level II) and two interrupted time series without a parallel control group (Level III-3). All review-level studies were moderate quality (meetings 58 – 69% of applicable quality criteria) and all primary studies contained critical limitations. GRADE analysis was not valid due to low number of included studies and heterogeneity between included studies.

Six of the seven included studies examined critical outcomes:

- One systematic review reported that there is insufficient evidence to determine if waterless care is superior to traditional bathing for HAIs (Zanichelli 69%)
- Boyce (2023) reported no difference between chlorhexidine gluconate (CHG) bathing and other wash products (placebo, bar soap) on the rates of SSI based on a prior review. This review also reported that daily CHG bathing in ICUs significantly reduced healthcare-associated bloodstream infections (HABSIs) including central line-associated bloodstream infections (CLABSIs) and reduced rate of blood culture contamination. A smaller number of studies in this review also reported that daily CHG bathing reduced other HAI; however evidence quality was poor
- Mallinckrodt (2023) included sterile water for bathing amongst a large number of infection control recommendations
- A moderate-quality RCT (crossover) enrolling 2,637 patients found no difference between traditional bathing and waterless bathing (disposable washcloths) on hospital-associated infections or multidrug-resistant organisms (MDROs) (Martin 2017)
- A moderate quality interrupted time series (ITS) study of 105 patients reported a significant decrease in respiratory nontuberculous mycobacteria (NTM) isolation following tap water avoidance and sterile water for consumption and patient care (Baker 2021)
- Moulin (2024) reported successful control of New Delhi metallo-betalactamase positive *Klebsiella pneumoniae* (NDM-KP) following implementation of a bundle of care including waterless care.

Table 5: Waterless patient care (including patient hygiene) without sink removal (7 studies)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
NHMRC I: SR			
Groven (2017) 69%	Patient skin condition	Limited importance	Washing without water performed better for skin dryness/hydration/ abnormalities but there was no difference for skin lesions
Zanichelli (2021) 69%	**HAIs**	**Critical**	HAIs and skin colonisation are minimally affected by the bathing technique or frequency however skin integrity may benefit from waterless bathing
	Patient skin colonisation	Important but not critical	
	Skin integrity	Limited importance	
NHMRC I: NR			
Mallinckrodt (2023) 67%	***E. anophelis* pleuritis cases**	**Critical**	Water-free care is one of a number of strategies to control *E. anopheles I* cases
Boyce (2023) 58%	**HAIs / SSIs**	**Critical**	Similar SSI rates bathing with CHG vs. other wash products. Daily CHG bathing in ICU and other settings may reduce HAI but evidence quality is poor.
NHMRC II: RCT			
Martin (2017) 60% #	**HAIs**	**Critical**	No difference in HAIs, however 4 cases of patient-sink same MDRO pathogen. Patient skin integrity deterioration was significantly less for ABHR
	Multidrug-resistant organisms (MDRO)	Important but not critical	
	Patient skin integrity	Limited importance	
NHMRC III-3: Interrupted time series with no control			
Baker (2021) 75% #	**Nontuberculous Mycobacteria Isolates**	**Critical**	Implementation of tap water avoidance decreased the incidence
Moulin (2024) 50% #	**New Delhi metallo-β-lactamase-producing *Klebsiella pneumoniae* cases**	**Critical**	Sinks continually re-colonised or remained colonised until the final component of the sink intervention, including waterless patient care and extensive sink cleaning

 # - Critical study limitations according to GRADE criteria (Appendix 3)

Alcohol-based hand rub vs. soap and water (review of reviews only: 1 review)

Research evidence for this comparison has been reviewed previously and the current version of the Australian Guidelines for the Prevention and Control of Infection in Healthcare recommend that:

- “alcohol-based hand rubs that contain between 60% and 80% v/v ethanol or equivalent should be used for all routine hand hygiene practices” (p. 7) and
- “soap and water should be used for hand hygiene when hands are visibly soiled” (p. 8)

Primary research examining alcohol-based hand rub (ABHR) vs. soap and water was therefore not within the scope of this review. This review did identify one high-quality systematic review of six studies focusing on neonatal infection, which reported sparse data and uncertain findings.

Table 6: Sink removal without additional waterless care interventions without sink removal (1 review)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
I: SR			
Kuti (2021) 100%	**Neonatal infection**	**Critical**	Sparse data available which were of moderate- to very low-certainty. No superiority of one hand hygiene agent over another

Key findings: Secondary review question How could health service organisations measure the environmental impact of waterless models of care?

- Across all levels of research, switching from traditional scrubbing to alcohol-based hand rubs significantly reduced water consumption, ranging from tens of thousands to millions of litres annually
- Alcohol-based hand rubs reduce plastic and material waste by eliminating the need for hand towels, brushes, and sponges.
- Alcohol-based hand rubs were also found to be more efficient than traditional methods of hand antisepsis, requiring smaller volumes, lasting longer per container, and thus producing less waste. For example, Restaino et al. (2024) showed that each 500 mL bottle of alcohol-based hand rub provided 167 scrubs, compared with 50 scrubs per bottle for povidone-iodine and chlorhexidine.
- Across studies, alcohol-based hand rubs were cheaper per use and reduced supply costs. The largest financial savings, however, came from shorter preparation times, which reduced operating room time costs
- Overall, the findings across the literature demonstrate that alcohol-based hand rubs consistently reduce water consumption, lower material waste, and generate significant cost savings.

Introduction

Waterless or water-free care is “the targeted avoidance of sinks and reduction of tap-water-related activities such as handwashing with disinfectant soap or solution prior to patient care.” [p. 45] (1).

Waterless care is a relatively new concept in the context of infection prevention and control which has been driven by the linkage of antimicrobial resistance (AMR) to wastewater systems (2). An early example of linkage of infection to water was a 1995 study which found that child deaths in a Manchester hospital were found to be due to contamination of total parenteral nutrition resulting from splashing from a nearby sink. This led to a recommendation to remove water services from the total parenteral nutrition preparation area (2). Other waterless care interventions include use of alcohol-based hand rub instead of handwashing with water; applying filters on taps; and cleaning of surfaces with wipes (2,3). In addition, use of bottled sterile water and disposable wipes for body washing and sterile water for other hygiene such as toothbrushing and shaving are alternatives to use of tap water (2).

Waterless care has been suggested to address not only AMR outbreaks but also overall incidence of acquisition of Gram-negative organisms (2). This is of particular significance for critically ill patients in settings such as ICUs, who are especially vulnerable to HAIs due to immunocompromise combined with multiple procedures and invasive devices (3).

Recent reviews of the effectiveness of waterless care illustrate that the field is still evolving. A systematic review by Low et al. (2024) focusing on intensive care units (ICU) identified only seven quasi-experimental studies between 1980 and 2024 (3); and a narrative review on broader settings included seven studies from 2000 – 2024 (2). The relatively small evidence base is reflected by clinical practice guidelines - for example the Australian Guidelines for the Prevention and Control of Infection in Healthcare do not explicitly define waterless care and there are few references to waterless care interventions (4).

Implementation of waterless care has been slow to date, with barriers identified including lack of awareness of risks associated with water / wastewater; reluctance to change practice; patient safety concerns; disruption to health services caused by engineering work; and skin-related conditions associated with replacing hand washing with ABHR (2).

Given the lack of relevant guidelines and implementation challenges, this review aimed to identify, evaluate and synthesise research evidence examining the effectiveness of waterless care. The primary review question was:

What is the effectiveness of waterless models of care in reducing the risk of healthcare-acquired infections and environmental colonisation / contamination?

Areas of particular interest were:

- Alcohol-based hand rub vs. soap and water [review of clinical practice guidelines and reviews due to the extensive primary evidence base]

- Non-water based vs. water-based hygiene for pre-surgical scrubbing [review of clinical practice guidelines, reviews and primary studies]
- Sink removal / avoidance and associated alternatives to sink use [review of clinical practice guidelines, reviews and primary studies]

Healthcare contributes to 4.4% of global greenhouse gas emissions, with operating rooms (ORs) disproportionately responsible, as surgical procedures are resource-intensive, consuming large volumes of single-use materials and water (Gasson et al., 2022; Lim et al., 2023). ORs are reported to consume three to six times more energy than other hospital areas and generate the greatest share of hospital waste, making them a key target in efforts to reduce hospitals' carbon footprint (Lim et al., 2023). They also produce significant water waste through laundering, sterilisation, and hand hygiene (Mastracci et al., 2024). However, most official guidelines tend to overlook the environmental impacts of recommended practices with only the ACSQHC National Hand Hygiene Initiative Implementation Guide (2024) noting that an advantage of using alcohol-based hand rubs is that it does not require running water or paper towels, thereby reducing waste and supporting sustainability objectives.

A secondary area of interest was how the environmental sustainability of waterless care interventions is measured and considered. The secondary review question was:

How could health service organisations measure the environmental impact of waterless models of care?

Methods

Primary review question

A rapid systematic review approach was used to address the primary review question:

What is the effectiveness of waterless models of care in reducing risk of healthcare-acquired infections and environmental colonisation / contamination?

Rapid reviews bring together knowledge from published research using a systematic approach combined with techniques to enhance resource efficiency. The Cochrane Collaboration described these techniques as “speeding up the ways we plan, do, and/or share the results of conventional structured (systematic) reviews, by simplifying or omitting a variety of methods that should be clearly defined by the authors” [p. 3] (5).

Rapid reviews have evolved over the last 15 years to balance the need for comprehensiveness and rigor against the relatively short timelines of end-users such as policymakers (6). This rapid review adhered to recommended practices in rapid reviews, namely thoughtful co-design of review parameters with knowledge users; limiting data extraction to the most important relevant areas pertaining to the research question; and utilising flexible searching techniques across at least two databases and with input from a specialist librarian (5). The review approach was consistent with the PRISMA statement (7).

The key characteristic of this rapid review that distinguished it from a full systematic review was that the focus of inquiry was studies published from 2015 onwards. However, this included reviews and guidelines that will have identified, appraised and synthesised studies published prior to 2015. Additionally, a relevance-based search of the Google Scholar database (limited to the 100 most relevant articles) was used to capture key / highly-cited publications prior to 2015.

NOTE: *Rapid reviews offer a comprehensive summary of research in a defined time period and employ robust techniques which minimise bias. They satisfy standards for publication in a peer-reviewed journal but carry limitations associated with covering literature in a defined period. This should be taken into account when interpreting review findings and in relevant decision-making processes drawing upon this review.*

A review protocol was developed in close consultation with the Australian Commission on Safety and Quality in Healthcare (hereafter referred to as ‘the Commission’). The protocol was registered on the Open Science Framework on August 22, 2025. The protocol was embargoed for the duration of the project at the request of the Commission. Details of the search strategy, study selection, data extraction and quality appraisal procedures, copied from the registered protocol, are contained in Appendix 1.

Secondary review question

A rapid evidence profile was undertaken to address the secondary review question:

How could health service organisations measure the environmental impact of waterless models of care?

Identified publications relevant to the secondary question were harvested from citations of the primary review question search. However, because the primary focus of the review was effectiveness of waterless models of care, this review did not comprehensively cover the topic of measurement of environmental impact.

Therefore, a targeted search of the Google Scholar was undertaken:

1. limited to 2021 onwards: "environmental impact of alcohol-based hand rub"
2. limited to 2021 onwards: “sustainability of alcohol-based hand rub”

A search of the Scopus AI database was undertaken with the query “what are environmental impacts of alcohol-based hand rubs” – returned results were captured in other searches, however some papers were used for background and context purposes.

Additionally, limited additional de novo searching (e.g. Google Scholar, one of the databases above) to identify research focusing on environmental impacts of waterless care.

Note: This rapid evidence profile involved arbitrary selection of a limited number of relevant studies. The profile therefore does not claim to be a comprehensive coverage of this topic, and the findings should not be relied upon to support decision-making.

Statement on Generative AI

Artificial Intelligence (AI) platforms are increasingly used to support review processes; however, a recent comprehensive systematic review concluded that *“GenAI is not currently suitable for use in evidence synthesis without caution and human oversight as it makes a substantial number of mistakes during evidence synthesis tasks”* [p. 2] (8).

With this in mind and consistent with Monash University’s current AI Policies and Guidelines pertaining to human oversight of AI (9) we declare that:

- The screening platform used in this review, (Covidence) (10), contains inbuilt AI functionality which sorts citations by relevance. We did not cease screening based on relevance – all citations and full text articles were screened in full by two independent reviewers;

- Ad-hoc searches were used to identify research articles outside of those included in the review (for example background information, ‘gold set’ studies, references cited in included studies) that could inform development of the search strategy for this review. Platforms used for ad-hoc searching, for example Google Scholar and Scopus AI, employ AI to optimise search results; and

- Generative AI – defined as ‘computational techniques that are capable of generating seemingly new, meaningful content such as text, images or audio from training data’ [p. 111] (11) – was not used to write any section of this report or the associated review protocol.

Results: Primary review question

What is the effectiveness of waterless models of care in reducing risk of healthcare-acquired infections and environmental colonisation / contamination?

Search and selection

Following deduplication of searches, a total of 907 citations and abstracts and 60 full text studies were independently screened by two reviewers. A total of 46 studies were identified in relation to the primary and secondary areas of interest. Appendix 2 presents the PRISMA diagram summarising the selection process.

Forty studies pertaining to the primary review question (effectiveness of waterless models of care in reducing risk of healthcare-acquired infections and environmental colonisation / contamination), comprising:

- Ten systematic reviews [NHMRC Level I] (12–21)
- Eight narrative reviews [NHMRC Level I] (2,22–28)
- Four randomised controlled trials (RCTs) [NHMRC Level II] (29–32)
- Three comparative studies with concurrent controls [NMHRC Level III-2] (33–35)
- Twelve comparative studies without concurrent controls [NHMRC Level III-3] (36–47)
- Three case series with either post-test or pre-test/post-test outcomes [NHMRC Level IV] (48–50)

Study quality, characteristics and findings: primary review question

Included studies fell into two main categories and two subcategories:

- **Non-water based vs. water-based hygiene for pre-surgical scrubbing (17 studies)**
- **Sink removal combined with waterless care (10 studies)**
- Sink removal without additional waterless care interventions (5 studies)
- Waterless care interventions without sink removal (7 studies)
- Alcohol-based hand rub vs. soap and water (1 review; primary studies out of scope)

Below we present a summary of study quality, characteristics and findings across the two main categories. All quality appraisal findings across all included studies are contained in Appendix 3. Detailed data extraction tables for all included studies are contained in Appendix 4.

Non-water based vs. water-based hygiene for pre-surgical scrubbing (17 studies)

Study characteristics, quality and findings

Key findings

There is weak evidence that alcohol-based hand rub (ABHR) may be an effective or superior alternative to soap and water as a pre-surgical scrub. This is based mostly on studies assessing bacterial concentrations, with only two observational studies examining clinical outcomes in the last 10 years in the present review. Three high quality systematic reviews covering earlier studies identified only five studies measuring surgical site infections (2002 – 2010); all found no difference for ABHR vs. water-based scrubbing.

The 17 relevant studies published since 2015 comprised eight review-level studies (NHMRC Level I - five systematic reviews, three narrative reviews); three RCTs (Level II), three quasi-experimental controlled studies (Level III-1) and three case series (Level IV).

The five systematic reviews were conducted between 2016 – 2019 and collectively cited 70 studies (noting that studies may have been duplicated across reviews). Two of the three narrative reviews citated a total of 41 studies (including potential duplicates); one narrative review did not report on number of included studies.

The primary studies were conducted in a diverse range of countries – Taiwan (Tsai 2017, Shen 2015); Japan (Akita 2022); Spain (Sante 2023); Indonesia (Olivia 2025); Israel (Forer 2017); Brazil (Gaspar 2018); Japan (Iwakiri 2017); and the United States (Oriel 2017). Sample sizes in primary studies ranged from 20 (Forer 2017) to 1400 (Iwakiri 2017). The three randomised controlled trials recruited 23 (Sante 2023), 36 (Akita 2022) and 240 participants (Tsai 2017).

Seven of the included studies were of relatively high methodological quality (three systematic reviews, one RCT, two quasi-experimental controlled studies and one case series). These studies reported:

- Uncertain findings from a review of 10 trials measuring non-clinical outcomes (colony forming units) (Tanner 2016)
- Mixed findings on CFU and no difference on surgical site infections (SSI, two studies from 2002 and 2012) for waterless hand rub (WHR) vs. chlorhexidine gluconate (CHG) vs. povidone-iodine (PI) from a review of 11 studies (Ho 2016)
- ABHR associated with similar rates of SSI (pooled analysis of two trials from 2002 and 2009), but was better tolerated and was associated with less skin damage vs. traditional scrubbing in a review of 10 studies (Liu 2016)
- CFU count significantly lower with conventional chlorhexidine and waterless handrub vs. povidone–iodine scrub based on an RCT (N = 240) (Tsai 2017)
- No difference in bacterial skin concentrations (CFU) for ABHR vs. antimicrobial soap from a quasi-experimental trial (N = 71) (Olivia (2025)
- ABHR superior to conventional surgical hand scrub on culture rate (coagulase-negative staphylococci) from a quasi-experimental trial (N = 128) (Shen 2015)
- No difference on SSI for ABHR vs. traditional scrub based on a case series (N = 56 surgeons and 231 patients) (Gaspar 2018)

A further six studies were of relatively moderate quality (one narrative review, two RCTs, one quasi-experimental controlled study and two case series). Four studies were relatively poor quality (two systematic reviews, two narrative reviews)

Of the nine included primary studies:

- Only two studies measured critical outcomes (Surgical site infections)
    - Both were weak study designs with no control group (NHMRC IV - case series)
    - Both of studies did not contain critical methodological weaknesses based on GRADE criteria
    - Both found no difference on SSIs after introduction of ABHR
- One study measured an important but not critical outcome (pathogens in SSI)
    - This was a weak study design with no control group (NHMRC IV - case series)
    - It did not contain critical methodological weaknesses based on GRADE criteria
    - It found that *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and Enterobacter species were more common after introduction of ABHR
- Seven studies measured outcomes of limited importance
    - These comprised three RCTs (Level II), three quasi-experimental controlled studies (Level III-2) and one case series (Level IV)
    - Three of the studies had critical methodological weaknesses based on GRADE criteria including two of the three RCTs
    - The remaining four studies reported mixed (positive, neutral-non-significant) findings on ABHR for reducing colony forming units (CFU) with one Level IV study reporting that ABHR improved hand hygiene compliance.

Therefore, the overall evidence base for this intervention is classified as WEAK across all measured outcomes.

Commentary

The majority of studies of non-water based pre-surgical scrubbing examined bacterial contamination of the hands, a surrogate outcome for post-operative surgical site infection. This was not felt to be as important as clinical infection, as the level of bacterial contamination on the hands of the proceduralist associated with infection is not well defined. Although there is a substantial body of evidence for hand hygiene with alcohol-based hand rubs in other contexts, the level of bacterial suppression required to reduce infections following surgical procedures may be higher than that required to reduce infections in other contexts.

While there were randomised controlled trials identified in the systematic reviews that examined critical outcomes (clinical infection), they were insufficiently powered to conclude non-inferiority. Some studies suggested benefits associated with alcohol-based hand rub, with less damage to skin than following mechanical scrubbing. In the absence of conclusive evidence of effectiveness, we cannot assess the balance of desirable and undesirable effects. Other than effectiveness, we would anticipate few barriers to implementation as alcohol-based hand rub is widely used elsewhere in the hospital. The cost and resource use associated with alcohol-based hand rub would need to be considered. It is possible that inclusion of chlorhexidine gluconate (CHG) in alcohol-based hand rub confounds examination of alcohol-based hand rub; however, it is also noted that CHG is in most alcohol-based hand rubs.

Policy implications: There is insufficient evidence to recommend alcohol-based hand rub as an alternative to conventional pre-surgical scrub.

Practice implications: There is insufficient evidence to recommend alcohol-based hand rub as an alternative to conventional pre-surgical scrub.

Research implications: There is a need for larger clinical trials evaluating surgical site infections following pre-surgical scrub with alcohol-based hand rub vs conventional scrub with antiseptic and water.

Sink removal combined with waterless care (10 studies)

Key findings

There is weak evidence that sink removal and waterless care may be effective where clinical infections with Gram-negative pathogens are also identified in the sink. All identified primary studies were historically controlled (NHMRC Level III-3). Five of the seven studies were performed in the context of a clear outbreak, with two addressing increasing endemic multidrug resistant gram-negative infections. All identified primary studies were conducted in intensive care units.

Study characteristics, quality and findings

The 10 relevant studies published since 2015 comprised three reviews (NHMRC Level I - two systematic, one narrative), and seven interrupted time series without a parallel control group (Level III-3). All primary studies were in intensive care unit (ICU) settings, including one Australian study in a paediatric ICU.

The two included systematic reviews and one narrative review collectively cited a total of 25 studies (including potential duplicates). The seven included primary studies were conducted in Switzerland (Catho 2021, Martischang 2025, Scharer 2023); Spain (Cantero 2018, Shaw 2018); The Netherlands (Hopman 2017); and Australia (Tracy 2020). Participant numbers ranged from 12 (Cantero 2018) to 2,490 (Hopman 2017) with four studies enrolling between 120 – 255 participants (Martischang 2025, Scharer 2023, Shaw 2018, Tracy 2020)

Only one of the included studies was of relatively high methodological quality. This interrupted time series reported:

- Sink removal combined with waterless patient care significantly reduced patient colonisation with Gram-negative bacteria (GNB) in a sample of 2,490 patients, with a decrease in colonisation rate from 26.3 to 21.6 GNB/1000 ICU admission days reported (Hopman 2017)

Two moderate-quality systematic reviews (fulfilling 69 – 73% of relevant quality criteria) published in 2024 reported:

- Uncertain findings on GNB infection and colonisation due to heterogenous study design and low volume of studies in a review of 11 studies. The majority (10 / 11) of included studies focused on sink removal and modifications, with only one (Hopman 2017, included in the current review) combining sink removal with waterless care (Fucini 2024);
- Preliminary evidence from 7 studies that sink removal and waterless care helped terminate outbreaks involving taps in ICU settings (Low 2024)

Two moderate-quality interrupted time series reported:

- Sink removal combined with waterless patient care terminated an outbreak of *Pseudomonas aeruginosa* in a sample of 21 ICU patients (131 environmental samples) (Catho 2021)
- Sink removal combined with waterless patient care significantly reduced incidence of multi-drug resistant Gram-negative bacteria (MDR-GNB) in a sample of 202 ICU patients (Shaw 2018)

The remaining five studies were poor methodological quality, fulfilling only 25 – 50% of applicable quality criteria.

Of the seven included primary studies:

- Five studies measured critical outcomes (Infection)
    - All were relatively weak study designs with no control group (NHMRC III-3 - interrupted time series with no control group)
    - All had critical methodological weaknesses based on GRADE criteria
    - Four of the five studies reported that sink removal combined with waterless care ceased the outbreak (three studies) or reduced incidence in an endemic setting
- Two studies measured an important but not critical outcome (colonisation)
    - Both were relatively weak study designs with no control group (NHMRC III-3 - interrupted time series with no control group)
    - One had critical methodological weaknesses based on GRADE criteria; one did not
    - As reported above, the study with no critical weaknesses reported a significant reduction in colonisation
    - The other study reported that only cessation of routine bathing reduced incidence of colonisation

Therefore, the overall evidence base for this intervention is classified as WEAK across all measured outcomes.

Commentary

Studies examining sink removal combined with waterless care mostly suggested benefit based on a reduction in colonisation with the outbreak pathogen or with multidrug-resistant Gram-negative pathogens more generally. All studies involved designs with high risk of bias, without criteria to upgrade the strength of evidence (directness, consistency/precision, large magnitude of effect, strong dose response gradient, effect of residual plausible confounding).

We were unable to assess the balance of desirable and undesirable effects as long term sustainability and adverse effects were not generally reported. Issues that have been raised in personal correspondence with four authors of included articles include:

- The potential for legionella in stagnant water in residual plumbing systems, larval contamination due to reduced flow (51) and acquisition of *Comamonas testosteronii* from non-sterile bottled water;
- While the duration of the intervention was up to 29 months in the reported studies, waterless care remains in place after 10 years in at least one unit with the only adverse event being colonisation with *Comamonas testosteronii* linked to the use of commercially bottled water;
- Adoption in both high and low-resource settings including in the UK and Germany;
- Water contamination and scarcity is a driver of waterless care in some regions;
- Use of a multidisciplinary working group to aid implementation, adaption and sustainability of waterless care;

- Evidence that newly-built ICUs are not including sinks based on positive outcomes of sink removal and waterless care;
- Evidence that use of patient-area sinks for purposes other than hand hygiene (e.g. disposal of biological fluids, storage of medical devices or personal items such as tracheal cannulae and toothpaste) contributes to contamination and microbial growth in drains;
- Ensuring that no dead-end pipe sections were retained following sink removal is a strategy to prevent conditions favouring Legionella growth;
- Strategies that stop short of sink removal such as disinfection protocols and shut-off valves rarely eliminate biofilm formation in distal plumbing and therefore allow recolonisation;
- Decreasing use of sinks due to more adoption of use of alcohol-based hand rub may result in more heavy contamination due to reduced flushing.

While we are not aware of costing studies, we would anticipate that the costs of engineering sink removals and the consumables associated with waterless care would be considerable, and this intervention is not generally considered until other interventions have been explored and evaluated. The values and preferences of staff and patients would need to be considered in formulating recommendations.

Policy implications: Sink removal may be considered as an intervention where clinical infections or colonisation with resistant organisms have been linked to bacterial contamination of sinks. However, the available evidence base is weak and limited to ICU settings.

Practice implications: Any plan for sink removal should carefully consider potential risks including changed workflows and models of care. Although some health services report long term sustainability of sink-free care, the full benefits and potential harms of sink-free care have not been fully reported in studies. We note the long-term trend to the use of alcohol-based hand rub for hand hygiene, reducing the reliance on soap and water in patient care.

Research implications: In addition to more robust study designs to provide evidence of effectiveness and harms, future studies should also evaluate financial costs (including engineering changes and the cost of alternative products). We also note patient perspectives have not yet been reported. The effectiveness of alternative interventions, such as improving practices around fluid disposal and sink decontamination interventions, is also not known.

Results: Secondary review question

How could health service organisations measure the environmental impact of waterless models of care?

Six studies pertaining to the secondary review question (health service organisation measurement of the environmental impact of waterless models of care), comprising:

- One systematic review [NHMRC Level I] (52)
- Two narrative reviews [NHMRC Level I] (53,54)
- Three case series with either post-test or pre-test/post-test outcomes [NHMRC Level IV] 00

A further narrative review (55) and two primary case series studies (56,57) were identified through supplementary searching. Detailed data extraction tables for all included studies are contained in Appendix 4.

Examination of 28 guidelines from searching did not identify any further references relevant to the environmental impacts of waterless models of care. A list of the guidelines reviewed is contained in Appendix 5.

Water Savings

Water use occurs at multiple stages of a product's lifecycle, including packaging and manufacture (Duane et al., 2022). Evidence across all levels of research consistently shows that switching to waterless hand antisepsis, particularly in surgical settings, results in significant water savings. Mastracci et al. (2024) highlighted that a single 5-minute scrub can consume between 16 and 34 litres of water, noting that many facilities also waste additional water when sinks are left running after scrubbing. (54) In 2008, surgical handwashing in the UK was estimated to use 932,000 litres annually, leading to recommendations endorsed by the UK National Institute for Health and Care Excellence guidelines reported by Wyssusek et al, (2018) for an initial scrub technique at the start of an operating list, followed by alcohol-based hand rubs between subsequent cases providing hands are not visibly soiled. (53)

Converting to alcohol-based hand rubs could save millions of litres of water annually as alcohol-based hand rubbing requires substantially less water than traditional scrubbing, making it particularly suitable in water-scarce regions. (52,54) Reviewed case series further quantified these water savings.

Carannante et al. (2024) found that over a two-year period involving 1,190 surgeries, alcohol-based scrubbing used only 23.8 litres of water compared with 71,500 litres for traditional scrubbing. (58) Similarly, Posso et al. (2025) reported that a 2-minute scrub used 7.62 litres of water and projected that transitioning to waterless methods could reduce annual water use by nearly 90,000 litres. (59) Restaino et al. (2024) observed that daily water use for surgical handwashing reached 140.7 litres for chlorhexidine and 187.6 litres for povidone-iodine, compared to 0 litres for alcohol-based hand rubs. (60) Gasson et al. (2023) also demonstrated that a standard 3-minute scrub consumed 20.57 litres of water per person and estimated that switching to alcohol-based hand rubs could reduce daily water consumption by 57–70%. (57) Finally, Javitt et al. (2020) reported annual water savings of 61,631 litres per operating room, equating to approximately 47.7 litres saved per surgical procedure. (56)

Consistent with these findings, a life cycle assessment comparing hand hygiene methods against 16 measures of sustainability found that alcohol-based hand rubs, particularly isopropanol-based hand rubs, were more environmentally sustainable than soap-and-water hand washing. This was mainly due to the additional water required for laundering hand towels and treating wastewater produced by traditional hand washing. (55)

Waste Reduction

While fewer studies addressed waste reduction directly, some evidence highlighted reductions in plastic and material use associated with waterless hand hygiene methods. Restaino et al. (2024) reported that alcohol-based hand rubs eliminate the need for plastic brushes, sponges, and individually wrapped towels, thereby reducing plastic waste. The same study noted that each 500 mL bottle of alcohol-based rub provided 167 scrubs, compared to 50 scrubs per bottle for povidone-iodine and chlorhexidine, reducing packaging waste. Mastracci et al. (2024) also noted that eliminating water use removes the need for hand towels, which require laundering and contribute to environmental waste.

Cost Savings

Cost savings were consistently reported across the reviewed studies. Restaino et al. (2024) found that alcohol-based hand rubs cost €0.01 per scrub (approximately $0.0178 AUD) compared to €0.05 ($0.089 AUD) for povidone-iodine and chlorhexidine, with daily scrub costs of €0.23 ($0.4094 AUD) for alcohol-based antiseptics versus €1.15 ($2.047 AUD) for traditional methods, resulting in annual savings of €225.4 ($401.21 AUD). Carannante et al. (2024) reported that over two years, alcohol-based scrubbing cost €216 ($384.48 AUD) compared to €1,800 ($3,204 AUD) for brushes used in traditional scrubbing. Javitt et al. (2020) calculated the cost of alcohol-based hand rub (waterless, but referred to in the article as ‘alcohol based hand scrub’) at US$0.36 (approximately $0.5544 AUD) per scrub, compared to US$0.33 ($0.5082 AUD) for aqueous soap and US$0.43 ($0.6622 AUD) for chlorhexidine brushes, while also noting that the greatest financial savings came from reduced operating room time.

At the institutional level, Posso et al. (2025) estimated annual supply cost savings of US $3,090.96 ($4,760.08 AUD) from switching to alcohol-based hand rubs (waterless, but referred to in the article as ‘alcohol-based hand scrub’), with potential total annual savings of $1.3 million ($2.002 million AUD) when perioperative time costs were included. Javitt et al. (2020) similarly reported that institution-wide adoption of waterless scrubs at an ophthalmologic centre in the US could save between US $280,000 ($431,200 AUD) and US $348,000 ($535,920 AUD) per operating room (OR) annually, with the majority of savings attributed to reduced operating room time costs. Mastracci et al. (2024) also highlighted that alcohol-based scrubs are faster, thereby lowering operating room time costs. Restaino et al. (2024) reported time savings of 62.5% compared with povidone-iodine and 50% compared with chlorhexidine. Although the cost of OR time varies between facilities, the greater efficiency of alcohol-based hand rubs has the potential to generate significant savings for both institutions and patients (Mastracci et al., 2024).

Conclusion

In summary, the literature shows that waterless models of surgical hand antisepsis consistently reduce water use, lower material waste, and generate significant cost savings. To achieve true sustainability in healthcare, financial savings must be paired with improvements in environmental performance (Gasson et al., 2022). However, evidence on the broader environmental impacts of these practices remains limited, highlighting the need for further research.

Further reading

The following studies were cited in the review by Duane et al. (2022) but not included in the present review:

- Hoekman S, Broch A (2018) Environmental implications of higher ethanol production and use in the U.S.: A literature review. Part II – Biodiversity, land use change, GHG emissions, and sustainability. Renew Sustain Energy Rev 81:2;3159–3177
- Hoekman S, Broch A, Liu X (2018) Review Environmental implications of higher ethanol production and use in the U.S.: A literature review. Part I – Impacts on water, soil, and air quality. Renew Sustain Energy Rev 81(3):3140–3158. https://doi.org/10.1016/j. rser.2017.05.050
- Mahmood A, Eqan M, Pervez S et al (2020) COVID-19 and frequent use of hand sanitizers; human health and environmental hazards by exposure pathways. Sci Total Environ 742. https://doi.org/10. 1016/j.scitotenv.2020140561

Appendix 1: Search strategy, study selection, data extraction and quality appraisal procedures per registered review protocol

Search Strategy

For the **primary review question (effectiveness of waterless models of care)** we plan to examine the databases and search strategies used in the existing guidelines as a starting point to a search strategy. The following databases will be searched:

- Guideline portals
- Medline (OVID)
- Embase (OVID)
- Cochrane (OVID)
- Scopus
- Google Scholar (first 100 results sorted by relevance)

For the **secondary review question (measurement of environmental impact of waterless models of care)** we will conduct limited additional de novo searching (e.g. Google Scholar, one of the databases above) to identify additional studies focusing solely on environmental impacts.

Example search strategy (primary review question):

Ovid MEDLINE(R) <1946 to July Week 4 2025>

#	Query	1 Aug 2025
1	Hand Hygiene/	2,481
2	Hand Disinfection/	6,590
3	(hand adj5 (hygiene or disinfect* or antisep* or disinfect* or wash* or saniti*)).ti,ab,kf.	10,211
4	handwashing.ti,ab,kf.	2,849
5	**or/1-4**	**14,996**
6	(water-free or waterfree or water-less or waterless or "without water*" or "tap water avoidance").ti,ab,kf.	1,800
7	(alcohol* adj5 (handrub* or hand-rub*or handsaniti* or hand-saniti*)).ti,ab,kf.	473
8	(ABHR adj15 (alcohol* or hand*)).ti,ab,kf.	134
9	**or/6-8**	**2,363**
10	**5 and 9**	**633**
11	(hand* adj15 (water-free or waterfree or water-less or waterless or "without water*" or "tap water avoidance")).ti,ab,kf.	100
12	(clinical hand* adj5 (sink* or basin*)).ti,ab,kf.	8

#	Query	1 Aug 2025
13	((sink* or basin* or hand-basin* or handbasin*) adj5 (removal or avoidance)).ti,ab,kf.	153
14	**12 or 13**	**160**
15	Health Care Sector/ or health facilities/ or academic medical centers/ or health facilities, proprietary/ or hospitals, proprietary/ or hospitals/ or hospitals, community/ or hospitals, general/ or hospitals, group practice/ or hospitals, high-volume/ or hospitals, low-volume/ or hospitals, private/ or hospitals, religious/ or hospitals, public/ or hospitals, county/ or hospitals, district/ or hospitals, federal/ or hospitals, veterans/ or hospitals, municipal/ or hospitals, state/ or hospitals, rural/ or hospitals, special/ or hospitals, maternity/ or hospitals, pediatric/ or hospitals, psychiatric/ or hospitals, teaching/ or hospitals, university/ or hospitals, urban/	331,227
16	(hospital* or "health facilit*" or "health service*" or "health unit*" or "medical facilit*" or "medical cent*" or "health care" or "healthcare").ti,ab,kf.	2,291,669
17	**15 or 16**	**2,381,392**
18	**14 and 17**	**17**
19	Cross Infection/	63,557
20	**17 and 19**	**38,823**
21	(water-free or waterfree or water-less or waterless or "without water*" or "tap water avoidance").ti,ab,kf.	1,800
22	**20 and 21**	**34**
23	(((surg* or pre-surg* or operating) adj5 scrub*) and hand*).ti,ab,kf.	252
24	**9 and 23**	**21**
25	**10 or 11 or 18 or 22 or 24**	**689**
26	**limit 25 to english language**	**672**
27	**limit 26 to yr="2015 - 2026"**	**426**

Study Selection

For both the **primary review question (effectiveness of waterless models of care) and secondary review question (measurement of environmental impact of waterless models of care)** citations will be imported into Covidence, a web-based collaboration software platform that streamlines the production of systematic and other literature reviews.(Veritas Health Innovation 2023). Two reviewers will independently screen titles / abstracts and full text publications against the inclusion and exclusion criteria listed in Table 1. Disagreements will be resolved by consensus, with involvement of a third reviewer as required.

Data Extraction

The following information will be extracted from eligible studies for both the **primary review question (effectiveness of waterless models of care) and secondary review question (measurement of environmental impact of waterless models of care).**

For **clinical practice guidelines**, we will quote verbatim any relevant clinical practice guideline recommendations along with their supporting grade and explanation, noting that grading systems vary across clinical practice guidelines. Where feasible, relevant supporting evidence (e.g. high-ranking primary studies or reviews) will be cross-checked against included studies.

For **systematic reviews**, we plan to extract the following data:

- Author, date, aims, number of quality criteria met / total applicable criteria
- Number of studies included in the review
- Primary intervention focus
- Overall review findings (including risks / adverse events)
- Key conclusions reported by study authors (headline findings, headline conclusions on strength of evidence contained in the review)

For **primary studies**, we will extract the following data:

- Author, date, aims, number of quality criteria met / total applicable criteria
- Country, design
- Context: outbreak / non-outbreak
- Study population, sample size
- Intervention (primary intervention of interest as reported by the study authors): e.g. Sink removal; alcohol-based hand rub;
- Setting: e.g. Pre-surgical scrubbing / ICU / Ward
- Control (and other secondary interventions, where there is a control group)
- Outcomes: key reported outcomes will be extracted. These include, but are not limited to:
    - Reduction in healthcare-acquired infections (including colonisation with MDROs or other waterborne pathogens, which will be specified where reported)
    - Reduction in healthcare-acquired infections due to multi-resistant pathogens
    - Reduction in colonisation due to multi-resistant pathogens
    - Impact on patient / HCW skin health (allergy, dermatitis, irritation)
    - Impact on uptake of healthcare worker and patient hand hygiene
    - Impact on antimicrobial resistance
    - Impact on financial costs
    - Measurement of environmental impact of waterless models of care - methods and findings [secondary review question]
    - Impact on financial costs [secondary review question]
    - Impact on waste management, wastewater and other waste associated with patient care [secondary review question]
- Key conclusions reported by study authors

Table 1: Inclusion and exclusion criteria

	Include	Exclude
Population / Setting	Patients admitted to acute care hospitals (general acute care, intensive care) Health Care Workers	Patients who present to hospital but are not admitted (i.e. Emergency Room settings) Patients and health care workers in non-hospital settings All other populations Animal studies Laboratory studies Studies not involving patients or health care workers
Intervention	The use of waterless models of care for routine patient care with a focus on: Alcohol-based hand rub vs. soap and water [review of clinical practice guidelines and reviews due to the extensive primary evidence base] Non-water based vs. water-based hygiene for pre-surgical scrubbing [review of clinical practice guidelines, reviews and primary studies] Sink removal / avoidance and associated alternatives to sink use [review of clinical practice guidelines, reviews and primary studies]	Skin decolonisation outside of the context of sink removal / avoidance - skin decolonisation guidelines can require use of body wash with water and represent a larger body of evidence unrelated to the primary question of waterless care. Use of waterless techniques for routine environmental cleaning (for example, cleaning technologies such Ultraviolet light, fogging or misting, microfibre clothes)
Comparison	Routine patient care using tap water, HCW hand hygiene, scrubbing using tap water Studies without a comparator group will also be included	No exclusions on comparison
Outcome	No specific inclusions on outcome at the search and screen level	No exclusions on outcome at the search and screen level
Study characteristics	Clinical practice guidelines Peer-reviewed journal articles at review or primary study level English language 2015 - present	Books / Book chapters Conference abstracts without a full paper Theses Pre-print Grey literature reports Non-English language

Quality appraisal

Clinical practice guidelines will not be appraised for methodological quality as this is not feasible within the scope of this rapid review. Additionally, research evidence pertaining to relevant guidelines will be appraised as described below and quality appraisal of primary studies is based on the GRADE approach.

Primary review question (effectiveness of waterless models of care)

Methodological quality of systematic and narrative reviews will be evaluated using the AMSTAR 2 tool (61) and SANRA (62) tools respectively. Methodological quality of included primary studies will be evaluated at two levels:

1. Strength of study design, ranked on the NHMRC Hierarchy of Evidence (Table 2) (63)
2. For studies examining the primary outcome of interest - reduction in patient HAIs - strength of study methodology, based on the current online version of the GRADE Book (64). Specifically, we will consider:
    a. the eight GRADE criteria pertaining to quality of included studies (risk of bias, directness of evidence, consistency and precision of results, risk of publication bias, magnitude of the effect, dose-response gradient, and influence of residual plausible confounding);
    b. benefits, harms and burden;
    c. overall certainty of evidence about effects; and
    d. available information on values and preferences (noting this will not be the subject of a separate search but will be drawn from relevant information in included studies).

NOTE: It is not possible to determine if there is sufficient evidence to warrant use of the GRADE approach. If this is not feasible or valid, alternative methods of quality appraisal will be chosen specific to the included study designs (for example, Cochrane Risk of Bias tool for RCTs, JBI critical appraisal tools). These are also presented in Table 2. This review does not have sufficient scope to convene and co-ordinate guideline-panel level input and / or engage in prolonged deliberation with input of other stakeholder groups. Therefore, any GRADE recommendations developed by the project team will be *draft recommendations* for consideration by a larger panel consistent with best practice for clinical practice guideline development. Depending on review yield, we will undertake either dual, independent quality appraisal for all included studies to minimise bias; or use of a single quality appraiser with a selection of articles (e.g. 10%) dual appraised for quality control.

Secondary review question (measurement of environmental impact of waterless models of care)

Quality appraisal of studies pertaining only to the secondary review question will not be undertaken as this is not feasible and not the primary focus of the review.

Table 2: Classification of study designs and indicative critical appraisal tools (if GRADE is unfeasible / invalid)

	Study design and definition	Indicative appraisal tool
I	**A systematic review of level II studies** *"Systematic location, appraisal and synthesis of evidence from scientific studies."* (Coleman et al. 2008) NOTE: The NHMRC definition specifies that systematic reviews are focused on Level II studies (randomised controlled trials). Reviews in this topic area may not contain or be exclusive to RCTs. Study designs of included studies in reviews will be noted in the review findings. **(Narrative, scoping, and rapid reviews will also be included)**	AMSTAR 2 (systematic reviews); SANRA narrative reviews) (61,62)
II	**A randomised controlled trial** *"Experimental studies meet three conditions: manipulation, control and random assignment. Specifically, the researchers manipulate the intervention of interest and the control condition and they randomly allocate the participants to the intervention or control group. Random allocation refers to an authentically random process such as the toss of a coin or use of a table of random numbers" (p. 72) (Shadish, W, Cook, TD, and Campbell, DT 2002)*	The revised JBI critical appraisal tool for the assessment of risk of bias for randomised controlled trials (65).
III-1	**A pseudo-nonrandomised controlled trial (i.e. alternate allocation or some other method)** *" … allocation may not use an authentically random process. For example, if investigators use alternate group allocation like even and odd dates, they cannot ensure that each participant has an equal chance of landing in either group. Experimental studies without authentic random allocation but using systematic alternate group allocation methods mentioned above are experimental studies with pseudo randomisation, or pseudo-RCTs" (p. 72) (Shadish, W, Cook, TD, and Campbell, DT 2002)*	JBI checklist for quasi-experimental studies (non-randomised experimental studies) (66)
III-2	**A comparative study with concurrent controls**	JBI checklist for quasi-experimental studies (non-randomised experimental studies) (66)
	Non-randomised experimental trial: "*Quasi-experimental studies are studies where the intervention of interest and the control condition are controlled (manipulated) by the researchers, however, the allocation of participants is not a random, systematic or pseudo-random allocation. Frequently, participants self-select into groups or the researchers decide which persons should get the intervention and which persons should get the control (Shadish et al 2002)".*	JBI checklist for quasi-experimental studies (non-randomised experimental studies) (66)
	Cohort study: *"… outcomes for groups of people observed to be exposed to an intervention, or the factor under study, are compared to outcomes for groups of people not exposed".* Prospective = followed prospectively with further outcomes recorded as they happen; retrospective = defined at a point of time in the past and information collected on subsequent outcomes [NHMRC 2008].	JBI checklist for cohort studies (67)

	Study design and definition	Indicative appraisal tool
	Case-control study: *"… people with the outcome or disease (cases) and an appropriate group of controls without the outcome or disease (controls) are selected and information obtained about their previous exposure/non-exposure to the intervention or factor under study"* [NHMRC 2008].	JBI checklist for case control studies (68)
	Interrupted time series with a control group: *"… trends in an outcome or disease are measured over multiple time points before and after the intervention (factor under study) is introduced to a group of people, and then compared to the outcomes at the same time points for a group of people that do not receive the intervention (factor under study)"* [NHMRC 2008].	JBI checklist for case control studies (68)
III-3	**A comparative study without concurrent controls**	
	Historical control study: *"… outcomes for a prospectively collected group of people exposed to the intervention (factor under study) are compared with either (1) the outcomes of people treated at the same institution prior to the introduction of the intervention (i.e. control group/usual care), or (2) the outcomes of a previously published series of people undergoing the alternate or control intervention"* [NHMRC 2008].	JBI checklist for case control studies (68)
	Two or more single arm studies: *"… the outcomes of a single series of people receiving an intervention (case series) from two or more studies are compared"* [NHMRC 2008].	JBI checklist for case series (69)
	Interrupted time series without a parallel control group: *"… trends in an outcome or disease are measured over multiple time points before and after the intervention (factor under study) is introduced to a group of people, and compared*" [NHMRC 2008].	JBI checklist for quasi-experimental studies (non-randomised experimental studies) (66)
IV	**Case series** with either post-test or pre-test/post-test outcomes.	The National Institutes of Health (NIH) quality assessment tool for before-after (pre-post) study with no control group (70) OR JBI checklist for case series (69)
	Cross-sectional study*: "… a group of people are assessed at a particular point (or cross-section) in time and the data collected on outcomes relate to that point in time"* [NHMRC 2008].	JBI checklist for analytical cross-sectional studies (71)

Data Analysis and Reporting

Based on existing knowledge of research in this area it is anticipated that meta-analysis will be unfeasible. Therefore, a narrative synthesis of findings will be undertaken. A short commentary on the clinical and research implications of the review findings will also be included.

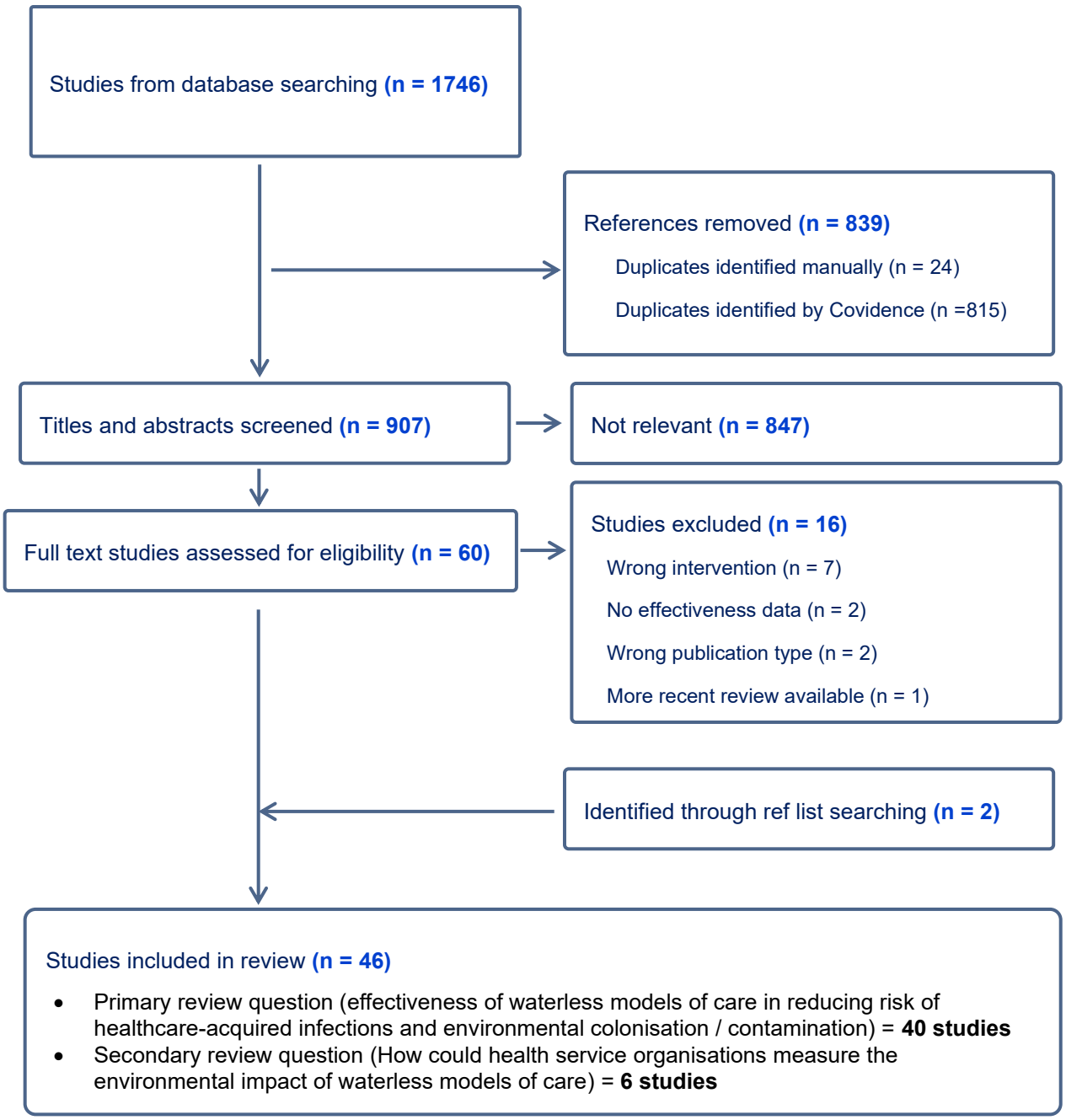
Statement on Generative AI

Artificial Intelligence (AI) platforms are increasingly used to support review processes; however, a recent comprehensive systematic review concluded that *"GenAI is not currently suitable for use in evidence synthesis without caution and human oversight as it makes a substantial number of mistakes during evidence synthesis tasks"* [p. 2] (8). With this in mind, we declare that:

- Our preferred citation screening platform (Covidence) (10) contains inbuilt AI functionality which sorts citations by relevance (we do not use Covidence for data extraction)
- AI-supported tools (e.g. Elicit, Scopus AI) may be used to identify potentially relevant 'gold set' articles that could inform development of the search strategy for this review. Identified articles will be read by the research team to confirm rigour and relevance, consistent with Monash University's current AI Policies and Guidelines pertaining to human oversight of AI (9).

Any use of AI in this project will be declared in written reports.

Appendix 2: Study selection (PRISMA)



Appendix 3: Quality appraisal findings

Level I: Systematic Reviews [n = 10]

AMSTAR II	Fucini (2024)	Gok (2016)	Groven (2017)	Ho (2019)	Kuti (2021)	Liu (2016)	Low (2024)	Tanner (2016)	Widodo (2019)	Zanichelli (2021)
1. Did the research questions and inclusion criteria for the review include the components of PICO? (Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?	Partial Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
3. Did the review authors explain their selection of the study designs for inclusion in the review?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Did the review authors use a comprehensive literature search strategy?	Yes	Partial Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial Yes	Yes
5. Did the review authors perform study selection in duplicate?	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes
6. Did the review authors perform data extraction in duplicate?	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No
7. Did the review authors provide a list of excluded studies and justify the exclusions?	No	No	No	No	Yes	No	No	Yes	No	No
8. Did the review authors describe the included studies in adequate detail?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
9. Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
10. Did the review authors report on the sources of funding for the studies included in the review?	No	No	No	No	Yes	No	No	No	No	No

AMSTAR II	Fucini (2024)	Gok (2016)	Groven (2017)	Ho (2019)	Kuti (2021)	Liu (2016)	Low (2024)	Tanner (2016)	Widodo (2019)	Zanichelli (2021)
11. If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?	Yes	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A
12. If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	No	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A
13. Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
14. Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?	Yes	No	No	Yes	Yes	Yes	No	Yes	No	Yes
15. If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A
16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Appraisal score: met / applicable	**11/15**	**5/13**	**9/13**	**14/16**	**13/13**	**10/13**	**9/13**	**12/13**	**3/13**	**9/13**

Level I: Narrative reviews [n = 8]

SANRA	Boyce (2023)	Fry (2019)	Inkster (2024)	Kearney (2021)	Khodabakshi (2020)	Mallinkrodt (2023)	Nthumba (2020)	Parkes (2018)
1. Justification of the article's importance for the readership	1	1	1	1	1	2	1	2
2. Statement of concrete / specific aims or formulation of questions	1	2	2	1	2	2	1	1
3. Description of the literature search	0	0	2	2	1	2	0	0
4. Referencing	2	2	1	1	1	1	2	1
5. Scientific reasoning	2	1	0	0	1	1	0	0
6. Appropriate presentation of data	1	1	0	1	0	0	0	0
Appraisal score	**7/12**	**7/12**	**6/12**	**6/12**	**6/12**	**8/12**	**4/12**	**4/12**

Level II: Randomised controlled trial [n = 4]

JBI checklist for randomised controlled trials	Akita (2022)	Martin (2017)	Santé (2023)	Tsai (2017)
1. Was true randomization used for assignment of participants to treatment groups?	Unclear	Unclear	Unclear	Yes
2. Was allocation to treatment groups concealed?	N/A	N/A	N/A	N/A
3. Were treatment groups similar at the baseline?	Yes	Yes	Unclear	Yes
4. Were participants blind to treatment assignment?	N/A	N/A	N/A	N/A
5. Were those delivering treatment blind to treatment assignment?	N/A	N/A	N/A	N/A
6. Were treatment groups treated identically other than the intervention of interest?	Yes	Unclear	Yes	Yes
7. Were outcomes assessors blind to treatment assignment?	Unclear	No	Unclear	Yes
8. Were outcomes measured in the same way for treatment groups?	Yes	Yes	Yes	Yes
9. Were outcomes measured in a reliable way?	Yes	Yes	Yes	Yes
10. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	No	Yes	Unclear	Yes
11. Were participants analyzed in the groups to which they were randomized?	Yes	Yes	Yes	Yes
12. Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	No	Unclear	Yes	Yes
Appraisal score: met / applicable	**6/10**	**6/10**	**6/10**	**10/10**
Critical study limitations based on GRADE (Items 2, 4, 5, 7, 10, 11): Grade table 5.4	**YES**	**YES**	**YES**	**NO**

Level III-2: Comparative study with concurrent controls [n = 3]: Non-randomised experimental trial

JBI checklist for quasi-experimental studies	Forer (2017)	Olivia (2025)	Shen (2015)
1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Yes	Yes	Yes
2. Were the participants included in any comparisons similar?	Unclear	Yes	Yes
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Unclear	Unclear	No
4. Was there a control group?	No	Yes	Yes
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?	No	Yes	Yes
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?	Yes	Yes	Yes
7. Were the outcomes of participants included in any comparisons measured in the same way?	Yes	Yes	Yes
8. Were outcomes measured in a reliable way?	Yes	Yes	Yes
9. Was appropriate statistical analysis used?	Yes	Yes	Yes
Appraisal score: met / applicable	**5/9**	**8/9**	**8/9**
Critical study limitations based on GRADE (Items 1, 2, 5, 6): GRADE Table 5.5	**YES**	**NO**	**NO**

Level III-3: Comparative study without concurrent controls [n = 12]: Interrupted time series without a parallel control group

JBI checklist for quasi-experimental studies	Baker (2021)	Cantero (2018)	Catho (2021)	De-Las-Casas-Camara (2022)	De-Las-Casas-Camara (2019)	Debast (2025)	Hopman (2017)	Martischang (2025)	Moulin (2024)	Scharer (2023)	Shaw (2018)	Tracey (2020)
1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Were the participants included in any comparisons similar?	Yes	Unclear	Unclear	Unclear	Unclear	Unclear	Yes	Unclear	Unclear	Unclear	Unclear	Yes
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Unclear	No	No	Unclear	Unclear	No	Yes	No	Unclear	Unclear	Unclear	Unclear
4. Was there a control group?	No	No	No	No	No	No	No	No	No	No	No	No
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	No
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?	N/A	N/A	N/A	No	No	N/A	Yes	Unclear	N/A	N/A	Unclear	N/A
7. Were the outcomes of participants included in any comparisons measured in the same way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Unclear
8. Were outcomes measured in a reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear
9. Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Appraisal score: met / applicable	**6/8**	**4/8**	**5/8**	**5/9**	**5/9**	**3/8**	**8/9**	**4/9**	**4/8**	**3/8**	**5/9**	**2/8**
Critical study limitations based on GRADE (Items 1, 2, 5, 6): GRADE Table 5.5	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**

Level IV: Case series with either post-test or pre-test/post-test outcomes [n = 3]

JBI checklist for case series	**Gaspar (2018)**	**Iwakiri (2017)**	**Oriel (2017)**
1. Were there clear criteria for inclusion in the case series?	Yes	Yes	Yes
2. Was the condition measured in a standard, reliable way for all participants included in the case series?	Yes	Yes	Yes
3. Were valid methods used for identification of the condition for all participants included in the case series?	Yes	Yes	Yes
4. Did the case series have consecutive inclusion of participants?	Yes	Yes	Yes
5. Did the case series have complete inclusion of participants?	Yes	Unclear	Yes
6. Was there clear reporting of the demographics of the participants in the study?	No	No	No
7. Was there clear reporting of clinical information of the participants?	Yes	No	No
8. Were the outcomes or follow up results of cases clearly reported?	Yes	Yes	Yes
9. Was there clear reporting of the presenting site(s)/clinic(s) demographic information?	Yes	No	No
10. Was statistical analysis appropriate?	Yes	Yes	Yes
Appraisal score: met / applicable	**9/10**	**6/10**	**7/10**
Critical study limitations based on GRADE (Items 1, 3, 8): GRADE Table 5.5	**NO**	**NO**	**NO**

Appendix 4: Study characteristics and key findings

Table A4a: Non-water based vs. water-based hygiene for pre-surgical scrubbing: 17 studies

Surgical hand scrub (ABHR vs soap/water): Level I – Systematic Review (n = 5)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions reported by authors	QA scoring
Tanner (2016) N = 14	Assess the effects of surgical hand antisepsis on (i) preventing surgical site infections (SSIs) and (ii) numbers of colony-forming units (CFUs) of bacteria on the hands of the surgical team	Four trials reported SSIs, all found no clear evidence in risk of SSI for alcohol rub vs. other 10 trials reported CFUs with mixed results	"Studies were small, and some did not present data or analyses that could be easily interpreted or related to clinical outcomes. These factors reduced the quality of the evidence." (p.1)"	"Uncertainty remains about the optimal method of hand antisepsis for minimising SSI outcomes" (p.19)	92% (12/13)
Ho (2019) N = 11	Compare antiseptic efficacies of waterless hand rub (WHR), chlorhexidine gluconate (CHG), and povidone-iodine (PI) in surgical settings	No significant differences in CFU counts between WHR and CHG WHR and CHG significantly lower CFU counts cf. povidone-iodine (PI) No significant differences in surgical site infection (SSI) rates between WHR and traditional hand scrub Waterless hand rubs showed the highest compliance and were most favourable.	Five trials showed high risk, three showed moderate risk and three showed low risk of bias.	"RCTs with consistent outcome measurement and accurate grouping are necessary to obtain comprehensive results" [p. 378]	88% (14/16)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions reported by authors	QA scoring
Liu & Mehigan (2016) N = 10	Review evidence of effect of surgical-scrub techniques on skin integrity and SSI	Hand rubbing techniques as effective as traditional scrubbing and better tolerated Hand rubbing appears to cause less skin damage than traditional scrub protocols Brushless techniques tolerated better than scrubbing	More than half of the studies were low methodological quality; three studies moderate quality; one study high methodological quality	"hand rubbing techniques are as effective as traditional scrubbing in preventing SSIs … regardless of concentration and length of time. Hand rubbing techniques better tolerated (less skin damage) Brushless techniques better for participants' skin	77% (10/13)
Gök (2016) N = 14	Reviewed randomized controlled and experimental studies comparing surgical hand washing methods and antiseptic agents	The addition of glycerol to alcohol-based products reduced antibacterial effects 85% ethanol has a higher bactericidal effect than other antiseptics Chlorhexidine gluconate can be used in surgical hand washing without scrubbing apparatus, with a higher bactericidal effect compared to povidone-iodine and other alcohol-based products	No quality appraisal reported Of 14 studies included, 2 RCTs, 8 Experimental and 4 RCT/Experimental	Scrubbing / use of special apparatus to scrub nails did not reduce bacteria and are no longer necessary; use of alcohol-based hand antiseptics is more appropriate Technique of surgical hand washing, effect of solution and preference of one over the other remains controversial … more RCTs are required	38% (5/13)

Widodo (2019) N = 11	Determine effectiveness of surgical hand washing using chlorhexidine, providone iodine and alcohol in reducing microorganisms on the hand	Three articles found alcohol hand rub more effective than chlorhexidine and providone iodine One article found both alcohol hand rub and chlorhexidine are more effective than providone iodine One article reported chlorhexidine, providone iodine and alcohol hand rub were equally effective	Nine journals good quality; two journals moderate quality Sample size varied from 20 - 6344 Measuring instruments included observation sheets, questionnaires, assessment sheets	"Surgical hand washing using chlorhexidine, providone iodine and alcohol are all effective at reducing microorganisms" (p.112)	23% (3/13)

Surgical hand scrub (ABR vs soap/water): Level I – Narrative Review (n = 3)

Citation N studies	Review aim	Key findings	Key conclusions reported by authors	QA score
Fry (2019) Overall N not specified; 15 included studies relevant to this review	To address current recommendations and guidelines on surgical hand hygiene and examine antiseptic ‘‘hand rubs’’ before surgical gloving vs. traditional scrub	Alcohol-based hand rubs comparable or better in reducing bacterial counts than other antiseptic choices Addition of chlorhexidine to alcohol rub may enhance antibacterial effects further Limited evidence comparing traditional surgical scrub with the alcohol-based hand rub on the rates of SSIs; four studies demonstrated no differences in SSI rates	“changing the pre-operative ritual at the scrub sink before operations will require years … current evidence favours alcohol rub instead of the traditional scrub … design of better and more tolerable formulations for the rub to minimise the tissue injury from the alcohol preparations appears to be the next step in the acceptance of this method” [p.133]	58% (7/12)
Khodabakhshi (2020) N = 26	To introduce soap and alcohol disinfectant solutions for surgical scrub and describe advantages and disadvantages	Cautions to consider include healthy skin, taking jewellery off, lack of long nails or artificial nails, covering the hair, mask, glasses, and slippers and aprons “Alcohol-based disinfectants have the fastest and strongest effect in reducing microbial load To increase effectiveness of hand hygiene with alcohol-based solutions authors recommended paying attention to the surgical team, teaching principles of their use and following manufacturer's instructions	“The use of hand sanitizers before surgery is one way to prevent SSI. Among these, alcohol-based solutions have been welcomed due to the lack of water consumption, no damage to the skin, high antiseptic properties, and rapid action” [p.89]	50% (6/12)

Citation N studies	Review aim	Key findings	Key conclusions reported by authors	QA score
Nthumba (2020) N not specified	Review current state of surgical hand preparation in low- and middle-income countries	Compared with traditional surgical scrub, ABHRs improves quality and reduces duration of surgical hand preparation and is at least equally effective for preventing SSIs The switch from traditional water-based SHP to ABHRs has not been achieved	"ABHRs are the most efficacious surgical hand preparation products available today. They are cost-effective and can safely be prepared locally in hospitals, even in LMICs" [p. 495]	33% (4/12)

Surgical hand scrub (ABR vs soap/water): Level II: Randomised controlled trial (n = 3)

Citation Country	Sample size Setting	N Participants Intervention	N Participants Control	Results	Key conclusions reported by authors	QA score
Tsai (2017) Taiwan	240 surgeons and scrub nurses Any surgery	N = 79 Waterless hand rub (1% chlorhexidine gluconate and 61% ethyl alcohol)	N = 77 10% povidone–iodine scrub N = 80 4% chlorhexidine scrub	**Primary outcome** No significant difference in mean CFU count among the groups after surgery. CFU count significantly lower with conventional chlorhexidine and waterless handrub vs. povidone–iodine scrub **No secondary outcomes**	Conventional chlorhexidine scrub and waterless hand rub superior in bacterial inhibition Authors recommended using conventional chlorhexidine scrub as a standard method for perioperative hand antisepsis, with waterless hand rub used if the higher cost is affordable	100% (10/10)

Citation Country	Sample size Setting	N Participants Intervention	N Participants Control	Results	Key conclusions reported by authors	QA score
Akita (2022) Japan	36 registered nurses in two hospitals Operating room	N = 18 A. Waterless: handwashing natural soap followed by ABHR [1% chlorhexidine gluconate (CHG)] x 10 days B. Two-stage: scrubbing with antiseptic detergent (4% CHG) followed by ABHR (1% CHG) x 10 days	N = 18 B followed by A (crossover trial)	**Primary outcome** No significant difference between intervention and control groups on bacterial reduction factor (RF) **Secondary outcomes** No significant difference between waterless and two-stage on *skin moisture* Waterless significantly *more useful in practice* based on questionnaires	"Handwashing using natural soap is simple and superior to hand scrubbing in several aspects" [p. 1]	60% (6/10)

Citation Country	Sample size Setting	N Participants Intervention	N Participants Control	Results	Key conclusions reported by authors	QA score
Santé (2023) Spain	23 volunteers Ward/setting not specified	N = 23 A. TCS: Triclosan 0.5% B. TCS + EtA: Triclosan 0.5% plus ethanol 70% hand rubbing C. Reference procedure: Propan-1-ol (60%-V/V)	N = 23 A-B-C in diff order with washout of 1 week between runs (Latin-square crossover RCT)	**Primary outcome** All interventions reduced CFU significantly, immediately and at 3 hours Immediate and 3-hour effect of TCS significantly inferior to both TCS + EtA and reference procedure **No secondary outcomes**	TCS by hand scrub did not meet the European criteria (EN12791, known as 'UNE') for surgical hand preparation (SHP). TCS + EtA met UNE noninferiority criterion – that is, they were not significantly inferior to the reference procedure; but did not meet the requirement for claiming an additional sustained effect compared with the reference procedure	60% (6/10)

Surgical hand scrub (ABR vs soap/water) - Level III-2: Comparative study with concurrent controls: Non-randomised experimental trial (n = 3)

Citation Country	Sample size Setting	N Participants Intervention	N Participants Control	Results (bold = primary outcome)	Key conclusions reported by authors	QA score
Olivia (2025) Indonesia	71 surgeons and nurses General surgery	n=35 Alcohol-based hand rub using 70% ethyl alcohol and 2.5% chlorhexidine	n=36 Antimicrobial soap for surgical hand scrub using 4% chlorhexidine soap group	**Primary outcome** Both methods significantly reduced CFU No significant difference between groups on CFU Gram-positive coccus bacteria were the primary microorganism identified in pre and post testing for both groups **No secondary outcomes**	Surgical hand-scrub and hand-rub have similar effectiveness in reducing bacterial counts on hands	89% (8/9)
Shen (2015) Taiwan	128 doctors and nurses Surgery (various types)	n=65 Alcohol-based hand rub using 61% ethyl alcohol and 1% chlorhexidine gluconate	n=63 Conventional surgical hand scrub using 4% chlorhexidine or 7.5% povidone-iodine	**Primary outcome** Significant difference in culture rate (%) between intervention and control (Intervention: Pre-post 6.2% - 10.8%; Control: Pre-post 47.6% - 25.4%) Most identified pathogens were Gram-positive; coagulase-negative staphylococci was the major pathogen **No secondary outcomes**	Alcohol-based hand rub was more effective for surgical antisepsis and had sustained efficacy, compared to conventional surgical scrub	89% (8/9)

Citation Country	Sample size Setting	N Participants Intervention	N Participants Control	Results (bold = primary outcome)	Key conclusions reported by authors	QA score
Forer (2017) Israel	20 surgeons (case-crossover design) Ophthalmic Surgery	n=10 A. “Alcoholic Hand Rub” - 5 ml of 70% ethanol and 1% glycerine B. Routine 3-minute Antimicrobial Scrub (4% chlorhexidine gluconate (CHG) or 1% povidone-iodine (PVP-I)	n=10 B – A (reverse order)	**Primary outcome** Significant reduction in mean colony forming units (CFU)/mL on hands with Alcoholic Hand Rub vs. Routine group No significant difference between CHG vs PVP-I in the control group **No secondary outcomes**	Alcohol rub is more effective than routine surgical hand preparation with PVP-I and CHG in reducing bacterial counts on hands	56% (5/9)

Surgical hand scrub (ABHR vs soap/water): Level IV: Case series with either post-test or pre-test/post-test outcomes (n = 3)

Citation Country	Sample size Setting	Pre-intervention	Intervention	Results	Key conclusions reported by authors	QA score
Gaspar (2018) Brazil	Surgeons (n = 56) and patients (n=231) Cardiac and orthopedic surgical teams	(3 months) Traditional surgical scrub with antimicrobial soap (either 2% chlorhexidine or 10% PVPI)	(3 months) Alcohol-based hand rub available in the operating room; training (4 hr workshops x 5); observation / feedback	**Primary outcome** No significant difference in surgical hand preparation compliance overall In a subset of surgeons from both periods (n=33), there was a significant increase in compliance during-intervention **Secondary outcome** Patient SSI pre-post 8.3% (11/132) - 4.0% (4/99): not significant	Alcohol-based surgical hand preparation improves quality and reduces duration of preparation vs. traditional surgical scrub, however there was no difference in surgical site infections	90% (9/10)
Iwakiri (2017) Japan	Patients (n=1,400) Orthopedic surgery	(13 months) Traditional hand scrub n=712	(10 months) Waterless hand rub n=688	**Primary outcome** No significant difference in SSI incidence: (n = 12, 1.3%) control vs (n = 8, 1.1%) **Secondary outcome** Cost per hand hygiene episode: $2 for traditional hand scrub vs less than $1 for waterless hand rub	Waterless hand rub with an alcohol-based chlorhexidine gluconate solution can be a safe, quick, and cost-effective alternative to traditional hand scrub	60% (6/10)

Citation Country	Sample size Setting	Pre-intervention	Intervention	Results	Key conclusions reported by authors	QA score
Oriel (2017) United States	6344 cultures from superficial and deep surgical site infections (SSI) Retrospective analysis of using hospital data and CDC surgery database	2007- 2009 Traditional aqueous surgical scrubs (TSS)	2013-2014 Alcohol-based hand rub (ABHR)	**Primary outcome** Pathogen frequency at hospital: *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and Enterobacter species more common in **ABHR** period *Klebsiella pneumoniae/K. Oxytoca* more common in **TSS** period Similar pathogen frequency in CDC National Healthcare Safety Network database to hospital data, however *Coagulase-negative* more common in NHSN and *Klebsiella (pneumoniae/oxytoca)* more common at hospital **No secondary outcomes**	Over time, and with the introduction of an ABHR for surgical hand antisepsis, there was change in SSI pathogens identified	44% (4/9)

Table A4b: Sink removal and waterless care: 10 studies

Sink removal and waterless care: Level I: Systematic Reviews (n = 2)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions reported by authors	QA scoring
Fucini (2024) N = 11 studies	"To investigate which sink interventions may reduce GNB infection and colonisation rates in the ICU" (p. 82)	Main interventions were water filters, removal of sinks, sink heating and vibration devices, new taps and hopper covers. Interventions reduced GNB colonisation /infection rates in the ICU. Nevertheless, the studies reported different outcomes and had very different sample sizes and baseline incidence rates for GNB acquisition.	No randomized controlled trials were included in the analysis, and all studies were reported to have moderate to serious risk of bias	"Few studies have investigated the association of sinks in patient rooms with healthcare-associated acquisition of GNB in non-outbreak settings. Heterogeneity in study design made it impossible to generalize the results. Prospective trials are needed …"	73% (11/15)
Low (2024) n= 7	"effectiveness of sink removal with or without waterfree activities in the ICU environment to reduce water-borne healthcare-associated infections." (p.61)	"All included studies utilised sink removal in patient-fronting areas as their main intervention…Removal of sinks and water-free interventions appear to have an impact on GNB and pulmonary nontuberculous mycobacterium acquisition." (p.69)	"Overall quality was assessed to be good based on the JBI critical appraisal checklist" (p.69)	"Preliminary evidence, from a limited number of studies of which the majority were conducted in an outbreak setting, suggest that sink removal and other water-free interventions in the ICU helped terminate outbreaks involving taps and decrease hospital onset respiratory isolation of pulmonary NTB." (p.61-62)	69% (9/13)

Sink removal and waterless care: Level I: Narrative Reviews (n = 1)

Citation N studies	Review aim	Key findings	Key conclusions reported by authors	QA score
Inkster (2024) N=7	"To determine the arguments for and against radical measures such as reducing the water and wastewater outlets in healthcare facilities, and the methods that have been implemented to ensure that patient care is still, first and foremost, a priority." p.37	Waterless care was largely instigated in response to outbreaks of Gram-negative bacteria in ICUs. "A spectrum of changes could be introduced by units, ranging from wipes for bathing patients, to placing the clinical handwash station outside the patient room, to true water-free care whilst still retaining a handwash basin" p.39 "If ICUs are not aware of any transmission events from water or wastewater systems on the unit, it will be unlikely that practices will be changed." p.39 "The risks from not changing to water-free patient care need to be understood." p.39	"Waterless or water-free care is a relatively new concept, and this was reflected by the small body of literature identified" p.37 There is a requirement for change that needs a collaborative approach to develop solutions, which understands the risks from not changing to water-free patient care. The move to water-free patient care has been relatively slow due to a range of real and perceived challenges and barriers to change.	50% (6/12)

Sink removal and waterless care: Level III-3: Interrupted time series without a parallel control group (n = 7)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Hopman (2017) The Netherlands	Patients 2,490 total: Pre (n=1496) Post (n=1444) ICU	Remove patient room sinks Water-free patient care: Universal gloving and gowning Hand wipes Disinfection with ABHR Dissolving medication in bottled water Disposable materials Rinse-free shampoo cap Moistened disposable wash gloves Bottled water Electric / bottled water shaving	**Primary outcome** A significant immediate reduction in the rate of patient colonisation with GNB. Monthly colonisation rates: Gram-negative bacilli vs Yeast as 'negative control': decrease from 26.3 to 21.6 GNB/1000 ICU admission days The reduction in GNB colonisation rate became more pronounced in patients with a longer ICU-Length of Stay. **No secondary outcomes**	Removal of sinks from patient rooms and introduction of a method of 'water-free' patient care significantly reduced patient colonisation with GNB Plausible that a longer stay in an ICU increases the exposure to potential pathogens in the direct patient surroundings including sinks.	89% (8/9)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Catho (2021) Switzerland* *Same setting as Martischang (2025); different organism / timeframe	21 patients infected or colonised with Verona Integron-encoded Metallo-β-lactamase-positive *Pseudomonas aeruginosa* 131 environmental samples ICU	Sink removal in patient rooms. Sinks kept in dedicated waste disposal rooms; two sinks in preparation rooms. 'Water-free' patient care: Bottled water Electric / bottled water shaving Chlorhexidine-free washing gloves Shampoo cap Disposable materials for canula care Hand washing: soap followed by ABHR Further minimise drain usage Ventilator-associated pneumonia prevention bundle with selective oral-pharyngeal decontamination administration. Staff education MDRO screening with increasing intensity	**Primary outcome** Post intervention, there was no new patients infected or colonised with Verona Integron-encoded Metallo-β-lactamase-positive *Pseudomonas aeruginosa* within 8 months until an outbreak in a COVID-19 unit at 12 months, however there was no clear ICU acquisition. **Secondary outcome** 16/131 (12.2%) environmental samples were positive grew Verona Integron-encoded Metallo-β-lactamase-positive *Pseudomonas aeruginosa* in sink traps and drains.	Waterless patient care with removal of the sinks in patient rooms terminated the outbreak The outbreak was genomically linked to environmental water sources.	63% (5/8)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Shaw (2018) Spain	202 patients and with multi-drug resistant gram-negative bacteria (MDR-GNB) ICU	1. Sink removal in all patient rooms, except two sinks in the central nurse room. 2. Deep cleaning / disinfection of sinks 3. Antibacterial water filters in the taps, replaced monthly 4. Filtered water from central sinks for patient daily hygiene (first half of post-intervention) 5. Water discarded in a disposal room outside of the hospitalisation area 6. Chlorhexidine-impregnated washcloths for patient hygiene (second half of post-intervention)	**Primary outcome** Statistically significant decrease in incidence of MDR-GNB: Pre: 9.15 vs Post: 2.20 per 1000 patient-days *Interventions greatest impact was in reducing new cases of K. pneumoniae, rather than of P. aeruginosa* *202 new cases over 35,909 patient-days over the course of the study (43 months pre, 29 months post)* **No secondary outcomes**	A new water-safe policy, including removal of sinks from all patient rooms, reduced incidence of MDR-GNB in endemic setting Impact on different organisms may reflect differences in the adhesion to biofilm; *P. aeruginosa* spread further down into the wastewater drainage; K. pneumoniae would remain in the proximal drains facilitating faster elimination.	56% (5/9)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Cantero (2018) Spain	12 patients with *Chryseobacterium indologenes* infection 232 environmental samples ICU	**Stage 1** Reeducation of staff on standard and contact precautions; Implementation of contact precautions **Stage 2** Removal of aerators; bottled water for patients; Point-of-use water filtration for clinical care and respiratory devices reprocessing **Stage 3** Close down of patient care handwashing station; Sealing of hemodialysis drain connections; Waterless patient hygiene; Re-design of the reprocessing room incl. training in reprocessing	**Primary outcomes** 2.72 *C. indologenes* cases per 1,000 patient days, then no cases for 5 months after introduction of stage 3 of interventions **Secondary outcomes** *C. indologenes* was identified in: - 8 handwashing sinks in patient boxes; 5 of these related to patient cases. - 3 air samples taken close to the sinks Environmental and patient samples were genetically linked Many other species of bacteria were recovered from the water drainage system and air samples close to the sinks	Sinkholes can act as a reservoir for microorganisms, therefore, patients and equipment should be protected from sink splashes to avoid contamination	50% (4/8)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Martischang (2025) Switzerland* *Same setting as Catho (2021) but different organism and timeframe	167 cases of *Serratia marcescens* infection or colonisation ICU	**Intervention period 1: *Behavioural***, training sessions, procedures to enhance standard precautions, and segregation of contaminated and non-contaminated areas ***Intervention period 2: Architectural:*** removed all sinks from patient rooms, and most of the sinks in medication preparation areas. Water-free' patient care: Bottled water Electric / bottled water shaving Chlorhexidine-free washing gloves Shampoo cap Disposable materials for canula care Hand washing: soap followed by ABHR ***General Infection Control and Surveillance Measures***, including patients on ventilation for more than 48 h underwent thrice-daily selective oropharyngeal decontamination (SOD)	**Primary outcome** The interventions did not significantly reduce S. *marcescens* incidence per 1000 patient days: Baseline:2.74 Period 1:1.69 Period 2: 2.95 **Secondary outcomes** Interventions did not significantly change hand hygiene compliance or antibiotic consumption. There was an association of infection with administration of SOD.	The outbreak was not controlled by interventions. Waterless care may not have been effective due to the selective pressure by SOD or the maintenance of ventilatory circuits.	44% (4/9)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Schärer (2023) Switzerland	255 patients 276 environmental samples with multi-drug resistant *Pseudomonas aeruginosa* ICU	Intervention Part 1: Replacement of the sink siphons Intervention Part 2: Removal of all sinks in the proximity of patients and in medication preparation areas Waterless patient care: Handwashing of visibly soiled hands; designated 'contaminated' sink outside of patient and medication preparation areas, followed by ABHR Bottled drinking, medication and oral care water Body washing - Disposable washing gloves Disposable cap internally coated with a pre-moistened cloth Shaving - Use of filtered water Intermittent haemodialysis - Use of modified pre-existing connections in patient areas (Flushing of water pipes) Both periods included standard containment measures	**Primary outcome** 29/255 (11%) patients with a MDR *P. aeruginosa* infection or colonisation with clonality in 28 patients and all 10 environmental samples. **Secondary outcomes** MDR P. *aeruginosa* was isolated from sinks samples (10/134, 7.5%) and gastroscopes (1/8, 12.5%), but not air samples. The outbreak strain initially re-grew in replaced sink siphons (intervention 1), but not after intervention 2.	Sink removal combined with the introduction of waterless patient care terminated the outbreak Water systems in ICUs represent a risk for outbreaks with biofilm-associated bacteria, especially in stagnant water, such as sink siphons.	38% (3/8)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Tracy (2020) Australia	Total 120 52 Phase 1 65 Phase 2 3 Phase 3 Babies positive for multidrug-resistant gram-negative bacteria (MRGNB) NICU	**Phase 1 (Jan 2006 - Jan 2007):** • All neonates sampled weekly • Environmental screening • Cohorting of MRGNB-positive babies • Sink cleaning, mechanical clearing and replacement of drain pipes • Intensive ward level education • Restriction of broad-spectrum antimicrobials • Reinforcement of good hand hygiene practices **Phase 2 (Feb 2007 - May 2007)** Phase 1 plus: • Neonates screened twice weekly • Intensification of hand hygiene and antimicrobial use interventions • Staff screening **Phase 3 (Jun 2007 - Dec 2007)** Phase 2 plus: • Routine bathing of neonates in NICU prohibited • 6/8 NICU sinks decommissioned (remaining sinks were used only when an aseptic surgical technique was required)	**Primary outcome** After phase 3 and more than 10 years without sinks, cases of MRGNB have been occasional and sporadic, with no outbreaks of traceable to water supply. Phase 1:Sustained evidence of MRGNB transmission Phase 2: Sustained detections of MRGNB continued (65 babies MRGNB positive) Phase 3: Dramatic and persistent decrease in the colonisation of neonates in the NICU (three new isolates detected in the remainder of 2007) **No secondary outcomes**	"Cessation of routine bathing of infants and closing of most of the unit's sinks rapidly and persistently decreased the incidence of colonisation via presumed droplet transmission." (p.510)	25% (2/8)

Table A4c: Sink removal without additional waterless care interventions: 5 studies

Sink removal without additional waterless care interventions: Level I: Narrative reviews (n = 2)

Citation N studies	Review aim	Key findings	Key conclusions (headline findings)	QA score
Kearney (2021) n=30	To describe interventions to minimise the contamination of hospital sinks by carbapenemase-producing bacteria (CPB) and prevent transmission to vulnerable patients	From most to least effective, interventions were: (1) Remove handwashing sinks from critical care units (2) Physical barriers or room modification to protect patients from sinks e.g. sink placement, drainage and sink/wastewater system interaction (3) Engineering controls e.g. drain covers, waste disposal covers, heating and vibration units to remove drain contamination (4) Administrative controls low quality evidence due to bundled nature of interventions e.g. screening, staff education, workflow changes	"Ascertaining the optimal method to end CPB outbreaks in critical care is challenging due to the lack of prospective studies available … literature suggests that sinks can and do serve as reservoirs of CPB near critically ill patients, and should be considered hazardous, especially when sub-optimally designed or used " p.55	50% (6/12)

Citation N studies	Review aim	Key findings	Key conclusions (headline findings)	QA score
Parkes (2018) n=42 (as per table 1)	Review recent outbreaks related to contaminated hospital sinks with a focus on design features and healthcare provider behaviours; discuss risk mitigation strategies	**Recent outbreaks:** "While any water source within healthcare facilities may be susceptible to colonisation with waterborne pathogens, contaminated hand hygiene sinks are commonly implicated as the source of outbreaks. These outbreaks most frequently occur in neonatal and adult intensive care units (ICUs) and burn units, as well as hematology-oncology and transplant wards" p1.2 **Mitigation strategies:** 1. Address design features that promote sink-related infections: (a) promotion of biofilm and (b) disruption and dispersion of biofilm (c) basin depth (d) faucet positioning 2. Behavioural contributors: (a) misuse of sinks, (b) placement of patient care materials adjacent to sinks Infection control strategies: (a) cleaning and disinfection, (b) biofilm disruption, (c) point-of-use filters, (d) replacement of sink plumbing and/or fixtures	Hospital sinks provide a permissive environment for biofilm formation and microbial colonisation, and sink-related outbreaks are increasingly reported over time. The role of hospital sinks has become even more salient in the era of emerging antimicrobial resistance…. Risk mitigation strategies such as cleaning and disinfection as well as sink replacement have been employed with variable success, often halting outbreaks or reducing clinical cases but failing to decolonize the sinks." p.11	33% (4/12)

Sink removal without additional waterless care interventions: Level III-3 (n = 3)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
De-Las-Casas-Cámara (2019) Spain *One less year of data than De-Las-Casas-Cámara (2022)	951* (302 pre vs 350 post) non-fermenting gram-negative bacilli (NFGNB) isolates related to bronchoaspirate samples (BAS) of patients with invasive mechanical ventilation (IMV) ICU	Removing sinks from ICU cubicles *Same intervention as De-Las-Casas-Cámara (2022)	**Primary outcome** Significant reduction in isolates related to healthcare per 1000 days of IMV of isolations between pre-intervention 11.28 (n=29) and post-intervention:1.9 (n=2) *The results for isolates related to healthcare and cases related to healthcare were similar.* **No secondary outcomes**	NFGNB was detected in existing faucets and previous infection control measures failed, however removal of sinks was successful to stop the outbreak The only potentially relevant complementary intervention was the indication to reduce nebulisation through inhalation – the mask is now discarded after each use	56% (5/9)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
De-Las-Casas-Cámara (2022) Spain *An additional year of data than De-Las-Casas-Cámara (2019)	1,291* (302 pre vs 690 post) patients with antibiotic consumption for *Enterobacteriaceae* and NFGNB ICU	Removing sinks from ICU cubicles *Same intervention as De-Las-Casas-Cámara (2019) (water-free wipes, mitts, and scalp caps in the second post-intervention year to replace the system of bottles and dishes with soap and water – however the authors stated this did not impact the measured year 2016 – 2017 “in which the main effect is the sinks removal” (p. 3)	**Primary outcome** Antibiotic consumption**:** *Enterobacteriaceae* Pre-post Defined daily doses (DDD) 4642.28 vs. 1469.46: 1.61-fold lower *NFGNB* 5598.45 vs. 1276.33: 2.24-fold lower **Secondary outcomes** Multi-drug resistant bacteria days Pre-post intervention: 149.07 year 1 219.41 year 2 (n=24) vs. 104.21 year 1 97.68 year 2 (n=47) 1.84-fold lower	Removal of the sinks reduced the consumption of antibiotics and MDR days Results to justify sink removal: 1. Parallel reduction in the pre-existing NFGNB problem 2. Pre-intervention reduction antibiotic consumption for Enterobacteriaceae but not NFGNBs 3. Antibiotics for NFGNBs reduced after the sink removal with higher magnitude cf. Enterobacteriaceae antibiotics; consistent with the fact that the highest ratio of NFGNBs are found in wet reservoirs 4. Reduction in Zero Resistance indicators statistically significant post-intervention, while a similar reduction was not seen at the regional and national levels.	56% (5/9)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Debast (2025) The Netherlands	Total 10 (5 colonized and 5 infected) patients with Verona Integron-encoded Metallo-β-lactamase-positive *Pseudomonas aeruginosa* ICU	Infection control measures (pre): Bi-weekly patient MDRO screening Contact tracing and patient isolation Environmental swabs if CRPA-VIM positive Selective decontamination (SDD) regimen Water drainage-free procedures Reinforced hand hygiene for medical staff and patients Environmental cleaning **Chronological sink activities:** Single sink decontaminated New splash- and aerosol-reducing inlets, renewed 3 monthly unless positive culture occurred earlier Monthly replacement of new splash- and aerosol-reducing inlets Replacement of faucets Removal of all water fixtures in patient rooms	**Primary outcome** Contaminated sinks were identified as the outbreak source. A bundle of infection prevention measures did not terminate the outbreak, only removal all water fixtures stopped transmission of Verona Integron-encoded Metallo-β-lactamase P. *aeruginosa.* *Contact tracing and source investigations found no interpatient transmission.* **No secondary outcomes**	Sinks were identified as the source without interpatient transmission Future hospital design should minimize contamination from drains and sinks to reduce the nosocomial infection risk	38% (3/8)

Table A4d: Waterless care interventions without sink removal: 7 studies

Waterless care interventions without sink removal: Level I: Systematic reviews (n = 2)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions reported by authors	QA scoring
Groven (2017) N = 6	To assess the effectiveness of washing without water in comparison to the traditional bed bath for the full body wash of immobile patients.	"The results of these high-quality studies show that washing without water performed better than the traditional bed bath regarding skin abnormalities and bathing completeness. No differences between washing without water and the traditional bed bath were found for outcomes related to significant skin lesions, resistance during bathing and costs in the studies of high quality." (p.1)	"Only two studies (of the same research group) were considered of high quality" (p.1)	Compared to the traditional bed bath, washing without water might offer more advantages and value to the patient and the nursing staff, but possibly also to other stakeholders such as family members and the management of health care institutions …There is a need for additional research to focus on hygiene outcomes, value perceptions and experiences "(p. 14)	69% (9/13)
Zanichelli (2021) N = 7	"compare the efficacy of different bathing practices in reducing skin colonisation, health care-associated infections (HAI) or their impact on skin integrity." (p.3)	"3 of 4 studies showed a potential benefit of disposable washcloths and no-rinse skin products to protect the skin from mild lesions, in particular when they are used in elderly and dependent patients … In terms of the impact on HAIs and skin colonisation, none of the included studies addressing these outcomes described a significant beneficial effect of bathing."(p.606-607)	MMAT was used in this study "Caution is required when interpreting the findings of this systematic review given the small number of eligible studies for each outcome of interest" (p.607)	"in adult patients, skin colonisation and the risk of HAI are minimally affected by the bathing technique or frequency … prevention approaches that combine different interventions are usually more effective in reducing HAI than single preventive measures …use of no-rinse washcloths could be implemented in elderly patients in long-term care settings where disruption of skin integrity is more prevalent." (p.607)	69% (9/13)

Waterless care interventions without sink removal: Level I: Narrative reviews (n = 2)

Citation N studies	Review aim	Key findings	Key conclusions (headline findings)	QA score
Mallinckrodt (2023) n=80	"a review of the literature on healthcare-associated E. *E. anophelis* outbreaks … recommendations on infection prevention strategies and control measures based on the published scientific evidence and our own experience." (p. 2)	"The most commonly detected sources of outbreaks were water taps with aerators, however, transmission from patient-to-patient, through contaminated medical equipment or donor tissue as in the presented case are also established routes." p.10 "Infection control specialists should be counselled in the design of patient rooms. In high-risk units like intensive cares, the use of wet points should be avoided as much as possible." p4	Strategies to prevent and reduce spread *of E. anophelis* include water-free patient rooms, adequate hygiene and disinfection practices, and optimised diagnostic techniques for screening, identification and molecular typing.	67% (8/12)
Boyce (2023) N= not specified	"To update information regarding the best practices and products for preoperative bathing, surgical hand scrubs, surgical site preparation, daily chlorhexidine gluconate (CHG) bathing in intensive care units (ICUs) and non-ICU settings, and for prevention of infection during intravascular access" p.58	**Preoperative bathing:** Current guidelines recommended plain or antimicrobial soap prior to surgery, but do not make recommendations on the timing of baths, total number of baths, or use of CGH-impregnated cloths. **Surgical hand scrubs:** antimicrobial soap and ABHR yields similar SSI rates, however ABHR may cause less skin irritation is easier to use and requires shorter scrub times vs. antimicrobial soap. **Surgical site preparation:** guidelines recommend alcohol-containing antiseptic: products often contain isopropanol combined with either CHG or with povidone iodine. **Daily CHG bathing:** reduces incidence of central line associated bloodstream infections in ICU; evidence is mixed for non-ICU patients; numerous barriers to implementation in ICU.	Progress has been made on skin antisepsis products and protocols, but regardless of the type of skin antiseptic selected, improvements in technique are still needed.	58% (7/12)

Waterless care interventions without sink removal: Level II: Randomised controlled trial (n = 1)

Author (date) Country	Sample size Setting	N Participants Intervention	N Participants Control	Results (bold = primary outcome)	Key conclusions reported by authors	QA score
Martin (2017) United States	2,637 patients Medical-surgical units	A. Prepackaged disposable washcloths	B. Traditional bath basins (soap and water) B followed by A (crossover trial, 8 months each)	**Primary outcome** No difference between groups on the incidence of hospital-associated infections or MDRO acquisition **Secondary outcome** Patient skin integrity deterioration was significantly less in the intervention group	"We were unable to demonstrate a statistically significant reduction in HAI or MDRO acquisition associated with basin elimination, we were able to demonstrate 4 instances where the same MDRO pathogen was isolated from a clinical patient culture and the basin of the same patient after standard-of-care (basin) bathing"	60% (6/10)

Waterless care interventions without sink removal: Level III-3: Interrupted time series without a parallel control group (n = 2)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Baker (2021) United States	105 patients 137 unique episodes of hospital-onset respiratory nontuberculous mycobacteria (NTM) isolation ICU (3 ICUs and 1 intermediate unit)	May 2014 Unit-wide tap water avoidance occurred in 3 ICUs and 1 intermediate lung transplant stepdown unit: Sterile water for consumption and patient-care activities requiring water Ice was also avoided After 11 months, other changes were made "to the hospital's water management plan to improve water flow rates, temperature gradients, and disinfectant levels" (p.524)	**Primary outcome** NTM isolation decreased from 41.0 to 9.9 episodes / 10 000 patient-days during the 19-month intervention period (IRR, 0.24; 95% CI .17–.34; P < .0001) Rates of hospital-onset episodes of respiratory NTM isolation per 10 000 patient-days decreased significantly for *Mycobacterium abscessus* complex, *Mycobacterium chelonae-Mycobacterium* immunogenum, *Mycobacterium avium* complex and *Mycobacterium gordonae* "After implementation of the protocol, overall pulmonary NTM acquisition on the 4 study units decreased by 76%." (p.526) **No secondary outcomes**	"We demonstrated a substantial decrease in respiratory NTM isolation among ICU and intermediate unit patients after introduction of a protocol for tap water avoidance. Other hospitals with endemic NTM, new water systems, or patients at high risk for pulmonary NTM infection, such as lung transplant recipients, should consider implementation of similar protocols." (p.526-527)	75% (6/8)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Moulin (2024) Switzerland	5 cases with New Delhi metallo-betalactamase positive Klebsiella pneumoniae (NDM-KP) Neurosurgical intermediate care unit	**General measures:** Weekly screening for intestinal carriage of MDRO in ICU; Targeted screening in non-ICU setting; Contact precautions; Contact tracing **Enhanced measures** Education rounds to reinforce hand hygiene; Material and environment disinfection; Enhanced environmental cleaning **Sink measures (chronological order)** Replaced NDM-KP-positive P-traps; Weekly steam disinfection; Replaced the whole washbasin circuit of colonised sinks with daily disinfection by chlorine bleach; Combined disinfection with chlorine bleach and steam over 3 months	**Primary outcome** Sinks continually re-colonised or remained colonised until the final component of the sink intervention. Subsequently, no new NDM-KP patient cases were detected and sink traps remained negative at 6 months. **Secondary outcome** 3/8 sink traps were positive for NDM-KP with all isolate genomes were genetically similar	Successful control of an environmental reservoir using multimodal IPC measures, underscored by waterless patient care and the meticulous replacement and disinfection of P-traps and connecting pieces. Multidisciplinary collaboration (plumbing and cleaning) is required for success	50% (4/8)

Table A4e: Alcohol-based hand rub vs. soap and water: 1 study

Level I – Systematic Review (n = 1)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions (headline findings)	Strategy	QA scoring
Kuti (2021) N = 6	"To determine the effectiveness of different hand hygiene agents for preventing neonatal infection in both community and health facility settings"	"Two percent chlorhexidine gluconate (CHG) antiseptic detergent) probably reduces the risk of bacterial infections in neonates compared to alcohol hand sanitiser within the first 28 days of life…There was not much difference in the undesirable effects of various hand hygiene interventions on the skin of caregivers. We are not sure which type of hand hygiene is best for preventing infection in newborn babies" (p.3)	"Three studies were rated as having low risk for allocation bias, two studies were rated as unclear risk, and one was rated as having high risk. One study was rated as having a low risk of bias for allocation concealment, one study was rated as unclear risk, and four were rated as having high risk. Two studies were rated as having low risk for performance bias and two were rated as having low risk for attrition bias." (p.2)	"the sparse available data were of moderate- to very low-certainty. We are uncertain as to the superiority of one hand hygiene agent over another because this review included very few studies with very serious study limitations" (p.2)	ABR vs soap / water	100% (13/13)

Table A4f: Secondary review question: How could health service organisations measure the environmental impact of waterless models of care? Evidence gathered from search for Primary review question

Study Characteristics: Level I - Systematic reviews (n = 1)

Author (date) N included studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions (headline findings)
Sridhar (2024) N = 12	Determine whether waterless hand rubs are suitable as hand scrubs for preoperative hand antisepsis	Due to increasing water scarcity, traditional hand scrubbing methods need to be replaced with waterless methods with no compromise on infections or patient safety. Compared to traditional surgical scrubbing, hand rubbing takes up significantly less water making it beneficial in resource-limited settings.	Quality of included studies not stated. Authors note that while procedures across studies were generally similar, some variations still exist.	Overall, waterless hand rubbing is as effective as hand scrubbing in preventing surgical site infections and is therefore a viable solution to address water scarcity concerns. All studies except one reported that hand rub solutions are also more affordable, making them accessible in poorer countries and hospitals.

Study Characteristics: Level I - Narrative reviews (n = 2)

Author (date)	Review aim	Key findings	Key conclusions (headline findings)
Mastracci (2024)	Evaluate the environmental and cost impact of waterless alcohol-based hand rubbing compared to traditional water-based hand scrubbing.	Waterless alcohol-based hand rubbing (ABR) for hand antisepsis offers cost savings and supports value-based care. It reduces expenses related to water, scrub materials, and OR time. Though the cost of water at a specific hospital facility varies based on location. Depending on scrub sink flow rate, a 5-minute scrub uses an estimated 16–34 L of water. Some studies note that sinks are occasionally left running after scrubbing. Eliminating water use also removes the need for hand towels, which require water for laundering. Switching from traditional water-based scrubbing to ABR can reduce environmental waste and care costs. Water costs vary by facility, but ABR materials are generally cheaper than those for water-based scrubbing (e.g., soap and scrub brushes vs. soap-impregnated brushes, picks, and towels). ABR is also faster, potentially lowering OR time costs. While these costs differ across facilities, ABR's time efficiency can benefit both hospitals and patients.	Converting to waterless alcohol-based hand rubbing can save millions of litres of water annually, helping reduce surgical staff's impact on resource overuse and water scarcity, without compromising patient care.
Wyssusek (2025) N = 82	Investigate how current operating room (OR) practices in Australia affect the environment and determine how greening initiatives can be improved.	Paper looks at OR waste in general, not focused on waterless care. A 2008 study reported that in a UK hospital, approximately 932,000 litres was used annually for surgical handwashing and suggested replacing traditional water-and-soap scrubbing with alcohol-based hand rubs. Based on this data, the authors recommended a scrub at the start of the operating list, followed by alcohol-based rubs between cases if hands are not visibly soiled. However, they also noted that "despite the reduction in wasted water, this approach was found to be more costly than traditional hand hygiene practices." (p.14)	In general, greening interventions in the perioperative environment should occur in small steps because acceptance by staff members is more likely to occur when changes take place gradually.

Study Characteristics: Level IV - Case series (n = 3)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors
Carannante (2024) Not stated but all authors are from Italy	N = 6 surgeons Operating room	N = 3 surgical wash with alcohol-based solution N = 3 surgical wash with water Estimated the water and soap usage over a two-year period for traditional surgical hand disinfection and the associated water volumes and costs were compared with those of alcohol-based agents.	**Primary outcome** A significant volume of water is saved when using alcohol-based surgical hand scrub. It was estimated that in a two-year period covering 1,190 surgeries, alcohol-based scrubbing used just 23.8 L of water, compared to 71,500 L with traditional methods. **Secondary outcome** The cost of brushes for traditional scrubbing was approximately €1,800, while alcohol-based scrubbing cost € 216.	In regions without advanced water-saving infrastructure, adopting a waterless hand disinfection policy could significantly reduce OR environmental impact without compromising patient safety.
Posso (2025) United States	N = 8 OR scrub sinks Operating room (plastic and reconstructive surgery)	Volume of water collected 3 times from each OR sink while cost estimates for alcohol-based scrub solutions and impregnated wet-scrub brushes were from the perioperative service of the hospital	**Primary outcome** OR scrub sinks used an average of 7.62 L of water in 2 minutes. If every procedure used water-based scrubbing, water consumption would reach 87,233.76 L per year. Shifting to waterless scrubbing resulted in annual supply cost savings of $3,090.96 (USD). Therefore, replacing a 6-minute water-based scrub with alcohol-based hand hygiene for every surgery could yield estimated annual savings of $1,316,445.48 (USD). **No secondary outcomes**	Adopting alcohol-based scrubs can yield substantial savings. Water use could be reduced by nearly 90,000 litres annually, offering notable environmental benefits. Economically, alcohol-based scrubs are less costly than impregnated brushes, lowering consumable expenses by thousands of dollars each year. Additionally, replacing water-based scrubs with waterless procedures may also save up to $1 million (USD) annually through reduced perioperative time costs.

Restaino (2024) Italy	Results are based on the estimate that there are 1715 scheduled gynecologic surgeries a year Operating block (gynecology)	Handwashing with medicated soap vs. waterless alcohol-based hand rub In the case of chlorhexidine scrub, the amount of water used is obtained by calculating 2.04 L multiplied by 3 min totalling 6.12 L of water used per scrub; the quantity of product recommended per scrub is 10 mL	**Primary outcome** Daily water use for surgical handwashing estimated at 140.7 L for chlorhexidine; 187.6 L for povidone-iodine; 0 L for ABHR. Water use per scrub 6.12 L for chlorhexidine; 8.16 L for povidone-iodine - 10 ml of product used per scrub. ABHR use no water and only 3 ml of product per scrub. Statistically significant differences were found in water use, product volume, and number of scrubs per bottle (P = 0.001). **Secondary outcomes** ABHR reduces plastic waste. Each 500 ml bottle provides 167 scrubs (3 ml per use) cf. 50 scrubs per bottle for povidone-iodine and chlorhexidine (10 ml per use). ABHR eliminates need for plastic brushes, sponges, and individually wrapped towels Daily scrub costs €1.15 for povidone-iodine/chlorhexidine; €0.23 for alcohol-based antiseptics = annual savings of €225.4 excluding plastic disposal costs, which were likely higher for traditional scrubs At an estimated €2.50 per bottle, cost per scrub is €0.05 for povidone-iodine and chlorhexidine, and €0.01 for alcohol-based hand rubs resulting in 80% cost savings. ABHR saves 62.5% and 50% in time compared to povidone-iodine and chlorhexidine respectively (P = 0.023) and reduce antiseptic product use by 70%.	“Given its [alcohol-based surgical hand rub] non-inferior antiseptic efficacy, this water-saving and plastic-saving procedure is easy and, if routinely adopted by surgeons, it would allow the use of such a precious resource as water to be optimised, thus making operating theatres “greener” “

Table A4f: Secondary review question: How could health service organisations measure the environmental impact of waterless models of care? Evidence gathered from de novo searching

Study Characteristics: Level I – Narrative review (n = 1)

Author (date)	Review aim	Key findings	Key conclusions (headline findings)
Duane (2022)	Compare the environmental sustainability of the UK population of four methods of hand hygiene in the COVID-19 context. These include ethanol-based hand scrub (HS), isopropanol-based HS, liquid soap Handwash (HW), and bar soap HW.	A life cycle assessment (LCA) of the four hand hygiene methods was performed and measured against 16 measures of sustainability such as climate change (kg CO_2 eq), fossil fuel use (MJ) and ozone layer depletion (kg CFC^{11} eq). The overall human health impact was measured using Disability Adjusted Life Years (DALYs). The biggest contributor to the DALY impact, for all methods of hand hygiene, was ozone depletion (kg CFC^{11} eq) followed by water usage (m^3 water eq). Soap: The LCA of liquid soap showed that the soap oils used (e.g., palm and coconut oils) contributed significantly to its environmental footprint, ranging from 24% for ionising radiation to 93.6% for freshwater eutrophication. Both liquid and bar soaps require tap water for handwashing, which accounts for 28% of the footprint, while laundering hand towels adds 10.17% for liquid soap and 17.92% for bar soap, respectively. The authors also note that additional water will be required to treat the wastewater produced from this method. Overall, bar soap is environmentally preferable compared to liquid soap due to reduced plastic packaging and lower soap usage per wash. Alcohol scrub: The LCA showed that isopropanol performed better than ethanol in nearly all environmental impact categories except fossil fuel use, as it is derived from fossil fuels while the ethanol studied was produced via fermentation. However, fossil fuel use was the least significant of the 16 sustainability measures in the LCA, with normalised results of zero across all products. In general, hand sanitiser was found to be more environmentally sustainable than handwashing with liquid soap, primarily due to handwashing requiring water use and hand towels for drying.	Overall, “isopropanol HS had the lowest impact in 14 out of the 16 categories, followed by ethanol HS and bar soap (which had the lowest impact in fossil fuel use and photochemical ozone formation respectively).” (p.48740) In conclusion, hand hygiene using hand sanitiser or soap and water all have an environmental impact, however, when compared, isopropanol-based HS was more environmentally sustainable than handwashing with soap.

Study Characteristics: Level IV - Case series (n = 2)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors
Gasson (2023) United Kingdom Determine potential water and financial savings by switching exclusively to an ABHR	Hand trauma surgery (n = 5) Carpal tunnel release (CRT) surgery (n = 16) “Each case had three to four persons scrubbing included lead surgeon, surgical assistant, scrub nurse and/or a medical / nursing student.” Operating room	Estimated water consumption by recording the time taken to fill a 1 L volumetric jug. Collected 3 samples, calculated mean and then extrapolated it to determine the amount of water dispensed from the tap in a standard 3 min scrub and subsequent 1 min scrub	**Primary outcome** Based on average jug fill time of 8.75 s (tap flow rate of 0.11429 litres / sec), 3-minute surgical scrub uses 20.57 litres of water per person (each additional minute 6.8574 litres). Hand trauma:143.99 litres / day (47.96 litres per person) CRT: 411.4 litres / day (205.7 litres per person) Use of ABHR could save 82.29 litres per day for a major trauma list and 288.7 litres per day for a CRT, reducing water usage by 57% (hand trauma) to 70% CRT). Hand trauma: £2.04 for chlorhexidine, £3.60 for iodine; £2.40 for alcohol rub. CRT: £7.14 for chlorhexidine, £12.60 for iodine, £8.40 for alcohol rub. Use of ABHR not a significant financial obstacle **No secondary outcomes**	Significant water savings can be achieved by switching to ABHR. However, further investigation is needed to understand the risk profile of this change. A prospective study should be conducted within hand trauma and CTR lists to assess infection rates, treatment costs, and follow-up requirements. To improve the sustainability of hand trauma and CTR lists, it is essential to consider the broader impact of this change, including outcomes beyond the surgical procedure itself i.e. areas not addressed in the current study.

Javitt (2020) United States A cost analysis was conducted to identify potential savings transitioning to waterless hand antisepsis.	8 scrub sinks Bascom Palmer Eye Institute (BPEI) Operating room (OR)	To measure flow rate water was allowed to run continuously for 2 minutes following WHO guidelines for surgical hand antisepsis. A five-year review of surgical activity at BPEI showed an annual average of 12,921 surgical procedures, with each procedure involving an average of three scrubbed personnel.	**Primary outcome** Switching exclusively to ABHR resulted in annual water savings of 61,631 litres per OR = $280,000 - $348,000 savings per OR per year. Wet scrub uses 15.9 litres of water = 47.7 litres per procedure. Average cost is $0.45 per litre = $277 per OR annually ABHR cost is $30.16 per 500 mL = $0.36 per scrub (6 ml / scrub, 83 procedures / container). Aqueous soap costs $18.41 per container = $0.33 14 mL / procedure), Chlorhexidine gluconate-impregnated scrub brushes cost $0.43 per unit. Overall, switching to waterless scrub methods yields supply cost savings of $1,360 per OR annually when dispensers are used, and $548 when chlorhexidine brushes are used. Scrub materials alone could cost $4,534 per scrubbed staff member per year. Operating room time = $53 per minute. 5-minute aqueous scrub = $279,623 additional cost per OR per year; increased to $348,102 per OR per year using WHO standard 6-min scrub time. **No secondary outcomes**	A shift from traditional water-based preoperative hand antisepsis to waterless, alcohol-based techniques could save a modern U.S. healthcare institution approximately $281,323 per operating room (OR) annually The majority of cost savings stem from reduced supply costs and savings in chargeable OR time. Cost per scrub using alcohol-based products is two-thirds that of traditional wet scrub; and less than half the cost of a wet scrub using soap dispensers and brushes. Switching to waterless scrubs also frees up resources for sanitation and drinking water Waterless hand antisepsis is now well established as equal or superior to traditional scrubbing in terms of safety and efficacy. The study concludes that while water savings are notable, the greater financial impact lies in reduced supply, staff, and facility costs—offering both environmental and economic benefits.

Appendix 5: List of guidelines searched for references to environmental impacts of waterless care

Guideline	Reference to environmental impact of waterless care
NICE (2017) Healthcare-associated infections: prevention and control in primary and community care	Not mentioned
NICE (2017) Antimicrobial stewardship: changing risk-related behaviours in the general population	Not mentioned
NHMRC approved guidelines (2015-2025) 35+ guidelines checked	Not mentioned
NHMRC Preventing Infection: 2.2 Hand Hygiene	Environmental impacts of suggested hand hygiene (soap and water, hand sanitiser) and hand drying methods not mentioned.
WHO (2024) Water, sanitation and hygiene and infection prevention and control measures for infectious diarrhoea in health-care settings	Not mentioned
WHO (2025) Infection prevention and control: Alcohol-based handrub risks and hazards	Not mentioned
WHO (2009) WHO Guidelines on Hand Hygiene in Health CareFirst Global Patient Safety Challenge Clean Care is Safer Care	Not mentioned
WHO (2023) Global action plan and monitoring framework on infection prevention and control (IPC), 2024-2030	Not mentioned
GIN (2025) epic4: Guidelines for the prevention of healthcare-associated infections	Doesn't seem to be published yet
CDC (2024) About Handwashing	Not mentioned
CDC (2024) Hand Sanitizer Facts	Not mentioned
CDC (2024) Hand Sanitizer Guidelines and Recommendations	Not mentioned
CDC (2024) Hand Hygiene Frequently Asked Questions	Environmental impacts of waterless care not mentioned, though, guideline states "CDC recommends turning off the faucet after wetting your hands to reduce water use. Then, turn it on again after you have washed them for 20 seconds, to rinse off the soap."
CDC (2024) Clinical Safety: Hand Hygiene for Healthcare Workers	Not mentioned

CDC (2008) Guideline for Hand Hygiene in Health-Care Settings Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force	Not mentioned
CDC (2024) Research Gaps in Patient and Healthcare Personnel Safety	Not mentioned
CDC (2023) Updates: Guidelines for Environmental Infection Control in Health-Care Facilities (2003)	Not mentioned
CDC (2024) Guideline for Hand Hygiene in Healthcare Settings (2002)	Not mentioned
Calabrese et al. (2025) SAGES Guidelines Development: Clinical Practice Guideline Update Standard Operating Procedure	Not mentioned
Singapore Ministry of Health (2024) INFECTION PREVENTION AND CONTROL SPECIFICATIONSFORNEW HEALTHCARE BUILDINGS	Not mentioned
Provincial Infectious Diseases Advisory Committee (PIDAC) (2025) Routine Practices and Additional Precautions in All Health Care Settings, 3rd Edition, 4th Revision	Environmental impacts not mentioned. Guideline mentions ABHRs are less-time consuming than washing with soap and water.
RACGP (2024) Infection prevention and control guidelines: 2. Hand hygiene	Not mentioned
Victoria DoH (2024) Healthcare-associated infection prevention	Not mentioned
Victoria DoH (2024) Infectious diseases: guidelines and advice	Not mentioned
Safer Care Victoria (n.d.) Hand hygiene standards and reporting	Not mentioned
Victoria DoH (2024) Healthcare-associated infection prevention	Not mentioned
Western Australia DoH (2025) Healthcare associated infections	Not mentioned
ACSQHC (2024) National Hand Hygiene Initiative Implementation Guide	“Alcohol-based hand rub is appropriate for all situations where hands are not visibly dirty or contaminated and has the following advantages: - it takes only 15 to 20 seconds to decontaminate hands - it is less irritating and drying for skin than soap and water - it does not require running water or paper towels to dry hands, which reduces waste and helps achieve sustainability objectives.” (pg. 8)

Glossary

Term	Definition
Alcohol-based hand rub (ABHR)	“A TGA-listed alcohol-containing preparation designed for reducing the number of viable microorganisms on the hands without the use or aid of running water, and which is listed on the ARTG as a medicinal product” [p. 260] (National Health and Medical Research Council 2019) (4)
Antimicrobial Resistance (AMR)	“Failure of an antimicrobial to inhibit a microorganism at the antimicrobial concentrations usually achieved over time with standard dosing regimens” [p. 260] (National Health and Medical Research Council 2019) (4)
Clinician	“A healthcare provider, trained as a health professional, including registered and nonregistered practitioners. Clinicians may provide care within a health service organisation as an employee, a contractor or a credentialed healthcare provider, or under other working arrangements. They include nurses, midwives, medical practitioners, allied health practitioners, technicians, scientists and other clinicians who provide health care, and students who provide health care under supervision.” [p. 263] (National Health and Medical Research Council 2019) (4)
Hand hygiene	A general term applying to processes aiming to reduce the number of microorganisms on hands. This includes: application of a waterless antimicrobial agent (e.g. alcohol-based hand rub) to the surface of the hands; and use of soap/solution (plain or antimicrobial) and water (if hands are visibly soiled), followed by patting dry with single-use towels” [p. 263] (National Health and Medical Research Council 2019). (4)
Healthcare associated infections (HAIs)	“Infections acquired in healthcare facilities (‘nosocomial’ infections) and infections that occur as a result of healthcare interventions (‘iatrogenic’ infections), and which may manifest after people leave the healthcare facility” [p. 263] (National Health and Medical Research Council 2019). (4)
Health Care Worker (HCW)	“a person who works in a healthcare setting, whether paid or unpaid, clinical or non-clinical, permanent or casual (includes visiting, sessional and agency), full-time or part-time, in the facilities or services in scope for this guidance. The terms HCW, health worker and staff are interchangeable” [p. 263] (National Health and Medical Research Council 2019). (4)
Surgical alcohol-based hand rub (SABHR)	“Antiseptic hand rub performed preoperatively by the surgical team following the surgical pre-wash to eliminate transient flora and reduce resident skin flora. Such antiseptics often have persistent antimicrobial activity. Use should be in accordance with manufacturers' instructions. Surgical ABHRs are often a waterless and high percent alcohol solution” [p. 268] (National Health and Medical Research Council 2019). (4)
Waterless models of care (also referred to as “water-free” care / models of care)	**Definition supplied by Commission:** “Waterless models of care use products are used to deliver patient care without the need for sinks and tap water. Waterless models of care include: - Waterless bathing/hygiene products for patient care and/or skin decolonisation - Waterless hand hygiene sanitisers, including waterless surgical hand scrub products for healthcare workers (HCWs)” “targeted avoidance of sinks and reduction of tap-water-related activities such as handwashing with disinfectant soap or solution prior to patient care” [p. 45] (Buvaneswarran et al. 2024).

Note: Other operational definitions pertaining to infection and infection control were drawn from the Glossary of the Australian Guidelines for the Prevention and Control of Infection in Healthcare (2019, pp. 260 - 269) (4)

References

1. Buvaneswarran S, Chua MCW, Amin Z, Wang X, Low JM. Knowledge, attitudes, practices, and perceived challenges for healthcare workers on waterless intensive care unit (ICU) care at a neonatal ICU in Singapore. J Hosp Infect. 2024 Apr;146:44–51.
2. Inkster T, Walker J, Weinbren M. Water-free patient care: a narrative review of the literature and discussion of the pressing need for a way forward. J Hosp Infect. 2024 Oct 1;152:36–41.
3. Low JM, Chan M, Low JL, Chua MCW, Lee JH. The impact of sink removal and other water-free interventions in intensive care units on water-borne healthcare-associated infections: a systematic review. J Hosp Infect. 2024 Aug;150:61–71.
4. National Health and Medical Research Council. Australian Guidelines for the Prevention and Control of Infection in Healthcare [Internet]. Canberra, Australia: Commonwealth of Australia; 2019 [cited 2025 July 31]. Report No.: CD34. Available from: https://www.safetyandquality.gov.au/publications-and-resources/resource-library/australian-guidelines-prevention-and-control-infection-healthcare
5. Garritty C, Hamel C, Trivella M, Gartlehner G, Nussbaumer-Streit B, Devane D, et al. Updated recommendations for the Cochrane rapid review methods guidance for rapid reviews of effectiveness. BMJ. 2024 Feb 6;384:e076335.
6. Khangura S, Konnyu K, Cushman R, Grimshaw J, Moher D. Evidence summaries: the evolution of a rapid review approach. Syst Rev. 2012;1(1):10.
7. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021 Mar;n71.
8. Clark J, Barton B, Albarqouni L, Byambasuren O, Jowsey T, Keogh J, et al. Generative artificial intelligence use in evidence synthesis: A systematic review. Res Synth Methods. 2025 Apr 24;1–19.
9. Artificial intelligence at Monash [Internet]. 2025 [cited 2025 Aug 1]. AI Policies and Guidelines. Available from: https://www.monash.edu/ai/tools-training-and-resources/ai-policies-and-guidelines
10. Veritas Health Innovation. Covidence systematic review software [Internet]. Veritas Health Innovation; 2023. Available from: https://www.covidence.org/
11. Feuerriegel S, Hartmann J, Janiesch C, Zschech P. Generative AI. Bus Inf Syst Eng. 2024 Feb 1;66(1):111–26.
12. Ho YH, Wang YC, Loh EW, Tam KW. Antiseptic efficacies of waterless hand rub, chlorhexidine scrub, and povidone-iodine scrub in surgical settings: a meta-analysis of randomized controlled trials. J Hosp Infect. 2019;101(4):370–9.
13. Widodo H, Sesaria TG, Maulana M, Myint NM. Effectiveness of surgical hand washing with chlorhexidine, providone iodine and alcohol on reducing the microorganisms on the hands: A Systematic Review [Internet]. repository.unar.ac.id; 2019. Available from: https://repository.unar.ac.id/jspui/handle/123456789/575https://repository.unar.ac.id/jspui/bitstream/123456789/575/1/112-116.pdf
14. Kuti BP, Ogunlesi TA, Oduwole O, Oringanje C, Udoh EE, Meremikwu MM. Hand hygiene for the prevention of infections in neonates. Cochrane Database Syst Rev [Internet]. 2021;2021(1). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-

85100228929&doi=10.1002%2f14651858.CD013326.pub2&partnerID=40&md5=39ceedd80859e9246d3621f24221dc52

15. Groven F.M., Zwakhalen S.M., Odekerken-Schroder G., Joosten E.J., Hamers J.P. How does washing without water perform compared to the traditional bed bath: a systematic review. BMC Geriatr. 2017;17(1):31.

16. Zanichelli V, Pavoni C, Eastmond J, Longtin Y. Microbiological efficacy and skin tolerance of commonly used nonantiseptic inpatient bathing practices in non-ICU settings: A systematic review. Am J Infect Control. 2021;49(5):603–7.

17. Fucini GB, Hackmann C, Gastmeier P. Sink interventions in the ICU to reduce risk of infection or colonization with Gram-negative pathogens: a systematic review of the literature. J Hosp Infect. 2024;143:82–90.

18. Tanner J, Dumville JC, Norman G, Fortnam M. Surgical hand antisepsis to reduce surgical site infection. Cochrane Database Syst Rev [Internet]. 2016;2016(1). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84966373205&doi=10.1002%2f14651858.CD004288.pub3&partnerID=40&md5=4bbedacd315cb014c62a81d51b3a698d

19. Gök F, Kabu F, Özbayir T. Surgical hand washing: A systematic review. Int J Antisep Disinfect Steril [Internet]. 2016;(Query date: 2025-08-18 17:09:1024 cites: https://scholar.google.com/scholar?cites=15790897343616859334 & as_sdt=2005 & sciodt=0,5 & hl=en). Available from: https://jag.journalagent.com/ijads/pdfs/IJADS-32042-REVIEW-OZBAYIR.pdfhttps://jag.journalagent.com/ijads/pdfs/IJADS-32042-REVIEW-OZBAYIR.pdf

20. Liu LQ, Mehigan S. The Effects of Surgical Hand Scrubbing Protocols on Skin Integrity and Surgical Site Infection Rates: A Systematic Review. AORN J. 2016;103(5):468–82.

21. Low JM, Chan M, Low JL, Chua MCW, Lee JH. The impact of sink removal and other water-free interventions in intensive care units on water-borne healthcare-associated infections: a systematic review. J Hosp Infect. 2024;150:61–71.

22. Boyce JM. Best products for skin antisepsis. Am J Infect Control. 2023;51(11):A58–63.

23. Nthumba PM. Effective Hand Preparation for Surgical Procedures in Low- And Middle-Income Countries. Surg Infect. 2020;21(6):495–500.

24. Khodabakhshi M, Fanoudi H. Hand disinfectants and surgical site infections: A narrative review. J Surg Trauma [Internet]. 2020;(Query date: 2025-08-18 17:09:10). Available from: https://jsurgery.bums.ac.ir/article-1-239-en.htmlhttp://jsurgery.bums.ac.ir/files/site1/user_files_1e1611/fanoodi1376-A-10-236-1-d9cf81b.pdf

25. Fry D. Operating room hand preparation: to scrub or to rub? Surg Infect [Internet]. 2019;(Query date: 2025-08-18 17:09:1011 cites: https://scholar.google.com/scholar?cites=15666999243832250708 & as_sdt=2005 & sciodt=0,5 & hl=en). Available from: https://www.liebertpub.com/doi/abs/10.1089/sur.2018.302

26. Kearney A, Boyle MA, Curley GF, Humphreys H. Preventing infections caused by carbapenemase-producing bacteria in the intensive care unit - Think about the sink. J Crit Care. 2021;66:52–9.

27. Mallinckrodt L, Huis in ’t Veld R, Rosema S, Voss A, Bathoorn E. Review on infection control strategies to minimize outbreaks of the emerging pathogen Elizabethkingia anophelis. Antimicrob Resist Infect Control [Internet]. 2023;12(1). Available from:

https://www.scopus.com/inward/record.uri?eid=2-s2.0-85170194684&doi=10.1186%2fs13756-023-01304-1&partnerID=40&md5=ed6c0ba668126197d126ea7c3361e643

28. Parkes LO, Hota SS. Sink-Related Outbreaks and Mitigation Strategies in Healthcare Facilities. Curr Infect Dis Rep. 2018 Oct;20(10):42.

29. Tsai JC, Lin YK, Huang YJ, Loh EW, Wen HY, Wang CH, et al. Antiseptic Effect of Conventional Povidone-Iodine Scrub, Chlorhexidine Scrub, and Waterless Hand Rub in a Surgical Room: A Randomized Controlled Trial. Infect Control Hosp Epidemiol. 2017;38(4):417–22.

30. Martin ET, Haider S, Palleschi M, Eagle S, Crisostomo DV, Haddox P, et al. Bathing hospitalized dependent patients with prepackaged disposable washcloths instead of traditional bath basins: A case-crossover study. Am J Infect Control. 2017;45(9):990–4.

31. Santé L, Gómez-Lus ML, Martin-Villa C, Becerro-De-Bengoa-Vallejo R, Alou L, Sevillano D. Effect on the reduction of bacterial load after surgical hand antisepsis with triclosan 0.5% compared to triclosan 0.5% followed by 70% alcoholic solution. Infect Control Hosp Epidemiol. 2023;44(3):517–9.

32. Akita S, Fujioka M, Akita T, Tanaka J, Masunaga A, Kawahara T. Effects of Hand Hygiene Using 4% Chlorhexidine Gluconate or Natural Soap during Hand Rubbing Followed by Alcohol-Based 1% Chlorhexidine Gluconate Sanitizer Lotion in the Operating Room. Adv Wound Care. 2022;11(1):1–9.

33. Shen NJ, Pan SC, Sheng WH, Tien KL, Chen ML, Chang SC, et al. Comparative antimicrobial efficacy of alcohol-based hand rub and conventional surgical scrub in a medical center. J Microbiol Immunol Infect. 2015;48(3):322–8.

34. Forer Y, Block C, Frenkel S. Preoperative Hand Decontamination in Ophthalmic Surgery: A Comparison of the Removal of Bacteria from Surgeons' Hands by Routine Antimicrobial Scrub versus an Alcoholic Hand Rub. Curr Eye Res. 2017;42(9):1333–7.

35. Olivia C, Ibrahim K, Kurniawan T. Which Surgical Hand Preparation Method Is More Effective? A Comparative Study of Hand Rub and Hand Scrub. Nurs Rep [Internet]. 2025;15(7). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-105011518404&doi=10.3390%2fnursrep15070242&partnerID=40&md5=2bd1acda7c5357e15c8f28aacb531c1e

36. Cantero M, Parra LM, Muñez E, Iranzo R, Sánchez-Romero MI, Oteo J, et al. A cluster of *Chryseobacterium indologenes* cases related to drainage water in intensive care units. Infect Control Hosp Epidemiol. 2018 Aug;39(8):997–9.

37. Schärer V, Meier MT, Schuepbach RA, Zinkernagel AS, Boumasmoud M, Chakrakodi B, et al. An intensive care unit outbreak with multi-drug-resistant Pseudomonas aeruginosa – spotlight on sinks. J Hosp Infect. 2023;139:161–7.

38. Debast SB, Van Den Bos-Kromhout MI, De Vries-van Rossum SV, Abma-Blatter SEM, Notermans DW, Kluytmans JAJW, et al. Aquatic reservoir-associated outbreaks of multi-drug-resistant bacteria: a hospital outbreak report of Pseudomonas aeruginosa in perspective from the Dutch national surveillance databases. J Hosp Infect. 2025 Aug;162:310–8.

39. Shaw E, Gavaldà L, Càmara J, Gasull R, Gallego S, Tubau F, et al. Control of endemic multidrug-resistant Gram-negative bacteria after removal of sinks and implementing a new water-safe policy in an intensive care unit. J Hosp Infect. 2018;98(3):275–81.

40. Martischang R, Catho G, Cherkaoui A, Boroli F, Buetti N, Pugin J, et al. Impact of Multifaceted Interventions Including Waterless Patient Care on Endemic Occurrence of Serratia marcescens in an Intensive Care Unit. Pathogens [Internet]. 2025;14(4). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-105003397510&doi=10.3390%2fpathogens14040363&partnerID=40&md5=a45ba7c9ec0f51424e73e8f1527df32b

41. de-las-Casas-Cámara G, Giráldez-García C, Adillo-Montero MI, Muñoz-Egea MC, Martín-Ríos MD. Impact of removing sinks from an intensive care unit on isolations by gram-negative non-fermenting bacilli in patients with invasive mechanical ventilation. Med Clin (Barc). 2019;152(7):261–3.

42. De-Las-Casas-Cámara G, Collados-Arroyo V, García-Torrejón MC, Muñoz-Egea MC, Martín-Ríos MD. Impact of sink removal from intensive care unit rooms on the consumption of antibiotics and on results of Zero Resistance Project. Med Clin (Barc). 2022;158(1):1–6.

43. Catho G, Martischang R, Boroli F, Chraïti MN, Martin Y, Koyluk Tomsuk Z, et al. Outbreak of Pseudomonas aeruginosa producing VIM carbapenemase in an intensive care unit and its termination by implementation of waterless patient care. Crit Care [Internet]. 2021;25(1). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85113153839&doi=10.1186%2fs13054-021-03726-y&partnerID=40&md5=8be50f0b51e9ebcba212cc52fedb922e

44. Hopman J, Tostmann A, Wertheim H, Bos M, Kolwijck E, Akkermans R, et al. Reduced rate of intensive care unit acquired gram-negative bacilli after removal of sinks and introduction of “water-free” patient care. Antimicrob Resist Infect Control [Internet]. 2017;6(1). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85020475449&doi=10.1186%2fs13756-017-0213-0&partnerID=40&md5=a6f14121ca1cbe141456a9ece1323240

45. Tracy M, Ryan L, Samarasekara H, Leroi M, Polkinghorne A, Branley J. Removal of sinks and bathing changes to control multidrug-resistant Gram-negative bacteria in a neonatal intensive care unit: a retrospective investigation. J Hosp Infect. 2020 Apr;104(4):508–10.

46. Moulin E, Filippidis P, Paire-Ficout CA, Blanc DS, Grandbastien B, Senn L. Successful control of an environmental reservoir of NDM-producing Klebsiella pneumoniae associated with nosocomial transmissions in a low-incidence setting. Antimicrob Resist Infect Control [Internet]. 2024;13(1). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85208082068&doi=10.1186%2fs13756-024-01488-0&partnerID=40&md5=93f010d7a707e5044c166b77980cc140

47. Baker AW, Lewis SS, Alexander BD, Chen LF, Wallace RJ, Brown-Elliott BA, et al. Two-Phase Hospital-Associated Outbreak of *Mycobacterium abscessus* : Investigation and Mitigation. Clin Infect Dis. 2017 Apr 1;64(7):902–11.

48. Gaspar GG, Menegueti MG, Lopes AER, Santos ROC, de Araújo TR, Nassiff A, et al. Alcohol-based surgical hand preparation: Translating scientific evidence into clinical practice. Antimicrob Resist Infect Control [Internet]. 2018;7(1). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85049795394&doi=10.1186%2fs13756-018-0372-7&partnerID=40&md5=ddeda68be2846511416222f581afa427

49. Oriel BS, Chen Q, Wong K, Itani KMF. Effect of hand antisepsis agent selection and population characteristics on surgical site infection pathogens. Surg Infect. 2017;18(4):413–8.

50. Iwakiri K, Kobayashi A, Seki M, Ando Y, Tsujio T, Hoshino M, et al. Waterless Hand Rub Versus Traditional Hand Scrub Methods for Preventing the Surgical Site Infection in Orthopedic Surgery. Spine. 2017;42(22):1675–9.

51. Ross P, Perréard D, Genevois E, Boroli F, Pugin J, Zanella MC, et al. Collateral damage of a waterless intensive care unit. J Hosp Infect. 2024 Dec 1;154:126–8.

52. Sridhar L, Phadnis R, Tiruchirapalli KS, Hussain F, Kurumella SND, Chappidi SC. The Ideal Hand Hygiene Method in the Age of Water Scarcity: A Systematic Review and Meta-analysis. World J Laparosc Surg. 2024;17(3):157–63.

53. Wyssusek K, Keys M, ... Operating room greening initiatives–the old, the new, and the way forward: a narrative review. Waste Manag … [Internet]. 2019;(Query date: 2025-08-18 17:09:10232 cites: https://scholar.google.com/scholar?cites=9828612333553885917 & as_sdt=2005 & sciodt=0,5 & hl=en). Available from: https://journals.sagepub.com/doi/abs/10.1177/0734242X18793937

54. Mastracci JC, Bonvillain KW, Gaston RG. Surgical Hand Antisepsis: Environmental and Cost Impact in Hand Surgery. J Hand Surg. 2024;49(9):923–6.

55. Duane B, Pilling J, Saget S, Ashley P, Pinhas AR, Lyne A. Hand hygiene with hand sanitizer versus handwashing: what are the planetary health consequences? Environ Sci Pollut Res. 2022 July 1;29(32):48736–47.

56. Javitt MJ, Grossman A, Grajewski A, Javitt JC. Association Between Eliminating Water From Surgical Hand Antisepsis at a Large Ophthalmic Surgical Hospital and Cost. JAMA Ophthalmol. 2020 Apr 1;138(4):382.

57. Gasson S, Solari F, Jesudason EP. Sustainable Hand Surgery: Incorporating Water Efficiency Into Clinical Practice. Cureus [Internet]. 2023 Apr 30 [cited 2025 Oct 17]; Available from: https://www.cureus.com/articles/152234-sustainable-hand-surgery-incorporating-water-efficiency-into-clinical-practice

58. Carannante F, Bianco G, Miacci V, Mascianà G, D'Agostino F, Costa G, et al. Reducing water use in the operating room: a single-center retrospective analysis. Chir Turin. 2024;37(4):221–3.

59. Posso AN, Bloom J, Tobin M, Mustoe A, Mehdizadeh M, Nguyen KN, et al. Saving millions: The economic impact of switching to waterless surgical hand scrubs in plastic and reconstructive surgery. J Plast Reconstr Aesthet Surg. 2025;107:148–50.

60. Restaino S, Tius V, Arcieri M, Biasioli A, Pellecchia G, Driul L, et al. "Water or not water: That is the question." Analysis of costs and consumption of the operating theaters in a greener perspective. Int J Gynecol Obstet. 2024;165(3):1167–71.

61. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ. 2017;358:j4008.

62. Baethge C, Goldbeck-Wood S, Mertens S. SANRA—a scale for the quality assessment of narrative review articles. Res Integr Peer Rev. 2019 Dec;4(1):5.

63. Merlin T, Weston A, Tooher R. Extending an evidence hierarchy to include topics other than treatment: revising the Australian "levels of evidence." BMC Med Res Methodol. 2009 June 11;9(1):34.

64. The GRADE Book version 1.0 (updated September 2024) [Internet]. 2024 [cited 2025 May 27]. Available from: https://book.gradepro.org/

65. Barker TH, Stone JC, Sears K, Klugar M, Tufanaru C, Leonardi-Bee J, et al. The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials. JBI Evid Synth. 2023 Mar;21(3):494–506.

66. Tufanaru, C, Munn, Z, Aromatis, E, Campbell, J, Hopp, L. Checklist for quasi-experimental studies (non-randomized experimental studies). In Chapter 3: Systematic reviews of effectiveness. In: JBI Manual for Evidence Synthesis [Internet]. Adelaide, Australia: JBI; 2020. Available from: https://synthesismanual.jbi.global

67. Moola, S, Munn, Z, Tufanaru, C, Sears, K, Sfetcu, R, Currie, M, et al. Checklist for cohort studies. In Chapter 7: Systematic reviews of etiology and risk. In: JBI Manual for Evidence Synthesis [Internet]. Adelaide, Australia: JBI; 2020. Available from: https://synthesismanual.jbi.global

68. Moola, S, Munn, Z, Aromataris, E, Sears, K, Sfetcu, R, Currie, M, et al. Checklist for case control studies. In Chapter 7: Systematic reviews of etiology and risk. In: JBI Manual for Evidence Synthesis [Internet]. Adelaide, Australia: JBI; 2020. Available from: https://synthesismanual.jbi.global

69. Munn Z, Barker TH, Moola S, Tufanaru C, Stern C, McArthur A, et al. Methodological quality of case series studies: an introduction to the JBI critical appraisal tool. JBI Evid Synth. 2020 Oct;18(10):2127.

70. National Institutes of Health. The National Institutes of Health (NIH) quality assessment tool for before-after (Pre-Post) study with no control group [Internet]. 2021. Available from: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools

71. Moola, S, Munn, Z, Tufanaru, C, Sears, K, Sfetcu, R, Currie, M, et al. Checklist for analytical case-control studies. In Chapter 7: Systematic reviews of etiology and risk. In: JBI Manual for Evidence Synthesis [Internet]. Adelaide, Australia: JBI; 2020. Available from: https://synthesismanual.jbi.global

Appendix 2: Example search strategy (primary review question)

Example of Ovid MEDLINE(R) <1946 to July Week 4 2025>

#	Query	1 Aug 2025
1	Hand Hygiene/	2,481
2	Hand Disinfection/	6,590
3	(hand adj5 (hygiene or disinfect* or antisep* or disinfect* or wash* or saniti*)).ti,ab,kf.	10,211
4	handwashing.ti,ab,kf.	2,849
5	**or/1-4**	**14,996**
6	(water-free or waterfree or water-less or waterless or "without water*" or "tap water avoidance").ti,ab,kf.	1,800
7	(alcohol* adj5 (handrub* or hand-rub*or handsaniti* or hand-saniti*)).ti,ab,kf.	473
8	(ABHR adj15 (alcohol* or hand*)).ti,ab,kf.	134
9	**or/6-8**	**2,363**
10	**5 and 9**	**633**
11	(hand* adj15 (water-free or waterfree or water-less or waterless or "without water*" or "tap water avoidance")).ti,ab,kf.	100
12	(clinical hand* adj5 (sink* or basin*)).ti,ab,kf.	8
13	((sink* or basin* or hand-basin* or handbasin*) adj5 (removal or avoidance)).ti,ab,kf.	153
14	**12 or 13**	**160**
15	Health Care Sector/ or health facilities/ or academic medical centers/ or health facilities, proprietary/ or hospitals, proprietary/ or hospitals/ or hospitals, community/ or hospitals, general/ or hospitals, group practice/ or hospitals, high-volume/ or hospitals, low-volume/ or hospitals, private/ or hospitals, religious/ or hospitals, public/ or hospitals, county/ or hospitals, district/ or hospitals, federal/ or hospitals, veterans/ or hospitals, municipal/ or hospitals, state/ or hospitals, rural/ or hospitals, special/ or hospitals, maternity/ or hospitals, pediatric/ or hospitals, psychiatric/ or hospitals, teaching/ or hospitals, university/ or hospitals, urban/	331,227
16	(hospital* or "health facilit*" or "health service*" or "health unit*" or "medical facilit*" or "medical cent*" or "health care" or "healthcare").ti,ab,kf.	2,291,669
17	**15 or 16**	**2,381,392**

#	Query	1 Aug 2025
18	**14 and 17**	**17**
19	Cross Infection/	63,557
20	**17 and 19**	**38,823**
21	(water-free or waterfree or water-less or waterless or "without water*" or "tap water avoidance").ti,ab,kf.	1,800
22	**20 and 21**	**34**
23	(((surg* or pre-surg* or operating) adj5 scrub*) and hand*).ti,ab,kf.	252
24	**9 and 23**	**21**
25	**10 or 11 or 18 or 22 or 24**	**689**
26	**limit 25 to english language**	**672**
27	**limit 26 to yr="2015 - 2026"**	**426**

Appendix 3: List of included studies for primary and secondary review questions

Table 3 Surgical hand scrub (ABHR vs soap/water): Level I – Systematic Review (n = 5)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions reported by authors	QA scoring
Tanner (2016) N = 14	Assess the effects of surgical hand antisepsis on (i) preventing surgical site infections (SSIs) and (ii) numbers of colony-forming units (CFUs) of bacteria on the hands of the surgical team	Four trials reported SSIs, all found no clear evidence in risk of SSI for alcohol rub vs. other 10 trials reported CFUs with mixed results	"Studies were small, and some did not present data or analyses that could be easily interpreted or related to clinical outcomes. These factors reduced the quality of the evidence." (p.1)"	"Uncertainty remains about the optimal method of hand antisepsis for minimising SSI outcomes" (p.19)	92% (12/13)
Ho (2019) N = 11	Compare antiseptic efficacies of waterless hand rub (WHR), chlorhexidine gluconate (CHG), and povidone-iodine (PI) in surgical settings	No significant differences in CFU counts between WHR and CHG WHR and CHG significantly lower CFU counts cf. povidone-iodine (PI) No significant differences in surgical site infection (SSI) rates between WHR and traditional hand scrub Waterless hand rubs showed the highest compliance and were most favourable.	Five trials showed high risk, three showed moderate risk and three showed low risk of bias.	"RCTs with consistent outcome measurement and accurate grouping are necessary to obtain comprehensive results" [p. 378]	88% (14/16)
Liu & Mehigan (2016) N = 10	Review evidence of effect of surgical-scrub techniques on skin integrity and SSI	Hand rubbing techniques as effective as traditional scrubbing and better tolerated Hand rubbing appears to cause less skin damage than traditional scrub protocols	More than half of the studies were low methodological quality; three studies moderate quality; one study high methodological quality	"hand rubbing techniques are as effective as traditional scrubbing in preventing SSIs … regardless of concentration and length of time. Hand rubbing techniques better tolerated (less skin	77% (10/13)

		Brushless techniques tolerated better than scrubbing		damage) Brushless techniques better for participants' skin	
Gök (2016) N = 14	Reviewed randomized controlled and experimental studies comparing surgical hand-washing methods and antiseptic agents	The addition of glycerol to alcohol-based products reduced antibacterial effects 85% ethanol has a higher bactericidal effect than other antiseptics Chlorhexidine gluconate can be used in surgical hand washing without scrubbing apparatus, with a higher bactericidal effect compared to povidone-iodine and other alcohol-based products	No quality appraisal reported Of 14 studies included, 2 RCTs, 8 Experimental and 4 RCT/Experimental	Scrubbing / use of special apparatus to scrub nails did not reduce bacteria and are no longer necessary; use of alcohol-based hand antiseptics is more appropriate Technique of surgical hand washing, effect of solution and preference of one over the other remains controversial … more RCTs are required	38% (5/13)
Widodo (2019) N = 11	Determine effectiveness of surgical hand-washing using chlorhexidine, providone iodine and alcohol in reducing microorganisms on the hand	Three articles found alcohol hand rub more effective than chlorhexidine and providone iodine One article found both alcohol hand rub and chlorhexidine are more effective than providone iodine One article reported chlorhexidine, providone iodine and alcohol hand rub were equally effective	Nine journals good quality; two journals moderate quality Sample size varied from 20 - 6344 Measuring instruments included observation sheets, questionnaires, assessment sheets	"Surgical hand-washing using chlorhexidine, providone iodine and alcohol are all effective at reducing microorganisms" (p.112)	23% (3/13)

Table 4 **Surgical hand scrub (ABR vs soap/water): Level I – Narrative Review (n = 3)**

Citation N studies	Review aim	Key findings	Key conclusions reported by authors	QA score
Fry (2019) Overall N not specified; 15 included studies relevant to this review	To address current recommendations and guidelines on surgical hand hygiene and examine antiseptic ‘‘hand rubs’’ before surgical gloving vs. traditional scrub	Alcohol-based hand rubs comparable or better in reducing bacterial counts than other antiseptic choices Addition of chlorhexidine to alcohol rub may enhance antibacterial effects further Limited evidence comparing traditional surgical scrub with the alcohol-based hand rub on the rates of SSIs; four studies demonstrated no differences in SSI rates	“changing the pre-operative ritual at the scrub sink before operations will require years … current evidence favours alcohol rub instead of the traditional scrub … design of better and more tolerable formulations for the rub to minimise the tissue injury from the alcohol preparations appears to be the next step in the acceptance of this method” [p.133]	58% (7/12)
Khodabakhshi (2020) N = 26	To introduce soap and alcohol disinfectant solutions for surgical scrub and describe advantages and disadvantages	Cautions to consider include healthy skin, taking jewellery off, lack of long nails or artificial nails, covering the hair, mask, glasses, and slippers and aprons “Alcohol-based disinfectants have the fastest and strongest effect in reducing microbial load To increase effectiveness of hand hygiene with alcohol-based solutions authors recommended paying attention to the surgical team, teaching principles of their use and following manufacturer's instructions	“The use of hand sanitizers before surgery is one way to prevent SSI. Among these, alcohol-based solutions have been welcomed due to the lack of water consumption, no damage to the skin, high antiseptic properties, and rapid action” [p.89]	50% (6/12)
Nthumba (2020) N not specified	Review current state of surgical hand preparation in low- and middle-income countries	Compared with traditional surgical scrub, ABHRs improves quality and reduces duration of surgical hand preparation and is at least equally effective for preventing SSIs The switch from traditional water-based SHP to ABHRs has not been achieved	“ABHRs are the most efficacious surgical hand preparation products available today. They are cost-effective and can safely be prepared locally in hospitals, even in LMICs” [p. 495]	33% (4/12)

Table 5 Surgical hand scrub (ABR vs soap/water): Level II: Randomised controlled trial (*n* = 3)

Citation Country	Sample size Setting	N Participants Intervention	N Participants Control	Results	Key conclusions reported by authors	QA score
Tsai (2017) Taiwan	240 surgeons and scrub nurses Any surgery	N = 79 Waterless hand rub (1% chlorhexidine gluconate and 61% ethyl alcohol)	N = 77 10% povidone–iodine scrub N = 80 4% chlorhexidine scrub	**Primary outcome** No significant difference in mean CFU count among the groups after surgery. CFU count significantly lower with conventional chlorhexidine and waterless handrub vs. povidone–iodine scrub **No secondary outcomes**	Conventional chlorhexidine scrub and waterless hand rub superior in bacterial inhibition Authors recommended using conventional chlorhexidine scrub as a standard method for perioperative hand antisepsis, with waterless hand rub used if the higher cost is affordable	100% (10/10)
Akita (2022) Japan	36 registered nurses in two hospitals Operating room	N = 18 A. Waterless: handwashing natural soap followed by ABHR [1% chlorhexidine gluconate (CHG)] x 10 days B. Two-stage: scrubbing with antiseptic detergent (4% CHG) followed by ABHR (1% CHG) x 10 days	N = 18 B followed by A (crossover trial)	**Primary outcome** No significant difference between intervention and control groups on bacterial reduction factor (RF) **Secondary outcomes** No significant difference between waterless and two-stage on *skin moisture* Waterless significantly *more useful in practice* based on questionnaires	"Handwashing using natural soap is simple and superior to hand scrubbing in several aspects" [p. 1]	60% (6/10)

Santé (2023) Spain	23 volunteers Ward/setting not specified	N = 23 A. TCS: Triclosan 0.5% B. TCS + EtA: Triclosan 0.5% plus ethanol 70% hand rubbing C. Reference procedure: Propan-1-ol (60%-V/V)	N = 23 A-B-C in diff order with washout of 1 week between runs (Latin-square crossover RCT)	**Primary outcome** All interventions reduced CFU significantly, immediately and at 3 hours Immediate and 3-hour effect of TCS significantly inferior to both TCS + EtA and reference procedure **No secondary outcomes**	TCS by hand scrub did not meet the European criteria (EN12791, known as 'UNE') for surgical hand preparation (SHP). TCS + EtA met UNE noninferiority criterion – that is, they were not significantly inferior to the reference procedure; but did not meet the requirement for claiming an additional sustained effect compared with the reference procedure	60% (6/10)

Table 6 Surgical hand scrub (ABR vs soap/water) - Level III-2: Comparative study with concurrent controls: Non-randomised experimental trial (n = 3)

Citation Country	Sample size Setting	N Participants Intervention	N Participants Control	Results (bold = primary outcome)	Key conclusions reported by authors	QA score
Olivia (2025) Indonesia	71 surgeons and nurses General surgery	n=35 Alcohol-based hand rub using 70% ethyl alcohol and 2.5% chlorhexidine	n=36 Antimicrobial soap for surgical hand scrub using 4% chlorhexidine soap group	**Primary outcome** Both methods significantly reduced CFU No significant difference between groups on CFU Gram-positive coccus bacteria were the primary microorganism identified in pre and post testing for both groups **No secondary outcomes**	Surgical hand-scrub and hand-rub have similar effectiveness in reducing bacterial counts on hands	89% (8/9)
Shen (2015) Taiwan	128 doctors and nurses Surgery (various types)	n=65 Alcohol-based hand rub using 61% ethyl alcohol and 1% chlorhexidine gluconate	n=63 Conventional surgical hand scrub using 4% chlorhexidine or 7.5% povidone-iodine	**Primary outcome** Significant difference in culture rate (%) between intervention and control (Intervention: Pre-post 6.2% - 10.8%; Control: Pre-post 47.6% - 25.4%) Most identified pathogens were Gram-positive; coagulase-negative staphylococci was the major pathogen **No secondary outcomes**	Alcohol-based hand rub was more effective for surgical antisepsis and had sustained efficacy, compared to conventional surgical scrub	89% (8/9)
Forer (2017) Israel	20 surgeons (case-crossover design) Ophthalmic Surgery	n=10 A. “Alcoholic Hand Rub” - 5 ml of 70% ethanol and 1% glycerine B. Routine 3-minute Antimicrobial Scrub (4% chlorhexidine gluconate (CHG) or 1% povidone-iodine (PVP-I)	n=10 B – A (reverse order)	**Primary outcome** Significant reduction in mean colony forming units (CFU)/mL on hands with Alcoholic Hand Rub vs. Routine group No significant difference between CHG vs PVP-I in the control group **No secondary outcomes**	Alcohol rub is more effective than routine surgical hand preparation with PVP-I and CHG in reducing bacterial counts on hands	56% (5/9)

Table 7 Surgical hand scrub (ABHR vs soap/water): Level IV: Case series with either post-test or pre-test/post-test outcomes (*n* = 3)

Citation Country	Sample size Setting	Pre-intervention	Intervention	Results	Key conclusions reported by authors	QA score
Gaspar (2018) Brazil	Surgeons (n = 56) and patients (n=231) Cardiac and orthopaedic surgical teams	(3 months) Traditional surgical scrub with antimicrobial soap (either 2% chlorhexidine or 10% PVPI)	(3 months) Alcohol-based hand rub available in the operating room; training (4 hr workshops x 5); observation / feedback	**Primary outcome** No significant difference in surgical hand preparation compliance overall In a subset of surgeons from both periods (n=33), there was a significant increase in compliance during-intervention **Secondary outcome** Patient SSI pre-post 8.3% (11/132) - 4.0% (4/99): not significant	Alcohol-based surgical hand preparation improves quality and reduces duration of preparation vs. traditional surgical scrub, however there was no difference in surgical site infections	90% (9/10)
Iwakiri (2017) Japan	Patients (n=1,400) Orthopaedic surgery	(13 months) Traditional hand scrub n=712	(10 months) Waterless hand rub n=688	**Primary outcome** No significant difference in SSI incidence: (n = 12, 1.3%) control vs (n = 8, 1.1%) **Secondary outcome** Cost per hand hygiene episode: $2 for traditional hand scrub vs less than $1 for waterless hand rub	Waterless hand rub with an alcohol-based chlorhexidine gluconate solution can be a safe, quick, and cost-effective alternative to traditional hand scrub	60% (6/10)
Oriel (2017) United States	6344 cultures from superficial and deep surgical site infections (SSI) Retrospective analysis of using	2007- 2009 Traditional aqueous surgical scrubs (TSS)	2013-2014 Alcohol-based hand rub (ABHR)	**Primary outcome** Pathogen frequency at hospital: *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and Enterobacter species more common in **ABHR** period	Over time, and with the introduction of an ABHR for surgical hand antisepsis, there was change in SSI pathogens identified	44% (4/9)

	hospital data and CDC surgery database	*Klebsiella pneumoniae/K. Oxytoca* more common in **TSS** period Similar pathogen frequency in CDC National Healthcare Safety Network database to hospital data, however *Coagulase-negative* more common in NHSN and *Klebsiella (pneumoniae/oxytoca)* more common at hospital	**No secondary outcomes**

Table 8 Sink removal and waterless care: Level I: Systematic Reviews (*n* = 2)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions reported by authors	QA scoring
Fucini (2024) N = 11 studies	"To investigate which sink interventions may reduce GNB infection and colonisation rates in the ICU" (p. 82)	Main interventions were water filters, removal of sinks, sink heating and vibration devices, new taps and hopper cover. Interventions reduced GNB colonisation /infection rates in the ICU. Nevertheless, the studies reported different outcomes and had very different sample sizes and baseline incidence rates for GNB acquisition.	No randomized controlled trials were included in the analysis, and all studies were reported to have moderate to serious risk of bias	"Few studies have investigated the association of sinks in patient rooms with healthcare-associated acquisition of GNB in non-outbreak settings. Heterogeneity in study design made it impossible to generalize the results. Prospective trials are needed …"	73% (11/15)
Low (2024) n= 7	"effectiveness of sink removal with or without water free activities in the ICU environment to reduce water-borne healthcare-associated infections." (p.61)	"All included studies utilised sink removal in patient-fronting areas as their main intervention…Removal of sinks and water-free interventions appear to have an impact on GNB and pulmonary nontuberculous mycobacterium acquisition." (p.69)	"Overall quality was assessed to be good based on the JBI critical appraisal checklist" (p.69)	"Preliminary evidence, from a limited number of studies of which the majority were conducted in an outbreak setting, suggest that sink removal and other water-free interventions in the ICU helped terminate outbreaks involving taps and decrease hospital onset respiratory isolation of pulmonary NTB." (p.61-62)	69% (9/13)

Table 9 Sink removal and waterless care: Level I: Narrative Reviews (n = 1)

Citation N studies	Review aim	Key findings	Key conclusions reported by authors	QA score
Inkster (2024) N=7	"To determine the arguments for and against radical measures such as reducing the water and wastewater outlets in healthcare facilities, and the methods that have been implemented to ensure that patient care is still, first and foremost, a priority." p.37	Waterless care was largely instigated in response to outbreaks of Gram-negative bacteria in ICUs. "A spectrum of changes could be introduced by units, ranging from wipes for bathing patients, to placing the clinical handwash station outside the patient room, to true water-free care whilst still retaining a handwash basin" p.39 "If ICUs are not aware of any transmission events from water or wastewater systems on the unit, it will be unlikely that practices will be changed." p.39 "The risks from not changing to water-free patient care need to be understood." p.39	"Waterless or water-free care is a relatively new concept, and this was reflected by the small body of literature identified" p.37 There is a requirement for change that needs a collaborative approach to develop solutions, which understands the risks from not changing to water-free patient care. The move to water-free patient care has been relatively slow due to a range of real and perceived challenges and barriers to change.	50% (6/12)

Table 10 Sink removal and waterless care: Level III-3: Interrupted time series without a parallel control group *(n* = 7)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Hopman (2017) The Netherlands	Patients 2,490 total: Pre (n=1496) Post (n=1444) ICU	Remove patient room sinks Water-free patient care: Universal gloving and gowning Hand wipes Disinfection with ABHR Dissolving medication in bottled water Disposable materials Rinse-free shampoo cap Moistened disposable wash gloves Bottled water Electric / bottled water shaving	**Primary outcome** A significant immediate reduction in the rate of patient colonisation with GNB. Monthly colonisation rates: Gram-negative bacilli vs Yeast as 'negative control': decrease from 26.3 to 21.6 GNB/1000 ICU admission days The reduction in GNB colonisation rate became more pronounced in patients with a longer ICU-Length of Stay. **No secondary outcomes**	Removal of sinks from patient rooms and introduction of a method of 'water-free' patient care significantly reduced patient colonisation with GNB Plausible that a longer stay in an ICU increases the exposure to potential pathogens in the direct patient surroundings including sinks.	89% (8/9)
Catho (2021) Switzerland* *Same setting as Martischang (2025); different organism / timeframe	21 patients infected or colonised with Verona Integron-encoded Metallo-β-lactamase-positive *Pseudomonas aeruginosa* 131 environmental samples ICU	Sink removal in patient rooms. Sinks kept in dedicated waste disposal rooms; two sinks in preparation rooms. 'Water-free' patient care: Bottled water Electric / bottled water shaving Chlorhexidine-free washing gloves Shampoo cap Disposable materials for canula care Hand washing: soap followed by ABHR Further minimise drain usage	**Primary outcome** Post intervention, there was no new patients infected or colonised with Verona Integron-encoded Metallo-β-lactamase-positive *Pseudomonas aeruginosa* within 8 months until an outbreak in a COVID-19 unit at 12 months, however there was no clear ICU acquisition. **Secondary outcome** 16/131 (12.2%) environmental samples were positive grew Verona Integron-encoded Metallo-β-lactamase-positive	Waterless patient care with removal of the sinks in patient rooms terminated the outbreak The outbreak was genomically linked to environmental water sources.	63% (5/8)

		Ventilator-associated pneumonia prevention bundle with selective oral-pharyngeal decontamination administration. Staff education MDRO screening with increasing intensity	*Pseudomonas aeruginosa* in sink traps and drains.		
Shaw (2018) Spain	202 patients and with multi-drug-resistant gram-negative bacteria (MDR-GNB) ICU	7. Sink removal in all patient rooms, except two sinks in the central nurse room. 8. Deep cleaning / disinfection of sinks 9. Antibacterial water filters in the taps, replaced monthly 10. Filtered water from central sinks for patient daily hygiene (first half of post-intervention) 11. Water discarded in a disposal room outside of the hospitalisation area 12. Chlorhexidine-impregnated washcloths for patient hygiene (second half of post-intervention)	**Primary outcome** Statistically significant decrease in incidence of MDR-GNB: Pre: 9.15 vs Post: 2.20 per 1000 patient-days *Interventions greatest impact was in reducing new cases of K. pneumoniae, rather than of P. aeruginosa* *202 new cases over 35,909 patient-days over the course of the study (43 months pre, 29 months post)* **No secondary outcomes**	A new water-safe policy, including removal of sinks from all patient rooms, reduced incidence of MDR-GNB in endemic setting Impact on different organisms may reflect differences in the adhesion to biofilm; *P. aeruginosa* spread further down into the wastewater drainage; K. pneumoniae would remain in the proximal drains facilitating faster elimination.	56% (5/9)

Cantero (2018) Spain	12 patients with *Chryseobacterium indologenes* infection 232 environmental samples ICU	**Stage 1** Reeducation of staff on standard and contact precautions; Implementation of contact precautions **Stage 2** Removal of aerators; bottled water for patients; Point-of-use water filtration for clinical care and respiratory devices reprocessing **Stage 3** 13. Close down of patient care handwashing station; Sealing of hemodialysis drain connections; Waterless patient hygiene; Re-design of the reprocessing room incl. training in reprocessing	**Primary outcomes** 2.72 *C. indologenes* cases per 1,000 patient days, then no cases for 5 months after introduction of stage 3 of interventions **Secondary outcomes** *C. indologenes* was identified in: - 8 handwashing sinks in patient boxes; 5 of these related to patient cases. - 3 air samples taken close to the sinks Environmental and patient samples were genetically linked Many other species of bacteria were recovered from the water drainage system and air samples close to the sinks	Sinkholes can act as a reservoir for microorganisms; therefore, patients and equipment should be protected from sink splashes to avoid contamination	50% (4/8)
Martischang (2025) Switzerland* *Same setting as Catho (2021) but different organism and timeframe	167 cases of *Serratia marcescens* infection or colonisation ICU	**Intervention period 1: *Behavioural***, training sessions, procedures to enhance standard precautions, and segregation of contaminated and non-contaminated areas ***Intervention period 2: Architectural:*** removed all sinks from patient rooms, and most of the sinks in medication preparation areas. Water-free' patient care: Bottled water	**Primary outcome** The interventions did not significantly reduce S. *marcescens* incidence per 1000 patient days: Baseline:2.74 Period 1:1.69 Period 2: 2.95 **Secondary outcomes** Interventions did not significantly change hand hygiene compliance or antibiotic consumption.	The outbreak was not controlled by interventions. Waterless care may not have been effective due to the selective pressure by SOD or the maintenance of ventilatory circuits.	44% (4/9)

		Electric / bottled water shaving Chlorhexidine-free washing gloves Shampoo cap Disposable materials for canula care Hand washing: soap followed by ABHR ***General Infection Control and Surveillance Measures***, including patients on ventilation for more than 48 h underwent thrice-daily selective oropharyngeal decontamination (SOD)	There was an association of infection with administration of SOD.		
Schärer (2023) Switzerland	255 patients 276 environmental samples with multi-drug-resistant *Pseudomonas aeruginosa* ICU	Intervention Part 1: Replacement of the sink siphons Intervention Part 2: Removal of all sinks in the proximity of patients and in medication preparation areas Waterless patient care: Handwashing of visibly soiled hands; designated 'contaminated' sink outside of patient and medication preparation areas, followed by ABHR Bottled drinking, medication and oral care water Body washing - Disposable washing gloves Disposable cap internally coated with a pre-moistened cloth Shaving - Use of filtered water Intermittent haemodialysis - Use of modified pre-existing connections in patient areas (Flushing of water pipes)	**Primary outcome** 29/255 (11%) patients with a MDR *P. aeruginosa* infection or colonisation with clonality in 28 patients and all 10 environmental samples. **Secondary outcomes** MDR P. *aeruginosa* was isolated from sinks samples (10/134, 7.5%) and gastroscopes (1/8, 12.5%), but not air samples. The outbreak strain initially re-grew in replaced sink siphons (intervention 1), but not after intervention 2.	Sink removal combined with the introduction of waterless patient care terminated the outbreak Water systems in ICUs represent a risk for outbreaks with biofilm-associated bacteria, especially in stagnant water, such as sink siphons.	38% (3/8)

		Both periods included standard containment measures			
Tracy (2020) Australia	Total 120 52 Phase 1 65 Phase 2 3 Phase 3 Babies positive for multidrug-resistant gram-negative bacteria (MRGNB) NICU	**Phase 1 (Jan 2006 - Jan 2007):** • All neonates sampled weekly • Environmental screening • Cohorting of MRGNB-positive babies • Sink cleaning, mechanical clearing and replacement of drainpipes • Intensive ward level education • Restriction of broad-spectrum antimicrobials • Reinforcement of good hand hygiene practices **Phase 2 (Feb 2007 - May 2007)** Phase 1 plus: • Neonates screened twice weekly • Intensification of hand hygiene and antimicrobial use interventions • Staff screening **Phase 3 (Jun 2007 - Dec 2007)** Phase 2 plus: • Routine bathing of neonates in NICU prohibited 6/8 NICU sinks decommissioned (remaining sinks were used only when an aseptic surgical technique was required)	**Primary outcome** After phase 3 and more than 10 years without sinks, cases of MRGNB have been occasional and sporadic, with no outbreaks of traceable to water supply. Phase 1: Sustained evidence of MRGNB transmission Phase 2: Sustained detections of MRGNB continued (65 babies MRGNB positive) Phase 3: Dramatic and persistent decrease in the colonisation of neonates in the NICU (three new isolates detected in the remainder of 2007) **No secondary outcomes**	“Cessation of routine bathing of infants and closing of most of the unit’s sinks rapidly and persistently decreased the incidence of colonisation via presumed droplet transmission.” (p.510)	25% (2/8)

Table 11 Sink removal without additional waterless care interventions: Level I: Narrative reviews (*n* = 2)

Citation N studies	Review aim	Key findings	Key conclusions (headline findings)	QA score
Kearney (2021) n=30	To describe interventions to minimise the contamination of hospital sinks by carbapenemase-producing bacteria (CPB) and prevent transmission to vulnerable patients	From most to least effective, interventions were: (1) Remove handwashing sinks from critical care units (2) Physical barriers or room modification to protect patients from sinks e.g. sink placement, drainage and sink/wastewater system interaction (3) Engineering controls e.g. drain covers, waste disposal covers, heating and vibration units to remove drain contamination (4) Administrative controls low quality evidence due to bundled nature of interventions e.g. screening, staff education, workflow changes	"Ascertaining the optimal method to end CPB outbreaks in critical care is challenging due to the lack of prospective studies available … literature suggests that sinks can and do serve as reservoirs of CPB near critically ill patients, and should be considered hazardous, especially when sub-optimally designed or used" p.55	50% (6/12)
Parkes (2018) n=42 (as per table 1)	Review recent outbreaks related to contaminated hospital sinks with a focus on design features and healthcare provider behaviours; discuss risk mitigation strategies	**Recent outbreaks:** "While any water source within healthcare facilities may be susceptible to colonisation with waterborne pathogens, contaminated hand hygiene sinks are commonly implicated as the source of outbreaks. These outbreaks most frequently occur in neonatal and adult intensive care units (ICUs) and burn units, as well as hematology-oncology and transplant wards" p1.2 **Mitigation strategies:**	Hospital sinks provide a permissive environment for biofilm formation and microbial colonisation, and sink-related outbreaks are increasingly reported over time. The role of hospital sinks has become even more salient in the era of emerging antimicrobial resistance…. Risk mitigation strategies such as cleaning and disinfection as well as sink replacement have been employed with variable success, often halting outbreaks or reducing clinical cases but failing to decolonize the sinks." p.11	33% (4/12)

	1. Address design features that promote sink-related infections: (a) promotion of biofilm and (b) disruption and dispersion of biofilm (c) basin depth (d) faucet positioning 2. Behavioural contributors: (a) misuse of sinks, (b) placement of patient care materials adjacent to sinks Infection control strategies: (a) cleaning and disinfection, (b) biofilm disruption, (c) point-of-use filters, (d) replacement of sink plumbing and/or fixtures	

Table 12 Sink removal without additional waterless care interventions: Level III-3 (*n* = 3)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
De-Las-Casas-Cámara (2019) Spain *One less year of data than De-Las-Casas-Cámara (2022)	951* (302 pre vs 350 post) non-fermenting gram-negative bacilli (NFGNB) isolates related to bronchoaspirate samples (BAS) of patients with invasive mechanical ventilation (IMV) ICU	Removing sinks from ICU cubicles *Same intervention as De-Las-Casas-Cámara (2022)	**Primary outcome** Significant reduction in isolates related to healthcare per 1000 days of IMV of isolations between pre-intervention 11.28 (n=29) and post-intervention:1.9 (n=2) *The results for isolates related to healthcare and cases related to healthcare were similar.* **No secondary outcomes**	NFGNB was detected in existing faucets and previous infection control measures failed, however removal of sinks was successful to stop the outbreak The only potentially relevant complementary intervention was the indication to reduce nebulisation through inhalation – the mask is now discarded after each use	56% (5/9)
De-Las-Casas-Cámara (2022) Spain *An additional year of data than De-Las-Casas-Cámara (2019)	1,291* (302 pre vs 690 post) patients with antibiotic consumption for *Enterobacteriaceae* and NFGNB ICU	Removing sinks from ICU cubicles *Same intervention as De-Las-Casas-Cámara (2019) (water-free wipes, mitts, and scalp caps in the second post-intervention year to replace the system of bottles and dishes with soap and water – however the authors stated this did not impact the measured year 2016 – 2017 "in which the main effect is the sinks removal" (p. 3)	**Primary outcome** Antibiotic consumption**:** *Enterobacteriaceae* Pre-post Defined daily doses (DDD) 4642.28 vs. 1469.46: 1.61-fold lower *NFGNB* 5598.45 vs. 1276.33: 2.24-fold lower **Secondary outcomes** Multi-drug-resistant bacteria days Pre-post intervention: 149.07 year 1	Removal of the sinks reduced the consumption of antibiotics and MDR days Results to justify sink removal: 1. Parallel reduction in the pre-existing NFGNB problem 2. Pre-intervention reduction antibiotic consumption for Enterobacteriaceae but not NFGNBs 3. Antibiotics for NFGNBs reduced after the sink removal with higher magnitude cf. Enterobacteriaceae antibiotics; consistent with the fact that the highest ratio of NFGNBs are found in wet reservoirs 4. Reduction in Zero Resistance indicators statistically significant post-intervention, while a similar reduction	56% (5/9)

			219.41 year 2 (n=24) vs. 104.21 year 1 97.68 year 2 (n=47) 1.84-fold lower	was not seen at the regional and national levels.	
Debast (2025) The Netherlands	Total 10 (5 colonized and 5 infected) patients with Verona Integron-encoded Metallo-β-lactamase-positive *Pseudomonas aeruginosa* ICU	Infection control measures (pre): Bi-weekly patient MDRO screening Contact tracing and patient isolation Environmental swabs if CRPA-VIM positive Selective decontamination (SDD) regimen Water drainage-free procedures Reinforced hand hygiene for medical staff and patients Environmental cleaning **Chronological sink activities:** Single sink decontaminated New splash- and aerosol-reducing inlets, renewed 3 monthly unless positive culture occurred earlier Monthly replacement of new splash- and aerosol-reducing inlets Replacement of faucets Removal of all water fixtures in patient rooms	**Primary outcome** Contaminated sinks were identified as the outbreak source. A bundle of infection prevention measures did not terminate the outbreak, only removal all water fixtures stopped transmission of Verona Integron-encoded Metallo-β-lactamase P. *aeruginosa.* *Contact tracing and source investigations found no interpatient transmission.* **No secondary outcomes**	Sinks were identified as the source without interpatient transmission Future hospital design should minimize contamination from drains and sinks to reduce the nosocomial infection risk	38% (3/8)

Table 13 Waterless care interventions without sink removal: Level I: Systematic reviews (*n* = 2)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions reported by authors	QA scoring
Groven (2017) N = 6	To assess the effectiveness of washing without water in comparison to the traditional bed bath for the full body wash of immobile patients	"The results of these high-quality studies show that washing without water performed better than the traditional bed bath regarding skin abnormalities and bathing completeness. No differences between washing without water and the traditional bed bath were found for outcomes related to significant skin lesions, resistance during bathing and costs in the studies of high quality." (p.1)	Only two studies (of the same research group) were considered of high quality" (p.1)	Compared to the traditional bed bath, washing without water might offer more advantages and value to the patient and the nursing staff, but possibly also to other stakeholders such as family members and the management of health care institutions …There is a need for additional research to focus on hygiene outcomes, value perceptions and experiences "(p. 14)	69% (9/13)
Zanichelli (2021) N = 7	"compare the efficacy of different bathing practices in reducing skin colonisation, health care-associated infections (HAI) or their impact on skin integrity." (p.3)	3 of 4 studies showed a potential benefit of disposable washcloths and no-rinse skin products to protect the skin from mild lesions, in particular when they are used in elderly and dependent patients … In terms of the impact on HAIs and skin colonisation, none of the included studies addressing these outcomes described a significant beneficial effect of bathing."(p.606-607)	MMAT was used in this study "Caution is required when interpreting the findings of this systematic review given the small number of eligible studies for each outcome of interest" (p.607)	"in adult patients, skin colonisation and the risk of HAI are minimally affected by the bathing technique or frequency … prevention approaches that combine different interventions are usually more effective in reducing HAI than single preventive measures …use of no-rinse washcloths could be implemented in elderly patients in long-term care settings where disruption of skin integrity is more prevalent." (p.607)	69% (9/13)

Table 14 Waterless care interventions without sink removal: Level I: Narrative reviews (n = 2)

Citation N studies	Review aim	Key findings	Key conclusions (headline findings)	QA score
Mallinckrodt (2023) n=80	"a review of the literature on healthcare-associated E. *E. anophelis* outbreaks … recommendations on infection prevention strategies and control measures based on the published scientific evidence and our own experience." (p. 2)	The most commonly detected sources of outbreaks were water taps with aerators, however, transmission from patient-to-patient, through contaminated medical equipment or donor tissue as in the presented case are also established routes." p.10 "Infection control specialists should be counselled in the design of patient rooms. In high-risk units like intensive cares, the use of wet points should be avoided as much as possible." p4	Strategies to prevent and reduce spread *of E. anophelis* include water-free patient rooms, adequate hygiene and disinfection practices, and optimised diagnostic techniques for screening, identification and molecular typing.	67% (8/12)
Boyce (2023) N= not specified	To update information regarding the best practices and products for preoperative bathing, surgical hand scrubs, surgical site preparation, daily chlorhexidine gluconate (CHG) bathing in intensive care units (ICUs) and non-ICU settings, and for prevention of infection during intravascular access" p.58	**Preoperative bathing:** Current guidelines recommended plain or antimicrobial soap prior to surgery, but do not make recommendations on the timing of baths, total number of baths, or use of CGH-impregnated cloths. **Surgical hand scrubs:** antimicrobial soap and ABHR yields similar SSI rates, however ABHR may cause less skin irritation is easier to use and requires shorter scrub times vs. antimicrobial soap. **Surgical site preparation:** guidelines recommend alcohol-containing antiseptic: products often contain isopropanol combined with either CHG or with povidone iodine. **Daily CHG bathing:** reduces incidence of central line associated bloodstream infections in ICU; evidence is mixed for non-ICU patients; numerous barriers to implementation in ICU.	Progress has been made on skin antisepsis products and protocols, but regardless of the type of skin antiseptic selected, improvements in technique are still needed.	58% (7/12)

Table 15 Waterless care interventions without sink removal: Level II: Randomised controlled trial (n = 1)

Author (date) Country	Sample size Setting	N Participants Intervention	N Participants Control	Results (bold = primary outcome)	Key conclusions reported by authors	QA score
Martin (2017) United States	2,637 patients Medical-surgical units	A. Prepackaged disposable washcloths	B. Traditional bath basins (soap and water) B followed by A (crossover trial, 8 months each)	**Primary outcome** No difference between groups on the incidence of hospital-associated infections or MDRO acquisition **Secondary outcome** Patient skin integrity deterioration was significantly less in the intervention group	"We were unable to demonstrate a statistically significant reduction in HAI or MDRO acquisition associated with basin elimination; we were able to demonstrate 4 instances where the same MDRO pathogen was isolated from a clinical patient culture and the basin of the same patient after standard-of-care (basin) bathing"	60% (6/10)

Table 16 Waterless care interventions without sink removal: Level III-3: Interrupted time series without a parallel control group (n = 2)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors	QA score
Baker (2021) United States	105 patients 137 unique episodes of hospital-onset respiratory nontuberculous mycobacteria (NTM) isolation ICU (3 ICUs and 1 intermediate unit)	May 2014 Unit-wide tap water avoidance occurred in 3 ICUs and 1 intermediate lung transplant stepdown unit: Sterile water for consumption and patient-care activities requiring water Ice was also avoided After 11 months, other changes were made "to the hospital's water management plan to improve water flow rates, temperature gradients, and disinfectant levels" (p.524)	**Primary outcome** NTM isolation decreased from 41.0 to 9.9 episodes / 10 000 patient-days during the 19-month intervention period (IRR, 0.24; 95% CI .17–.34; P < .0001) Rates of hospital-onset episodes of respiratory NTM isolation per 10 000 patient-days decreased significantly for *Mycobacterium abscessus* complex, *Mycobacterium chelonae-Mycobacterium* immunogenum, *Mycobacterium avium* complex and *Mycobacterium gordonae* "After implementation of the protocol, overall pulmonary NTM acquisition on the 4 study units decreased by 76%." (p.526) **No secondary outcomes**	"We demonstrated a substantial decrease in respiratory NTM isolation among ICU and intermediate unit patients after introduction of a protocol for tap water avoidance. Other hospitals with endemic NTM, new water systems, or patients at high risk for pulmonary NTM infection, such as lung transplant recipients, should consider implementation of similar protocols." (p.526-527)	75% (6/8)

Moulin (2024) Switzerland	5 cases with New Delhi metallo-betalactamase positive Klebsiella pneumoniae (NDM-KP) Neurosurgical intermediate care unit	**General measures:** Weekly screening for intestinal carriage of MDRO in ICU; Targeted screening in non-ICU setting; Contact precautions; Contact tracing **Enhanced measures** Education rounds to reinforce hand hygiene; Material and environment disinfection; Enhanced environmental cleaning **Sink measures (chronological order)** Replaced NDM-KP-positive P-traps; Weekly steam disinfection; Replaced the whole washbasin circuit of colonised sinks with daily disinfection by chlorine bleach; Combined disinfection with chlorine bleach and steam over 3 months	**Primary outcome** Sinks continually re-colonised or remained colonised until the final component of the sink intervention. Subsequently, no new NDM-KP patient cases were detected and sink traps remained negative at 6 months. **Secondary outcome** 3/8 sink traps were positive for NDM-KP with all isolate genomes were genetically similar	Successful control of an environmental reservoir using multimodal IPC measures, underscored by waterless patient care and the meticulous replacement and disinfection of P-traps and connecting pieces. Multidisciplinary collaboration (plumbing and cleaning) is required for success	50% (4/8)

Table 17 Alcohol-based hand rub vs. soap and water: Level I – Systematic Review (n = 1)

Citation N studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions (headline findings)	Strategy	QA scoring
Kuti (2021) N = 6	"To determine the effectiveness of different hand hygiene agents for preventing neonatal infection in both community and health facility settings"	"Two percent chlorhexidine gluconate (CHG) antiseptic detergent) probably reduces the risk of bacterial infections in neonates compared to alcohol hand sanitiser within the first 28 days of life…There was not much difference in the undesirable effects of various hand hygiene interventions on the skin of caregivers. We are not sure which type of hand hygiene is best for preventing infection in newborn babies" (p.3)	"Three studies were rated as having low risk for allocation bias, two studies were rated as unclear risk, and one was rated as having high risk. One study was rated as having a low risk of bias for allocation concealment, one study was rated as unclear risk, and four were rated as having high risk. Two studies were rated as having low risk for performance bias and two were rated as having low risk for attrition bias." (p.2)	"the sparse available data were of moderate- to very low-certainty. We are uncertain as to the superiority of one hand hygiene agent over another because this review included very few studies with very serious study limitations" (p.2)	ABR vs soap / water	100% (13/13)

Table 18 Secondary review question: How could health service organisations measure the environmental impact of waterless models of care? Evidence gathered from search for Primary review question. Study Characteristics: Level I - Systematic reviews (n = 1)

Author (date) N included studies	Review aim	Key findings	Reported overall quality of included studies	Key conclusions (headline findings)
Sridhar (2024) N = 12	Determine whether waterless hand rubs are suitable as hand scrubs for preoperative hand antisepsis	Due to increasing water scarcity, traditional hand scrubbing methods need to be replaced with waterless methods with no compromise on infections or patient safety. Compared to traditional surgical scrubbing, hand rubbing takes up significantly less water making it beneficial in resource-limited settings.	Quality of included studies not stated. Authors note that while procedures across studies were generally similar, some variations still exist.	Overall, waterless hand rubbing is as effective as hand scrubbing in preventing surgical site infections and is therefore a viable solution to address water scarcity concerns. All studies except one reported that hand rub solutions are also more affordable, making them accessible in poorer countries and hospitals.

Table 19 Study Characteristics: Level I - Narrative reviews (n = 2)

Author (date)	Review aim	Key findings	Key conclusions (headline findings)
Mastracci (2024)	Evaluate the environmental and cost impact of waterless alcohol-based hand rubbing compared to traditional water-based hand scrubbing.	Waterless alcohol-based hand rubbing (ABR) for hand antisepsis offers cost savings and supports value-based care. It reduces expenses related to water, scrub materials, and OR time. Though the cost of water at a specific hospital facility varies based on location. Depending on scrub sink flow rate, a 5-minute scrub uses an estimated 16–34 L of water. Some studies note that sinks are occasionally left running after scrubbing. Eliminating water use also removes the need for hand towels, which require water for laundering. Switching from traditional water-based scrubbing to ABR can reduce environmental waste and care costs. Water costs vary by facility, but ABR materials are generally cheaper than those for water-based scrubbing (e.g., soap and scrub brushes vs. soap-impregnated brushes, picks, and towels). ABR is also faster, potentially lowering OR time costs. While these costs differ across facilities, ABR's time efficiency can benefit both hospitals and patients.	Converting to waterless alcohol-based hand rubbing can save millions of litres of water annually, helping reduce surgical staff's impact on resource overuse and water scarcity, without compromising patient care.
Wyssusek (2025) N = 82	Investigate how current operating room (OR) practices in Australia affect the environment and determine how greening initiatives can be improved.	Paper looks at OR waste in general, not focused on waterless care. A 2008 study reported that in a UK hospital, approximately 932,000 litres was used annually for surgical handwashing and suggested replacing traditional water-and-soap scrubbing with alcohol-based hand rubs. Based on this data, the authors recommended a scrub at the start of the operating list, followed by alcohol-based rubs between cases if hands are not visibly soiled. However, they also noted that "despite the reduction in wasted water, this approach was found to be more costly than traditional hand hygiene practices." (p.14)	In general, greening interventions in the perioperative environment should occur in small steps because acceptance by staff members is more likely to occur when changes take place gradually.

Table 20 Study Characteristics: Level IV - Case series (n = 3)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors
Carannante (2024) Not stated but all authors are from Italy	N = 6 surgeons Operating room	N = 3 surgical wash with alcohol-based solution N = 3 surgical wash with water Estimated the water and soap usage over a two-year period for traditional surgical hand disinfection and the associated water volumes and costs were compared with those of alcohol-based agents.	**Primary outcome** A significant volume of water is saved when using alcohol-based surgical hand scrub. It was estimated that in a two-year period covering 1,190 surgeries, alcohol-based scrubbing used just 23.8 L of water, compared to 71,500 L with traditional methods. **Secondary outcome** The cost of brushes for traditional scrubbing was approximately €1,800, while alcohol-based scrubbing cost € 216.	In regions without advanced water-saving infrastructure, adopting a waterless hand disinfection policy could significantly reduce OR environmental impact without compromising patient safety.
Posso (2025) United States	N = 8 OR scrub sinks Operating room (plastic and reconstructive surgery)	Volume of water collected 3 times from each OR sink while cost estimates for alcohol-based scrub solutions and impregnated wet-scrub brushes were from the perioperative service of the hospital	**Primary outcome** OR scrub sinks used an average of 7.62 L of water in 2 minutes. If every procedure used water-based scrubbing, water consumption would reach 87,233.76 L per year. Shifting to waterless scrubbing resulted in annual supply cost savings of $3,090.96 (USD). Therefore, replacing a 6-minute water-based scrub with alcohol-based hand hygiene for every surgery could yield estimated annual savings of $1,316,445.48 (USD). **No secondary outcomes**	Adopting alcohol-based scrubs can yield substantial savings. Water use could be reduced by nearly 90,000 litres annually, offering notable environmental benefits. Economically, alcohol-based scrubs are less costly than impregnated brushes, lowering consumable expenses by thousands of dollars each year. Additionally, replacing water-based scrubs with waterless procedures may also save up to $1 million (USD) annually through reduced perioperative time costs.
Restaino (2024)	Results are based on the estimate that	Handwashing with medicated soap vs. waterless alcohol-based hand rub	**Primary outcome** Daily water use for surgical handwashing estimated at 140.7 L for chlorhexidine; 187.6 L	“Given its [alcohol-based surgical hand rub] non-inferior antiseptic efficacy, this water-saving and

Italy	there are 1715 scheduled gynecologic surgeries a year Operating block (gynecology)	In the case of chlorhexidine scrub, the amount of water used is obtained by calculating 2.04 L multiplied by 3 min totalling 6.12 L of water used per scrub; the quantity of product recommended per scrub is 10 mL	for povidone-iodine; 0 L for ABHR. Water use per scrub 6.12 L for chlorhexidine; 8.16 L for povidone-iodine - 10 ml of product used per scrub. ABHR use no water and only 3 ml of product per scrub. Statistically significant differences were found in water use, product volume, and number of scrubs per bottle (P = 0.001). **Secondary outcomes** ABHR reduces plastic waste. Each 500 ml bottle provides 167 scrubs (3 ml per use) cf. 50 scrubs per bottle for povidone-iodine and chlorhexidine (10 ml per use). ABHR eliminates need for plastic brushes, sponges, and individually wrapped towels Daily scrub costs €1.15 for povidone-iodine/chlorhexidine; €0.23 for alcohol-based antiseptics = annual savings of €225.4 excluding plastic disposal costs, which were likely higher for traditional scrubs At an estimated €2.50 per bottle, cost per scrub is €0.05 for povidone-iodine and chlorhexidine, and €0.01 for alcohol-based hand rubs resulting in 80% cost savings. ABHR saves 62.5% and 50% in time compared to povidone-iodine and chlorhexidine respectively (P = 0.023) and reduce antiseptic product use by 70%.	plastic-saving procedure is easy and, if routinely adopted by surgeons, it would allow the use of such a precious resource as water to be optimised, thus making operating theatres “greener”

Secondary review question: How could health service organisations measure the environmental impact of waterless models of care? Evidence gathered from de novo searching.

Table 21 Study Characteristics: Level I – Narrative review (n = 1)

Author (date)	Review aim	Key findings	Key conclusions (headline findings)
Duane (2022)	Compare the environmental sustainability of the UK population of four methods of hand hygiene in the COVID-19 context. These include ethanol-based hand scrub (HS), isopropanol-based HS, liquid soap Handwash (HW), and bar soap HW.	A life cycle assessment (LCA) of the four hand hygiene methods was performed and measured against 16 measures of sustainability such as climate change (kg CO_2 eq), fossil fuel use (MJ) and ozone layer depletion (kg CFC^{11} eq). The overall human health impact was measured using Disability Adjusted Life Years (DALYs). The biggest contributor to the DALY impact, for all methods of hand hygiene, was ozone depletion (kg CFC^{11} eq) followed by water usage (m^3 water eq). Soap: The LCA of liquid soap showed that the soap oils used (e.g., palm and coconut oils) contributed significantly to its environmental footprint, ranging from 24% for ionising radiation to 93.6% for freshwater eutrophication. Both liquid and bar soaps require tap water for handwashing, which accounts for 28% of the footprint, while laundering hand towels adds 10.17% for liquid soap and 17.92% for bar soap, respectively. The authors also note that additional water will be required to treat the wastewater produced from this method. Overall, bar soap is environmentally preferable compared to liquid soap due to reduced plastic packaging and lower soap usage per wash. Alcohol scrub: The LCA showed that isopropanol performed better than ethanol in nearly all environmental impact categories except fossil fuel use, as it is derived from fossil fuels while the ethanol studied was produced via fermentation. However, fossil fuel use was the least significant of the 16 sustainability measures in the LCA, with normalised results of zero across all products. In general, hand sanitiser was found to be more environmentally sustainable than handwashing with liquid soap, primarily due to handwashing requiring water use and hand towels for drying.	Overall, “isopropanol HS had the lowest impact in 14 out of the 16 categories, followed by ethanol HS and bar soap (which had the lowest impact in fossil fuel use and photochemical ozone formation respectively).” (p.48740) In conclusion, hand hygiene using hand sanitiser or soap and water all have an environmental impact, however, when compared, isopropanol-based HS was more environmentally sustainable than handwashing with soap.

Table 22 Study Characteristics: Level IV - Case series (n = 2)

Citation Country	Sample size Setting	Intervention	Results	Key conclusions reported by authors
Gasson (2023) United Kingdom Determine potential water and financial savings by switching exclusively to an ABHR	Hand trauma surgery (n = 5) Carpal tunnel release (CRT) surgery (n = 16) "Each case had three to four persons scrubbing included lead surgeon, surgical assistant, scrub nurse and/or a medical / nursing student." Operating room	Estimated water consumption by recording the time taken to fill a 1 L volumetric jug. Collected 3 samples, calculated mean and then extrapolated it to determine the amount of water dispensed from the tap in a standard 3 min scrub and subsequent 1 min scrub	**Primary outcome** Based on average jug fill time of 8.75 s (tap flow rate of 0.11429 litres / sec), 3-minute surgical scrub uses 20.57 litres of water per person (each additional minute 6.8574 litres). Hand trauma:143.99 litres / day (47.96 litres per person) CRT: 411.4 litres / day (205.7 litres per person) Use of ABHR could save 82.29 litres per day for a major trauma list and 288.7 litres per day for a CRT, reducing water usage by 57% (hand trauma) to 70% CRT). Hand trauma: £2.04 for chlorhexidine, £3.60 for iodine; £2.40 for alcohol rub. CRT: £7.14 for chlorhexidine, £12.60 for iodine, £8.40 for alcohol rub. Use of ABHR not a significant financial obstacle **No secondary outcomes**	Significant water savings can be achieved by switching to ABHR. However, further investigation is needed to understand the risk profile of this change. A prospective study should be conducted within hand trauma and CTR lists to assess infection rates, treatment costs, and follow-up requirements. To improve the sustainability of hand trauma and CTR lists, it is essential to consider the broader impact of this change, including outcomes beyond the surgical procedure itself i.e. areas not addressed in the current study.
Javitt (2020) United States A cost analysis was conducted to identify potential savings	8 scrub sinks Bascom Palmer Eye Institute (BPEI) Operating room (OR)	To measure flow rate water was allowed to run continuously for 2 minutes following WHO guidelines for surgical hand antisepsis. A five-year review of surgical activity at BPEI showed an annual average of 12,921 surgical procedures, with each procedure involving an average of three scrubbed personnel.	**Primary outcome** Switching exclusively to ABHR resulted in annual water savings of 61,631 litres per OR = $280,000 - $348,000 savings per OR per year. Wet scrub uses 15.9 litres of water = 47.7 litres per procedure. Average cost is $0.45 per litre = $277 per OR annually	A shift from traditional water-based preoperative hand antisepsis to waterless, alcohol-based techniques could save a modern U.S. healthcare institution approximately $281,323 per operating room (OR) annually The majority of cost savings stem from reduced supply

transitioning to waterless hand antisepsis		ABHR cost is $30.16 per 500 mL = $0.36 per scrub (6 ml / scrub, 83 procedures / container). Aqueous soap costs $18.41 per container = $0.33 14 mL / procedure), Chlorhexidine gluconate-impregnated scrub brushes cost $0.43 per unit. Overall, switching to waterless scrub methods yields supply cost savings of $1,360 per OR annually when dispensers are used, and $548 when chlorhexidine brushes are used. Scrub materials alone could cost $4,534 per scrubbed staff member per year. Operating room time = $53 per minute. 5-minute aqueous scrub = $279,623 additional cost per OR per year; increased to $348,102 per OR per year using WHO standard 6-min scrub time. **No secondary outcomes**	costs and savings in chargeable OR time. Cost per scrub using alcohol-based products is two-thirds that of traditional wet scrub; and less than half the cost of a wet scrub using soap dispensers and brushes. Switching to waterless scrubs also frees up resources for sanitation and drinking water Waterless hand antisepsis is now well established as equal or superior to traditional scrubbing in terms of safety and efficacy. The study concludes that while water savings are notable, the greater financial impact lies in reduced supply, staff, and facility costs—offering both environmental and economic benefits

Appendix 4: Study outcomes for primary review question

Table 23 Non-water based vs. water-based hygiene for pre-surgical scrubbing (17 studies)

	Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
I: SR	Gök (2016) 38%	Antibacterial effect	Limited importance	ABHR causes less skin damage and has an antibacterial effect in a short time
		Skin integrity	Limited importance	
	Ho (2019) 88%	**SSI**	**Critical**	No differences in CFU or SSI however waterless hand rubs had the highest compliance
		CFU	Limited importance	
		Hand hygiene compliance	Limited importance	
	Liu (2016) 77%	**SSI**	**Critical**	No difference in SSI, however ABHR causes less skin damage
		Skin damage	Limited importance	
	Widodo (2019) 92%	Microorganisms on hands	Important not critical	All surgical hand-washing methods are effective at reducing microorganisms
	Tanner (2016) 23%	**SSI**	**Critical**	No significant differences in SSI or CFU, however waterless hand rubs had the highest compliance
		CFU	Limited importance	
		Hand hygiene compliance	Limited importance	
I: NR	Fry (2019) 58%	**SSI**	**Critical**	Limited literature, however, no difference in SSI. ABHR has a greater reduction in CFU.
		CFU	Limited importance	
	Khodabakhshi (2020) 50%	CFU	Limited importance	ABHR have the fastest and strongest effect in reducing microbial load and may limit skin damage
		Skin integrity	Limited importance	
	Nthumba (2020) 33%	**SSI**	**Critical**	No difference in SSI
II: RCT	Akita (2022) 60% #	CFU	Limited importance	No difference for both outcomes
		Staff skin moisture	Limited importance	
	Santé (2023) 60% #	CFU	Limited importance	Triclosan, triclosan + ethanol and propran-1-nol all reduced CFU immediately, but triclosan does not meet the European standard for sustained additional effect
	Tsai (2017) 100%	CFU	Limited importance	Conventional chlorhexidine scrub and waterless hand rub were superior in bacterial inhibition pre-surgery, but not post-surgery
III-2: quasi-experimental controlled	Forer (2017) 56% #	CFU	Limited importance	Alcohol rub was more effective after application (no surgery performed)
	Olivia (2025) 89%	CFU	Limited importance	Both ABHR and antimicrobial soap (4% chlorhexidine reduced CFU, but were not significantly different to each other regarding magnitude of effect
	Shen (2015) 89%	Culture rate	Limited importance	Alcohol-based hand rub was more effective, pre- and post-surgery

IV: Case series	Gaspar (2017) 90%	**SSI**	**Critical**	Improved compliance but no difference in SSI
		Hand hygiene compliance	Limited importance	
	Iwakiri (2017) 60%	**SSI**	**Critical**	No difference in SSI
	Oriel (2017) 70%	Pathogens SSI	Important but not critical	After the introduction of an ABHR for surgical hand antisepsis, there was change in SSI pathogens identified

Table 24 Sink removal combined with waterless care (10 studies)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
NHMRC I: SR			
Fucini (2024) 73%	HAIs	Critical	Sink rooms had significant higher incidence of HAI
Low (2024) 69%	HAIs	Critical	Preliminary, limited,= evidence that sink removal and water-free interventions terminate outbreaks
NHMRC I: NR			
Inkster (2024) 50%	Gram-negative infections/colonisation	Important but not critical	Limited literature however there is value in waterless care in reducing infection rates.
NHMRC III-3: Interrupted time series with no control			
Cantero (2018) 50% #	*C. indologenes* cases	Critical	No cases after 3 stage bundled sink outbreak response including closing patient care handwashing station and implementing waterless patient care
Catho (2021) ^ 63% #	Verona Integron-encoded metallo-β-lactamase *P. aeruginosa* cases	Critical	Bundled response including sink removal and waterless patient care ceased the outbreak
Hopman (2017) 89%	Patient colonisation with GNB	Important but not critical	Sink removal and waterless patient care reduced patient colonisation with GNB
Martischang (2025) ^ 44% #	*S. marcescens* cases	Critical	The outbreak was not controlled by interventions likely due to active pressure by selective oral decontamination (SOD) or the maintenance of ventilatory circuits.
Schärer (2023) 38% #	MDR *P. aeruginosa* infection or colonisation	Critical	Outbreak ceased after final stage of interventions, including waterless patient care and sink removal
Shaw (2018) 56% #	MDR-GNB colonisation or infection	Critical	Sink removal and water avoidance, including patient wipes, reduced incidence of MDR-GNB in endemic setting.
Tracy (2020) 25% #	Neonate colonisation with multidrug-resistant organism	Important but not critical	Only cessation of routine bathing of neonates decreased the incidence of colonisation

Table 25: Sink removal without additional waterless care interventions (5 studies)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
NHMRC I: NR			
Kearney (2021) 50%	Carbapenemase-producing bacteria (CPB)	Important but not critical	There are limited prospective studies available however studies confirm sinks serve as reservoirs of CPB
Parkes (2018) 33%	Organism isolated	Important but not critical	Sink cleaning, disinfection and replacement often cease outbreaks but fail to decolonise sinks
NHMRC III-3: Interrupted time series with no control			
De-Las-Casas-Cámara (2022) * 56% #	Antibiotic consumption	Important but not critical	Significant reduction in antibiotic consumption and MDR cases (including water-free patient care)
	Multidrug-resistant organism cases	Important but not critical	
De-Las-Casas-Cámara (2019) * 56% #	Nonfermenting gram-negative bacilli (NFGNB) in bronchial aspirate invasive mechanical ventilation cases	Critical	Significant case reduction after removing sinks (including water-free patient care); NFGNB detected in faucets
Debast (2025) 38% #	Verona Integron-encoded Metallo-β-lactamase P. aeruginosa cases	Critical	A bundle of infection prevention measures did not terminate the outbreak, only sink removal did.

Table 26 Waterless patient care (including patient hygiene) without sink removal (7 studies)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
NHMRC I: SR			
Groven (2017) 69%	Patient skin condition	Limited importance	Washing without water performed better for skin dryness/hydration/ abnormalities but there was no difference for skin lesions
Zanichelli (2021) 69%	HAIs	Critical	HAIs and skin colonisation are minimally affected by the bathing technique or frequency however skin integrity may benefit from waterless bathing
	Patient skin colonisation	Important but not critical	
	Skin integrity	Limited importance	
NHMRC I: NR			
Mallinckrodt (2023) 67%	*E. anophelis* pleuritis cases	Critical	Water-free care is one of a number of strategies to control *E. anopheles I* cases
Boyce (2023) 58%	HAIs / SSIs	Critical	Similar SSI rates bathing with CHG vs. other wash products. Daily CHG bathing in ICU and other settings may reduce HAI but evidence quality is poor.
NHMRC II: RCT			
Martin (2017) 60% #	HAIs	Critical	No difference in HAIs, however 4 cases of patient-sink same MDRO pathogen. Patient skin integrity deterioration was significantly less for ABHR
	Multidrug-resistant organisms (MDRO)	Important but not critical	
	Patient skin integrity	Limited importance	
NHMRC III-3: Interrupted time series with no control			
Baker (2021) 75% #	Nontuberculous Mycobacteria Isolates	Critical	Implementation of tap water avoidance decreased the incidence
Moulin (2024) 50% #	New Delhi metallo-β-lactamase-producing *Klebsiella pneumoniae* cases	Critical	Sinks continually re-colonised or remained colonised until the final component of the sink intervention, including waterless patient care and extensive sink cleaning

Table 27 Sink removal without additional waterless care interventions without sink removal (1 review)

Citation Quality (%)	Outcome	Outcome criteria	Conclusion relevant to relevant outcomes
I: SR			
Kuti (2021) 100%	Neonatal infection	Critical	Sparse data available which were of moderate- to very low-certainty. No superiority of one hand hygiene agent over another

Environmental impacts of waterless models of care

Six studies addressed methods for assessing environmental impacts.

Table 28 Evidence summary for environmental impacts of waterless models of care

Outcome	Summary of findings
Water consumption	Consistent reductions in water use were reported when waterless approaches replaced traditional water-based practices
Material use and waste	Reduced use of paper towels, brushes and related consumables was reported
Cost	Several studies reported financial savings associated with waterless approaches
Broader environmental impacts	Limited evidence was available regarding comprehensive environmental assessment methods

Appendix 5: Guideline Development Group Membership

Table 29: AICGs Guideline Development Group (GDG) Members

	Member name	Basis of appointment
1	co-Chair – Professor Peter Collignon AM	Content expert: Infectious diseases
2	co-Chair – Adjunct Professor Allison McMillan PSM	Content expert: Nursing and health policy
3	Ms Shiraz Abdulla	Implementation end user: Nursing (acute sector)
4	Ms Emma Coombes	Implementation end user: Allied health (primary care)
5	Dr Kathy Dempsey	Content expert: Infection prevention and control, large jurisdiction
6	Ms Sara Drew	Implementation end user: Nursing (primary/community sector)
7	Professor Thomas Gottlieb AO	Content expert: Infectious diseases
8	Professor Lisa Hall	Methodological expert: evidence brokering and guideline development
9	Dr Tanvir Kapoor	Implementation end user: Medical
10	Ms Lucy Lehane	Implementation end user: Clinical governance
11	Ms Rebecca McCann	Content expert: Infection prevention and control, small jurisdiction
12	Mr Sean Mutchmor	Implementation end user: Patient safety and quality (regional and rural sector)
13	Ms Angela Myers	Consumer representative: Primary care
14	Ms Stephanie Newell	Consumer representative: Hospital sector
15	Ms Clee Tonkin	Implementation end user: Allied Health (Hospital sector)
16	Dr Yvonne Zurynski	Implementation expert: Implementation science

Appendix 6: Reflective questions

Guideline Development Group - Meeting 2

Instructions

These reflective questions are for you to decide if there is enough evidence from the systematic review on waterless models of care to inform the development of new good practice statements for the appropriate and safe use of waterless models of care in healthcare.

Reflective question 1 relates to the appropriate use of alcohol-based hand scrub, reflective questions 2, 3 and 4 relate to waterless models of care (patient hygiene, sink avoidance).

You should use the information from the Summary of evidence for the systematic review on the effectiveness of waterless models of care to help you answer these reflective questions.

When answering each reflective question, consider if there is sufficient evidence in the systematic review to support the proposed changes to the recommendation or development of a good practice statement

- Answer options:
  Yes: you agree
  No: you don't agree
  Unsure: Currently, you need more information before you make a decision, or this is outside your scope of expertise, or you don't now.

For question 1; please declare any potential or real conflicts of interest before completing this survey and continue to answer all the questions for each topic.

Definitions

Waterless models of care are defined as *the targeted avoidance of sinks and reduction of tap-water-related activities such as handwashing with disinfectant soap or solution prior to patient care*.

Reflective question 1: Effectiveness of alcohol-based hand scrub.

Does the evidence from the systematic review support developing a **new good practice statement** for the appropriate use of alcohol-based surgical hand scrub?

Survey		
1. Conflict of interest	Do you have a conflict of interest related to this topic? *For example: Have you or anyone directly related to you received financial payment (e.g.: research grants, consultancy honoraria) from organisations/companies related to alcohol-based surgical hand scrub use or manufacturing.*	☐ Yes ☐ No ☐ Unsure - please add details:
2. Balance of effects - benefit versus harm	Do the benefits of using alcohol-based surgical hand scrub (the intervention) compared to traditional surgical scrubbing with soap and water (the comparator) outweigh the any potential or real harm to patients and or healthcare workers? *Consider the possible desirable outcomes (a reduction/no change in infection and patient colonisation, less skin irritation for HCWs, time and resource saving) compared to undesirable outcomes (increased infection/colonisations, additional resources/costs, potential changes to hand hygiene practices/reduced compliance)*	☐ Yes ☐ No ☐ Unsure
3. Certainty of evidence	How strong do you think the evidence is to support the use of alcohol-based surgical hand scrub for pre surgical hand hygiene (scrubbing)?	☐ Very low ☐ Low ☐ Moderate ☐ Strong/Large ☐ Unsure
4. Generalisability	Does the intervention (use of alcohol-based surgical hand scrub) apply to all clinical settings or specific settings only? *Consider if the intervention was only tested in hospitals or community settings, only for specific clinical procedures or under outbreak or non-outbreak conditions.*	☐ Yes, applies to all settings ☐ No, applies to specific settings only ☐ Unsure
5. Acceptability	Would the intervention (use of alcohol-based surgical hand scrub) be generally acceptable to patients, healthcare workers, and healthcare consumers? *Consider if the intervention could impact a person's values and preferences or access to receiving or providing healthcare.*	☐ Yes ☐ No ☐ Unsure

6. Resources (and other considerations)	How much resourcing/support would be required to implement the recommendation? *Consider what resources/support could be required* - *human resources (staffing levels and skills, additional staff education/training, updating supporting resources)* - *financial costs (products, purchasing, access to single rooms)* - *governance and system wide support for practice change* - *other infrastructure such as building modifications*	☐ Large ☐ Moderate ☐ Small ☐ Varies ☐ Unsure
7. Sustainability	Is the intervention (use of alcohol-based surgical hand scrub) economically sustainable? *Consider:* - *costs and resources associated with introducing the alcohol-based surgical hand scrub* - *other factors associated with the intervention from the systematic review (reduction in infections, time saving, reduction in HCWs skin irritation)* - *if there is any potential impact on service delivery.*	☐ Yes ☐ No ☐ Unsure
	Is the intervention (use of alcohol-based surgical hand scrub) environmentally sustainable? *Consider:* - *savings (water/brushes for scrubbing) and waste generation (plastic/packaging)* - *other factors associated with the intervention from the systematic review.*	☐ Yes ☐ No ☐ Unsure

Reflective question 2: Effectiveness of sink removal in addition to other waterless care interventions to reduce environmental colonisation, and patient colonisation or infection with waterborne pathogens

Does the evidence support developing a new good practice statement for the appropriate use of waterless care bundles/interventions to control outbreaks of waterborne pathogens in acute care settings?

Survey		
1. Conflict of interest	Do you have a conflict of interest related to this topic? *For example: Have you or anyone directly related to you received financial payment (e.g.: research grants, consultancy honoraria) from organisations/companies related to waterless hygiene/patient care use or manufacturing.*	☐ Yes ☐ No ☐ Unsure - please add details:
2. Balance of effects - benefit versus harm	Do the benefits of sink removal/avoidance in addition to other waterless patient care (the intervention) compared to routine sink use and patient care with water (the comparator) outweigh the any potential or real harm to patients and or healthcare workers? *Consider possible desirable outcomes (reduction in the environmental colonisation, patient infection or colonisation with waterborne pathogens/resolution of outbreaks associated with waterborne pathogens) compared to undesirable outcomes (increase in environmental colonisation, patient infection or colonisation, unable to resolve outbreaks associated with waterborne pathogens, impact on hand hygiene and other IPC strategies)*	☐ Yes ☐ No ☐ Unsure
3. Certainty of evidence	How strong do you think the evidence is to support sink removal/avoidance in addition to waterless care?	☐ Very low ☐ Low ☐ Moderate ☐ Strong/Large ☐ Unsure
4. Generalisability	Does the intervention (sink removal/avoidance in addition to waterless care) apply to all clinical settings or specific conditions? *Consider if the intervention was only tested in hospitals or community settings, only for specific clinical procedures or under outbreak or non-outbreak conditions.*	☐ Yes, applies to all settings ☐ No, applies to specific settings only ☐ Unsure
5. Acceptability	Would the intervention (sink removal/avoidance in addition to waterless care) be generally acceptable to patients, healthcare workers, and healthcare consumers? *Consider if the intervention could impact a person's values and preferences or access to receiving or providing healthcare.*	☐ Yes ☐ No ☐ Unsure

6. Resources (and other considerations)	How much resourcing/support would be required to implement the recommendation? *Consider what resources/support could be required* - *human resources (staffing levels and skills, additional staff education/training, updating supporting resources* - *financial costs (products, purchasing, access to single rooms)* - *governance and system wide support for practice change* - *other infrastructure such as building modifications*	☐ Large ☐ Moderate ☐ Small ☐ Varies ☐ Unsure
7. Feasibility	Is it feasible to recommend the sink removal/avoidance in addition to waterless care? *Consider if the intervention can be applied in all healthcare setting (rural/remote, primary care, acute care etc)*	☐ Yes - feasible in all healthcare settings ☐ May be feasible is some settings ☐ No - not feasible in any healthcare setting ☐ Unsure
8. Sustainability	Is the intervention (sink removal/avoidance in addition to waterless care) economically sustainable? *Consider:* - *costs and resources associated with sink removal/avoidance in addition to waterless care (cost of sink removal, associated building work, waterless care products).* - *other factors associated with the intervention from the systematic review (reduction in infections/colonisations, improved patient skin conditions, other infection prevention and control implications)* - *if there is any potential impact on service delivery.*	☐ Yes ☐ No ☐ Unsure

Reflective question 3: Effectiveness of sink removal only to reduce environmental colonisation and patient colonisation or infection with waterborne pathogens

Does the evidence support developing a new good practice statement for the appropriate use of waterless care bundles/interventions to control outbreaks of waterborne pathogens in acute care settings?

Survey

1. Conflict of interest	Do you have a conflict of interest related to this topic? *For example: Have you or anyone directly related to you received financial payment (e.g.: research grants, consultancy honoraria) from organisations/companies related to waterless hygiene/patient care use or manufacturing.*	☐ Yes ☐ No ☐ Unsure - please add details:
2. Balance of effects - benefit versus harm	Do the benefits of sink removal/avoidance only (the intervention) compared to routine sink use (the comparator) outweigh the any potential or real harm to patients and or healthcare workers? *Consider possible desirable outcomes (reduction in the environmental colonisation, patient infection or colonisation with waterborne pathogens/resolution of outbreaks associated with waterborne pathogens) compared to undesirable outcomes (increase in environmental colonisation, patient infection or colonisation, unable to resolve outbreaks associated with waterborne pathogens, impact on hand hygiene and other IPC strategies)*	☐ Yes ☐ No ☐ Unsure
3. Certainty of evidence	How strong do you think the evidence is to support sink removal/avoidance only?	☐ Very low ☐ Low ☐ Moderate ☐ Strong/Large ☐ Unsure
4. Generalisability	Does the intervention (sink removal/avoidance only) apply to all clinical settings or specific settings only? *Consider if the intervention was only tested in hospitals or community settings, only for specific clinical procedures or under outbreak or non-outbreak conditions.*	☐ Yes, applies to all settings ☐ No, applies to specific settings only ☐ Unsure
5. Acceptability	Would the intervention (sink removal/avoidance only) be generally acceptable to patients, healthcare workers, and healthcare consumers? *Consider if the intervention could impact a person's values and preferences or access to receiving or providing healthcare.*	☐ Yes ☐ No ☐ Unsure
6. Resources (and other considerations)	How much resourcing/support would be required to implement the recommendation? *Consider what resources/support could be required* - *human resources (staffing levels and skills, additional staff education/training, updating supporting resources)* - *financial costs (products, purchasing, access to single rooms)*	☐ Large ☐ Moderate ☐ Small ☐ Varies ☐ Unsure

	- *governance and system wide support for practice change* - *other infrastructure such as building modifications*	
7. Feasibility	Is it feasible to recommend the sink removal/avoidance? *Consider if the intervention can be applied in all healthcare setting (rural/remote, primary care, acute care etc)*	☐ Yes - feasible in all healthcare settings ☐ May be feasible is some settings ☐ No - not feasible in any healthcare setting ☐ Unsure
8. Sustainability	Is the intervention (sink removal/avoidance only) economically sustainable? *Consider:* - *costs and resources associated with sink removal/avoidance (cost of sink removal, associated building work).* - *other factors associated with the intervention from the systematic review (reduction in infections/colonisations, other infection prevention and control implications)* - *if there is any potential impact on service deliver*	☐ Yes ☐ No ☐ Unsure
	Is the intervention (sink removal/avoidance only) environmentally sustainable? *Consider:* - *savings (water) and waste generation* - *other factors associated with the intervention from the systematic review*	☐ Yes ☐ No ☐ Unsure

Reflective question 4: Effectiveness of waterless models of care without sink removal to reduce environmental colonisation and patient colonisation or infection with waterborne pathogens

Does the evidence support developing a new good practice statement for the appropriate use of waterless care bundles/interventions to control outbreaks of waterborne pathogens in acute care settings?

Survey

1. Conflict of interest	Do you have a conflict of interest related to this topic? *For example: Have you or anyone directly related to you received financial payment (e.g.: research grants, consultancy honoraria) from organisations/companies related to waterless hygiene/patient care use or manufacturing.*	☐ Yes ☐ No ☐ Unsure - please add details:
2. Balance of effects - benefit versus harm	Do the benefits of waterless models of care without sink removal (the intervention) compared to routine patient care (the comparator) outweigh the any potential or real harm to patients and or healthcare workers? *Consider possible desirable outcomes (reduction in the environmental colonisation, patient infection or colonisation with waterborne pathogens/resolution of outbreaks associated with waterborne pathogens) compared to undesirable outcomes (increase in environmental colonisation, patient infection or colonisation, unable to resolve outbreaks associated with waterborne pathogens, impact on hand hygiene and other IPC strategies)*	☐ Yes ☐ No ☐ Unsure
3. Certainty of evidence	How strong do you think the evidence is to support waterless models of care without sink removal?	☐ Very low ☐ Low ☐ Moderate ☐ Strong/Large ☐ Unsure
4. Generalisability	Does the intervention (waterless models of care without sink removal) apply to all clinical settings or specific settings? *Consider if the intervention was only tested in hospitals or community settings, only for specific clinical procedures or under outbreak or non-outbreak conditions.*	☐ Yes, applies to all settings ☐ No, applies to specific settings only ☐ Unsure
5. Acceptability	Would the intervention (waterless models of care without sink removal) be generally acceptable to patients, healthcare workers and healthcare consumers? *Consider if the intervention could impact a person's values and preferences or access to receiving or providing healthcare.*	☐ Yes ☐ No ☐ Unsure

6. Resources (and other considerations)	How much resourcing/support would be required to implement the recommendation? *Consider what resources/support could be required* - *human resources (staffing levels and skills, additional staff education/training, updating supporting resources)* - *financial costs (products, purchasing, access to single rooms* - *governance and system wide support for practice change* - *other infrastructure such as building modifications*	☐ Large ☐ Moderate ☐ Small ☐ Varies ☐ Unsure
7. Feasibility	Is it feasible to recommend the sink removal/avoidance? *Consider if the intervention can be applied in all healthcare setting (rural/remote, primary care, acute care etc)*	☐ Yes - feasible in all healthcare settings ☐ May be feasible is some settings ☐ No - not feasible in any healthcare setting ☐ Unsure
8. Sustainability	Is the intervention (waterless models of care without sink removal) economically sustainable? *Consider:* - *costs and resources associated with waterless models of care.* - *other factors associated with the intervention from the systematic review (reduction in infections/colonisations, other infection prevention and control implications)* - *if there is any potential impact on service deliver.*	☐ Yes ☐ No ☐ Unsure
	Is the intervention (waterless models of care without sink removal) environmentally sustainable? *Consider:* - *savings (water) and waste generation (plastic/packaging)* - *other factors associated with the intervention from the systematic review*	☐ Yes ☐ No ☐ Unsure

Appendix 7: Results of reflective questions

Reflective question 1: Effectiveness of alcohol-based hand scrub.

Does the evidence from the systematic review support developing a new good practice statement for the appropriate use of alcohol-based surgical hand scrub?

Figure 1 Do the benefits of using alcohol-based surgical hand scrub (the intervention) compared to traditional surgical scrubbing with soap and water (the comparator) outweigh the any potential or real harm to patients and/or healthcare workers?

Figure 2 How strong do you think the evidence is to support the use of alcohol-based surgical hand scrub for pre surgical hand hygiene (scrubbing)?

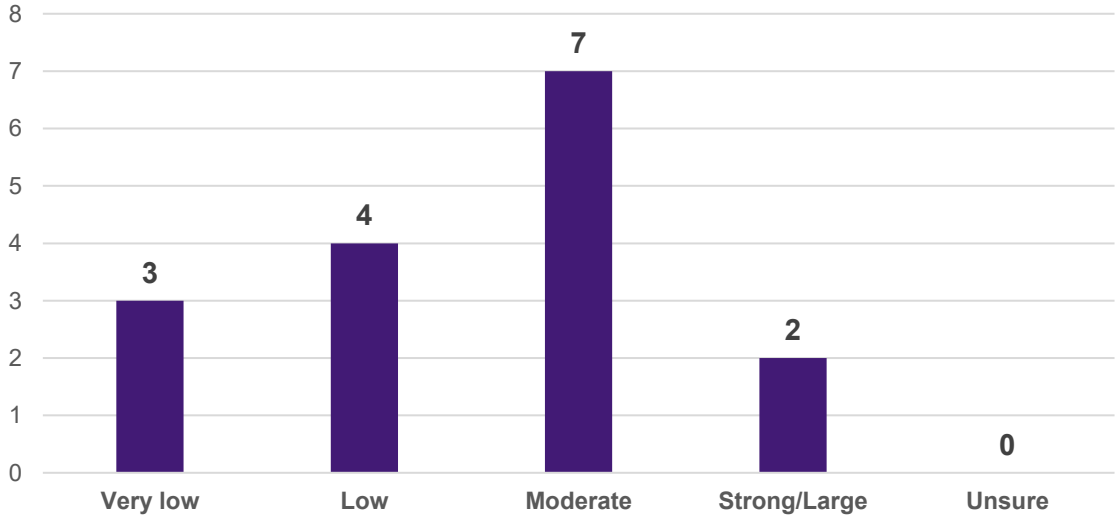


Figure 3 Does the intervention (use of alcohol-based surgical hand scrub) apply to all clinical settings or specific settings only?

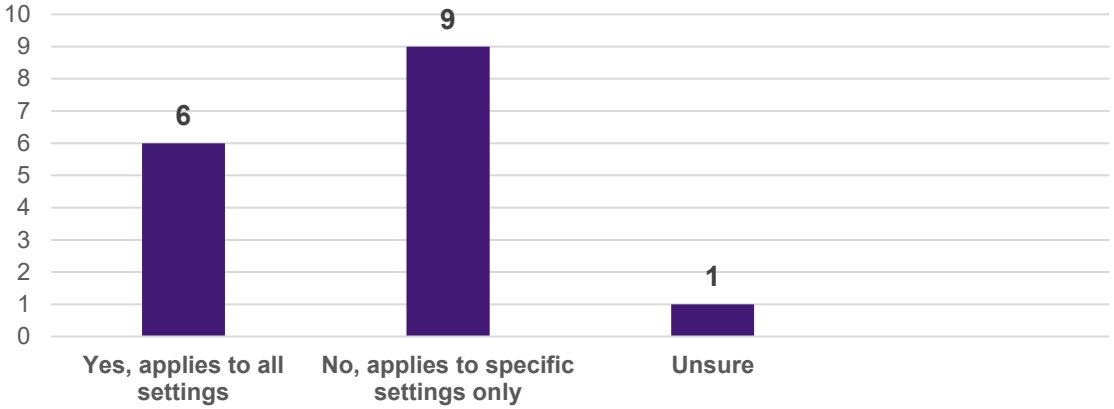


Figure 4 Would the intervention (use of alcohol-based surgical hand scrub) be generally acceptable to patients, healthcare workers, and healthcare consumers?

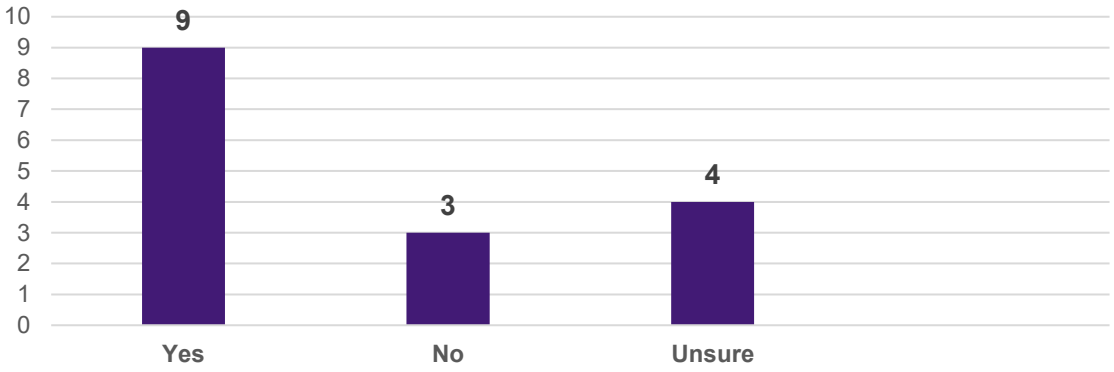


Figure 5 How much resourcing/support would be required to implement the recommendation?

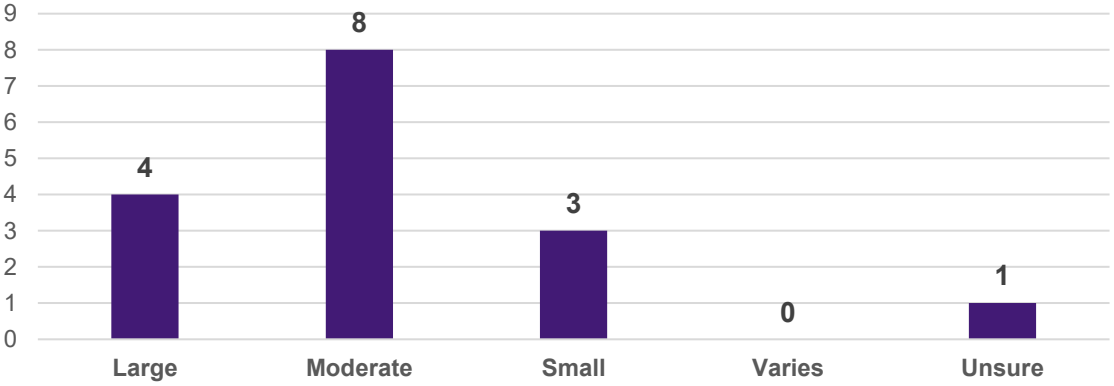


Figure 6 Is the intervention (use of alcohol-based surgical hand scrub) economically sustainable?

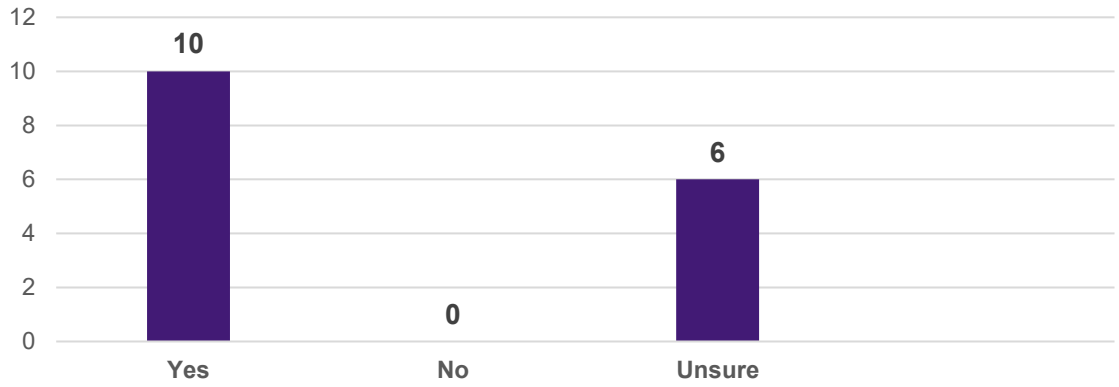
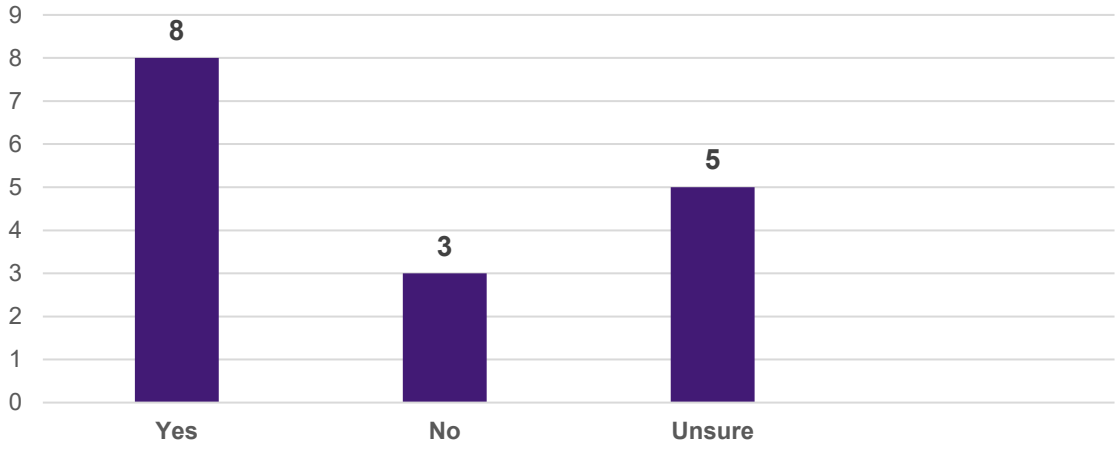


Figure 7 Is the intervention (use of alcohol-based surgical hand scrub) environmentally sustainable?



Summary of Member feedback on Reflective question 1

- **Clarity and scope of intent**

Members noted insufficient clarity in the question and supporting rationale. The proposal did not clearly define when ABHR would be inappropriate, did not limit application to surgical-level aseptic technique, and did not adequately emphasise the need for preliminary handwashing with soap and water.

- **Evidence base and interpretation**

Members generally accepted that the evidence indicates ABHR is at least equivalent to, and possibly better than, traditional methods in defined settings. However, they questioned data consistency and robustness and noted that local epidemiology, including endemic infection risk, would strongly influence implementation. Overall, Members viewed the evidence as promising but not yet definitive.

- **Practice implications and standards alignment**

Members identified this proposal as a substantial practice change, requiring alignment with existing operating theatre standards, clarity on whether ABHR would replace scrubbing or form part of a broader infection prevention bundle, and consideration of impacts on policy, education, compliance, and audit. Members advised further analysis before adopting a strong recommendation.

- **Acceptability and feasibility**

Members generally considered the proposal acceptable to patients and consumers. However, they expressed uncertainty about acceptance by surgical colleges, practitioners, and standards-setting bodies. Acceptability was viewed as context-dependent and likely to vary across settings.

- **Environmental considerations**

Some Members raised environmental concerns, particularly regarding plastic waste associated with ABHR products. They suggested comparing environmental impacts with water-based methods and considering reusable or refillable systems where feasible.

Overall position

Member feedback reflects conditional support with clear reservations. Members acknowledge the potential benefits of ABHR in surgical hand preparation but emphasise the need for clearer definitions, stronger evidence, and careful consideration of practical, regulatory, and environmental impacts before broad endorsement.

Reflective question 2: Effectiveness of sink removal in addition to other waterless care interventions to reduce environmental colonisation, and patient colonisation or infection with waterborne pathogens

Does the evidence support developing a new good practice statement for the appropriate use of waterless care bundles/interventions to control outbreaks of waterborne pathogens in acute care settings?

Figure 8 Do the benefits of sink removal/avoidance in addition to other waterless patient care (the intervention) compared to routine sink use and patient care with water (the comparator) outweigh the any potential or real harm to patients and or healthcare workers?

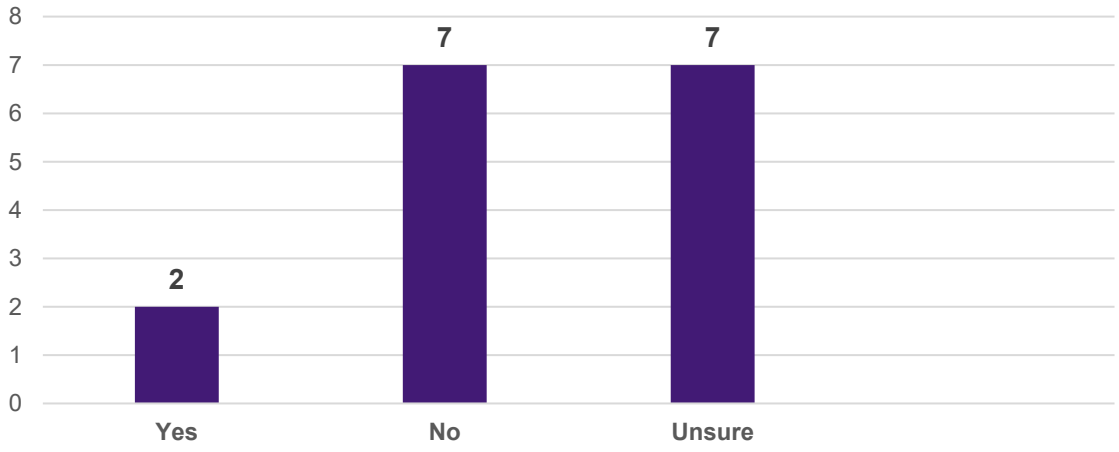


Figure 9 How strong do you think the evidence is to support sink removal/avoidance in addition to waterless care?

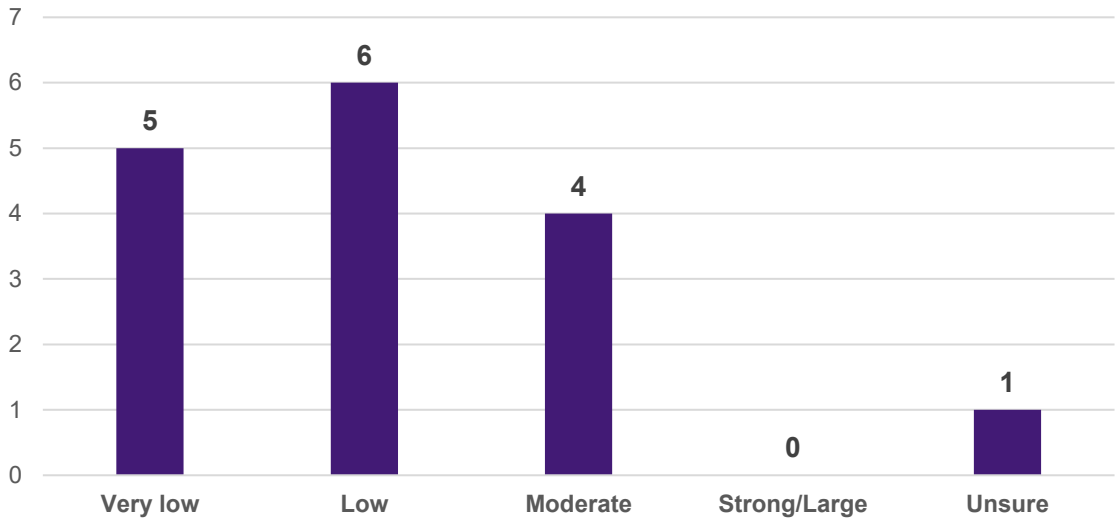


Figure 10 Does the intervention (sink removal/avoidance in addition to waterless care) apply to all clinical settings or specific conditions?

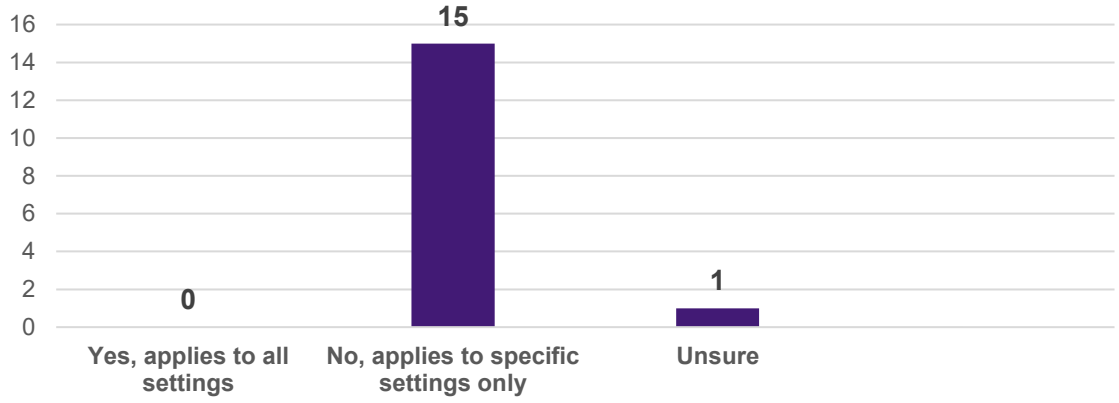


Figure 11 Would the intervention (sink removal/avoidance in addition to waterless care) be generally acceptable to patients, healthcare workers, and healthcare consumers?

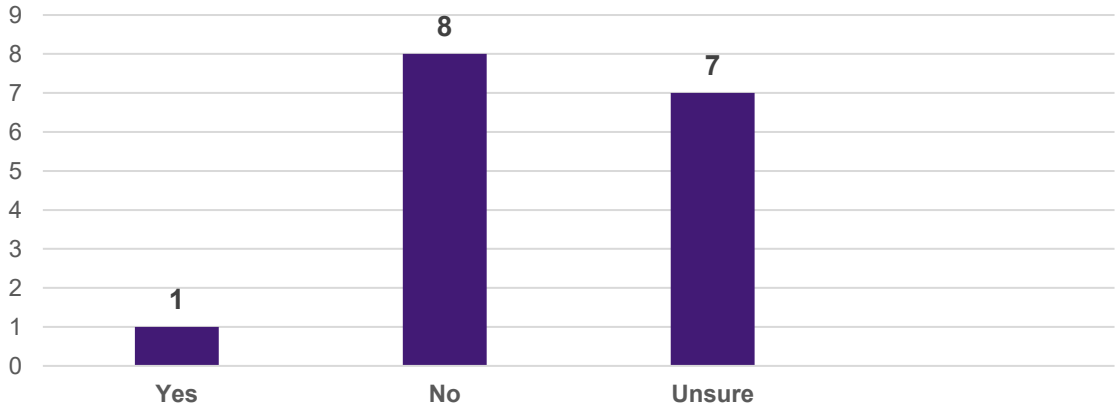


Figure 12 How much resourcing/support would be required to implement the recommendation?

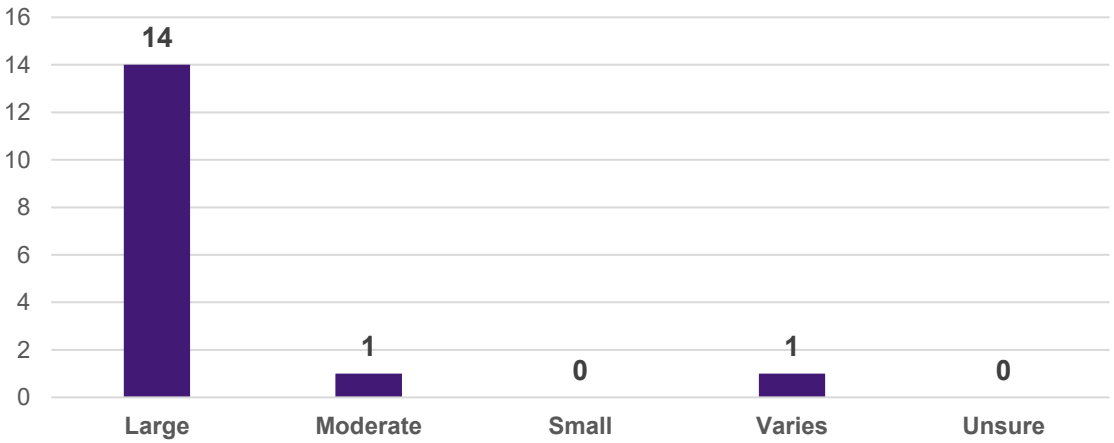


Figure 13 Is it feasible to recommend the sink removal/avoidance in addition to waterless care?

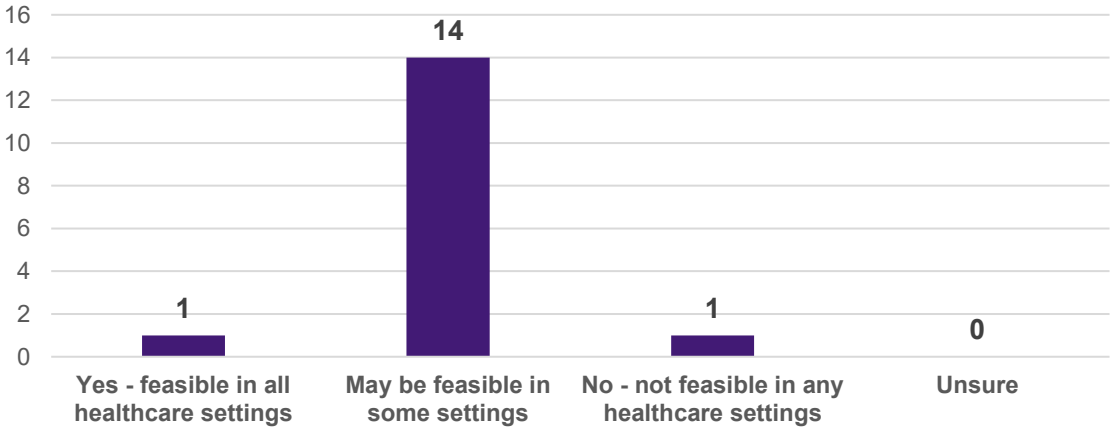


Figure 14 Is the intervention (sink removal/avoidance in addition to waterless care) economically sustainable?

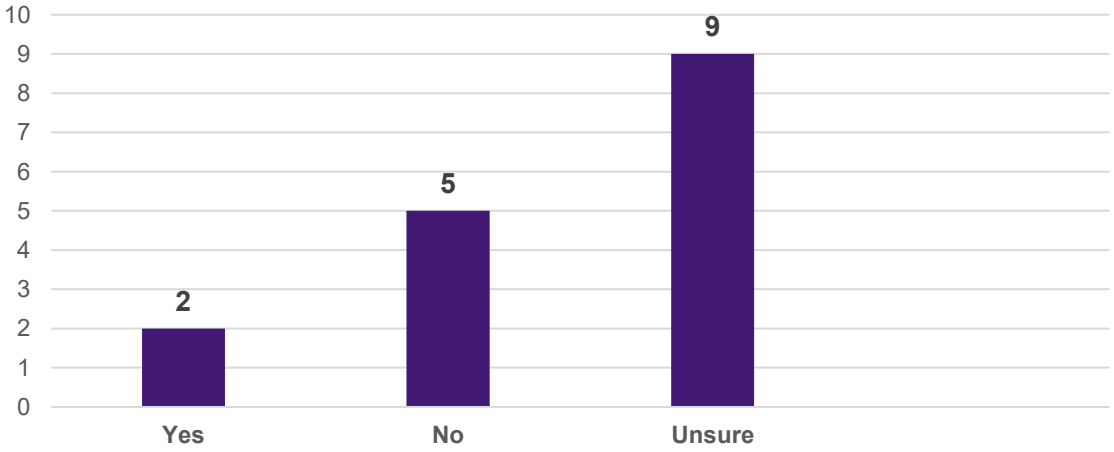
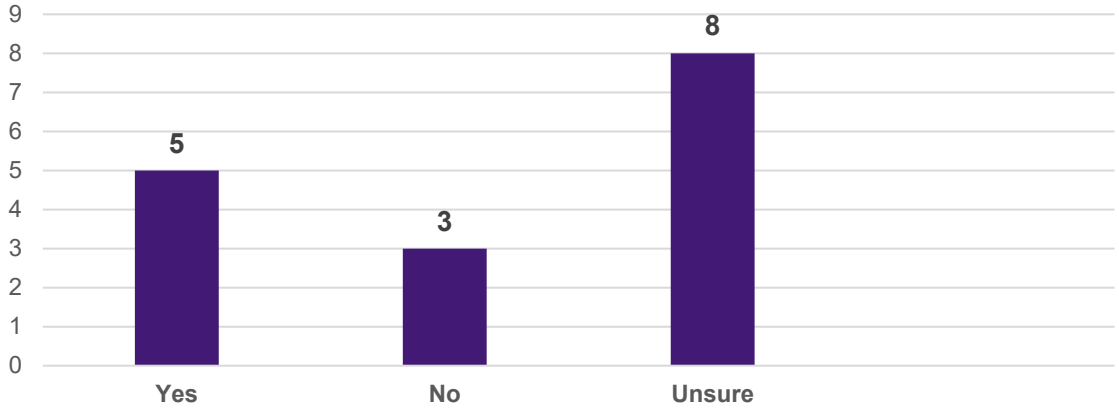


Figure 15 Is the intervention (sink removal/avoidance in addition to waterless care) environmentally sustainable?



Summary of Member feedback on Reflective question 2

- **Evidence base and applicability**

Members noted that the evidence base remains narrow and context-specific, therefore viewed the evidence as supportive for specific scenarios but not generalisable.

- **Scope and intent of the recommendation**

Members identified ambiguity in scope, noting that the appropriateness of sink removal depends on whether guidance targets outbreak response or routine, pre-emptive practice. Members found it difficult to assess benefit outside intensive care or outbreak settings. Several responses suggested limiting guidance to outbreak-specific use.

- **Practice implications and feasibility**

Members raised significant feasibility concerns, including impacts on patient care where alternative washing arrangements are required, workforce challenges such as training needs and potential effects on hand hygiene compliance, and major infrastructure costs associated with sink removal or redesign. In the absence of stronger evidence, Members did not support broad implementation.

- **Infrastructure and design considerations**

Members consistently recommended reframing the proposal away from sink removal, instead focusing on appropriate sink placement and numbers. They advised limiting sink removal to new builds or refurbishments in clearly defined settings and aligning recommendations with Australian healthcare culture, infrastructure, and workforce expectations. Members viewed this approach as more practical and acceptable.

- **Acceptability and setting-specific use**

Members considered sink removal acceptable only in limited contexts, such as recognised gram-negative organism outbreaks in intensive care units and selected neonatal intensive care settings. Members did not support broader application at this time.

- **Environmental and economic considerations**

Members acknowledged potential reductions in water use but raised concerns about increased plastic waste from waterless products and the economic and environmental costs associated with infrastructure change and waste generation. Members emphasised the need to explicitly assess these trade-offs.

Overall position

Member feedback indicates conditional, highly contextual support. Members recognise potential benefits of waterless approaches in outbreak-specific, high-risk settings but do not support routine sink removal. They emphasise the need for clearer scope, stronger evidence beyond outbreak settings, and a shift in focus toward sink placement and design rather than removal.

Reflective question 3: Effectiveness of sink removal only to reduce environmental colonisation and patient colonisation or infection with waterborne pathogens

Does the evidence support developing a new good practice statement for the appropriate use of waterless care bundles/interventions to control outbreaks of waterborne pathogens in acute care settings?

Figure 16 Do the benefits of sink removal/avoidance only (the intervention) compared to routine sink use (the comparator) outweigh the any potential or real harm to patients and/or healthcare workers?

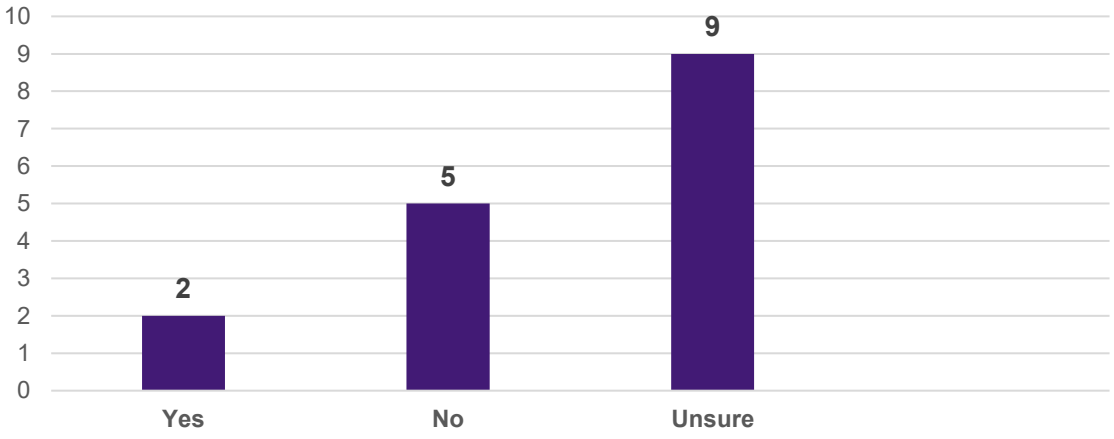


Figure 17 How strong do you think the evidence is to support sink removal/avoidance only?

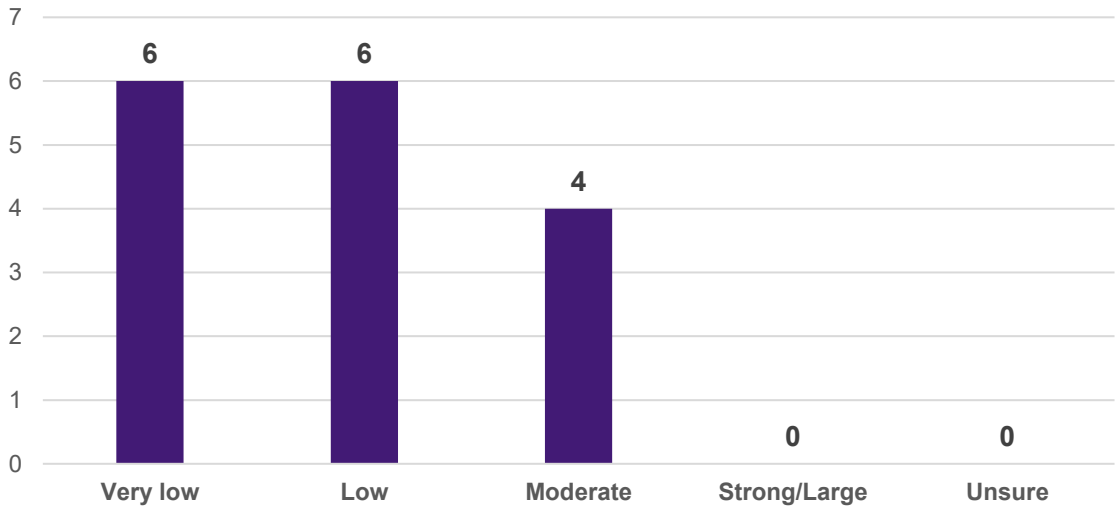


Figure 18 Does the intervention (sink removal/avoidance only) apply to all clinical settings or specific settings only?

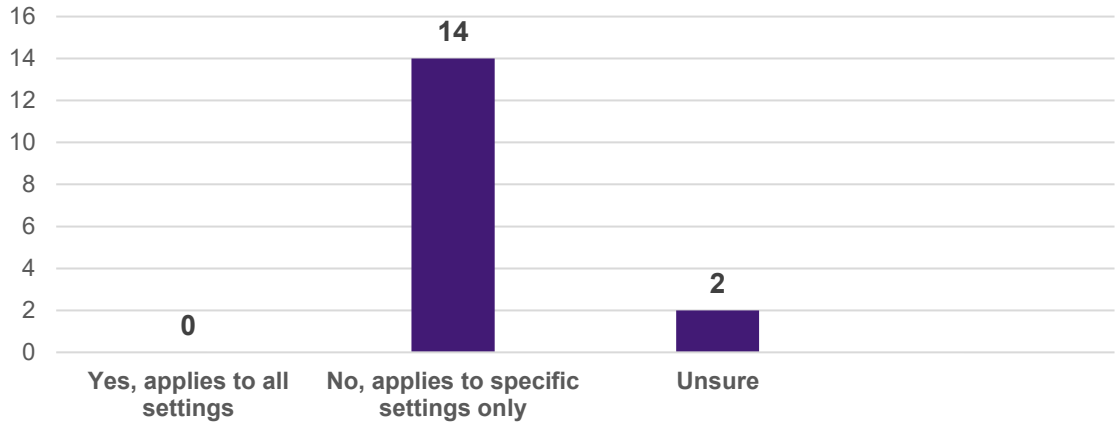


Figure 19 Would the intervention (sink removal/avoidance only) be generally acceptable to patients, healthcare workers, and healthcare consumers?

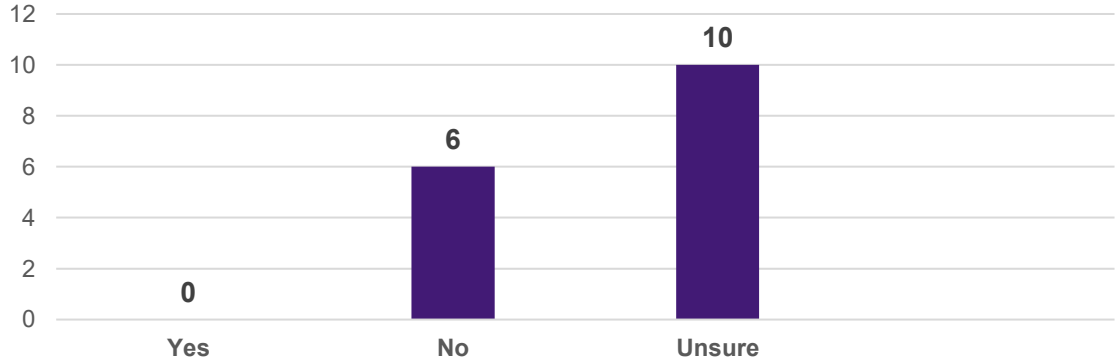


Figure 20 How much resourcing/support would be required to implement the recommendation?

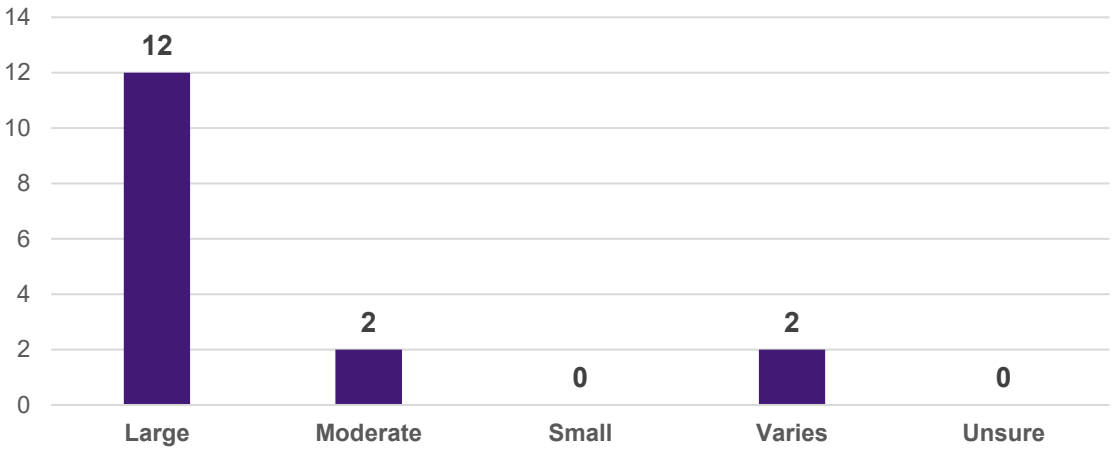


Figure 21 Is it feasible to recommend the sink removal/avoidance?

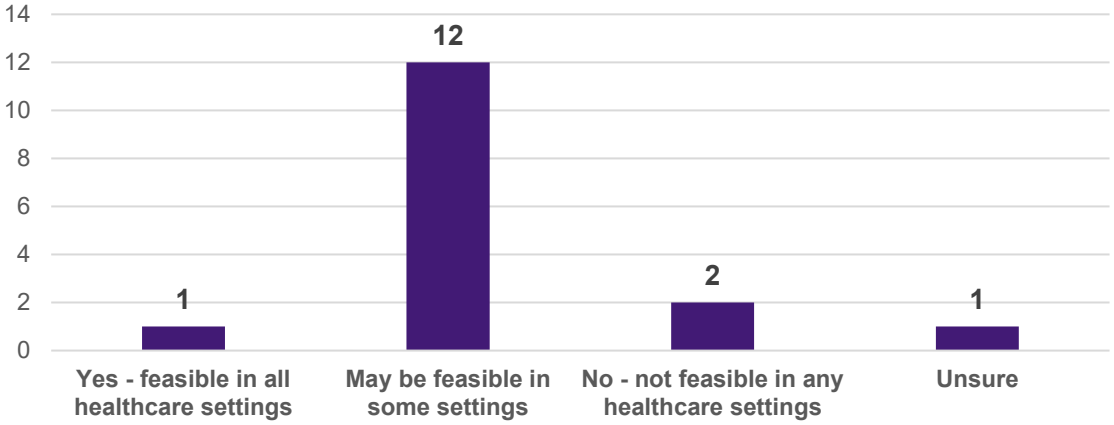


Figure 22 Is the intervention (sink removal/avoidance only) economically sustainable?

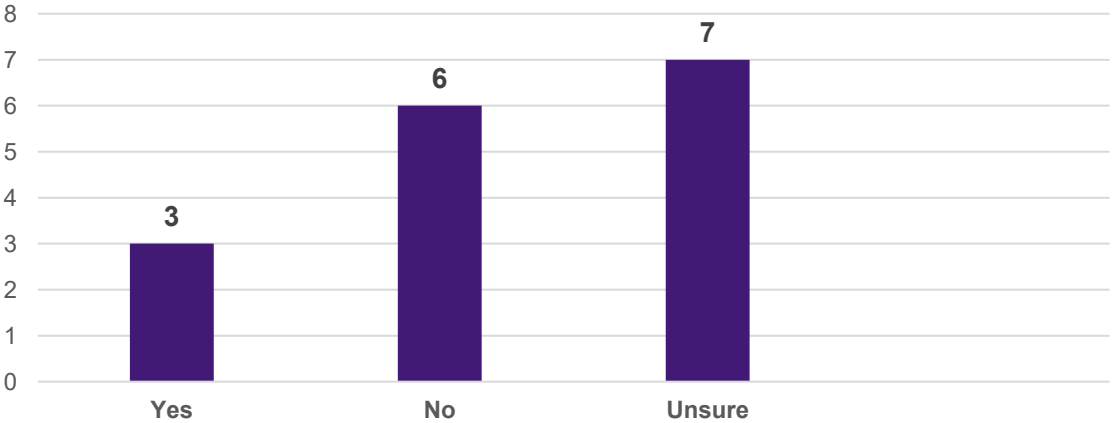
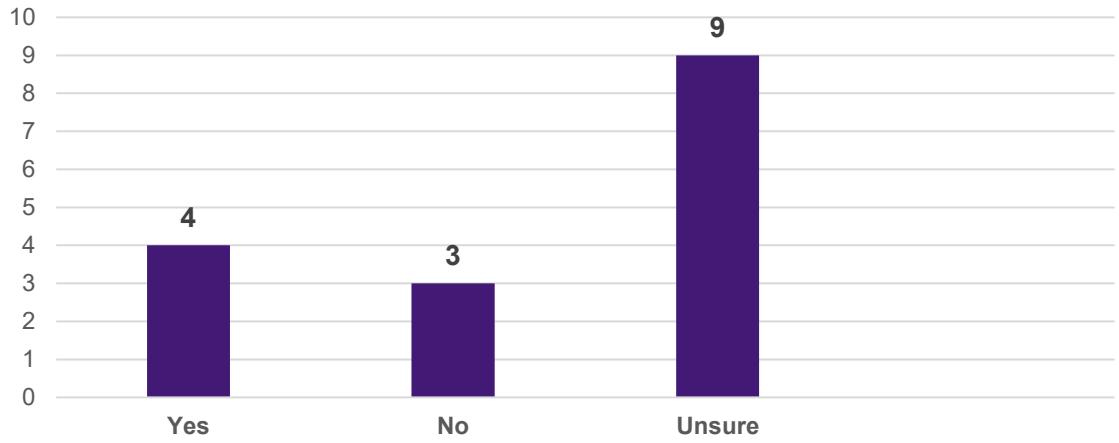


Figure 23 Is the intervention (sink removal/avoidance only) environmentally sustainable?



Summary of Member feedback on Reflective Question 3

- **Evidence base and quality**

Members noted that the available evidence is limited and largely derived from multimodal interventions, making it difficult to determine the independent impact of sink removal. As a result, Members found conclusions about effectiveness and broader impacts to be inconclusive based on the summary information provided.

- **Environmental impacts and trade-offs**

Members recognised potential environmental benefits, including reduced environmental reservoirs, less splashing, lower water use, and reduced wastewater contamination. However, they also highlighted likely trade-offs, such as increased single-use items, packaging waste, and potential building waste associated with sink removal. Members emphasised the need to assess these impacts in combination rather than in isolation.

- **Economic considerations**

Members noted that economic impacts would vary depending on factors such as patient acuity and building age. They raised concerns about the risk of future costs, including the possibility of needing to retrofit sinks after removal. Members viewed sink removal as more economically viable, if at all, in new builds rather than existing facilities.

- **Infrastructure and design considerations**

Members reiterated that proposals should be framed around appropriate positioning and rationalisation of sinks, rather than wholesale removal. Several Members suggested that sink avoidance may be feasible in specific settings within new builds, provided alternative facilities remain accessible for situations requiring handwashing.

- **Sustainability and mitigation strategies**

Members noted that while waterless models may increase plastic waste, this impact could be mitigated through refillable systems and sourcing products from suppliers with strong environmental credentials. Members highlighted the importance of explicitly addressing sustainability strategies alongside any proposed changes.

Overall position

In summary, Members expressed significant uncertainty about the environmental and economic case for sink removal due to limited and inconclusive evidence. Members supported further consideration of targeted, design-focused approaches, particularly in new builds, but cautioned against broad conclusions or recommendations at this stage.

Reflective question 4: Effectiveness of waterless models of care without sink removal to reduce environmental colonisation and patient colonisation or infection with waterborne pathogens

Does the evidence support developing a new good practice statement for the appropriate use of waterless care bundles/interventions to control outbreaks of waterborne pathogens in acute care settings?

Figure 24 Do the benefits of waterless models of care without sink removal (the intervention) compared to routine patient care (the comparator) outweigh the any potential or real harm to patients and/or healthcare workers?

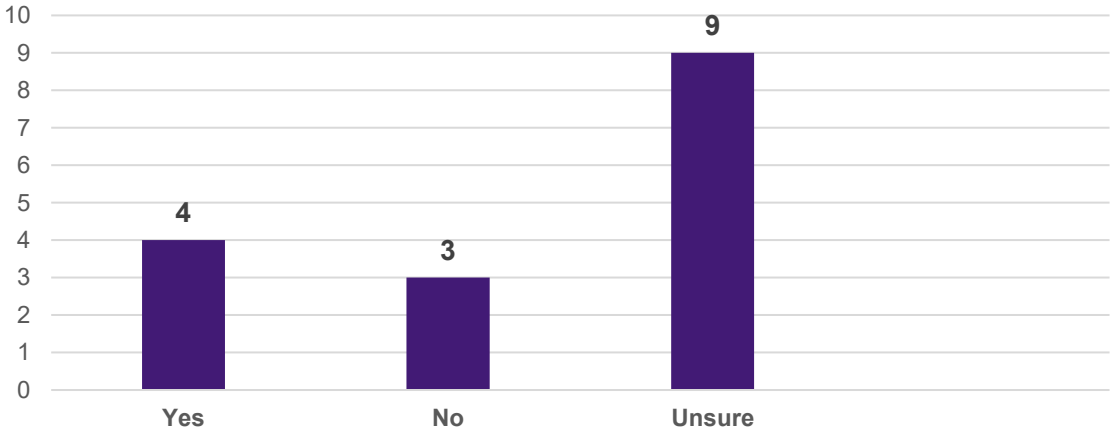


Figure 25 How strong do you think the evidence is to support waterless models of care without sink removal?

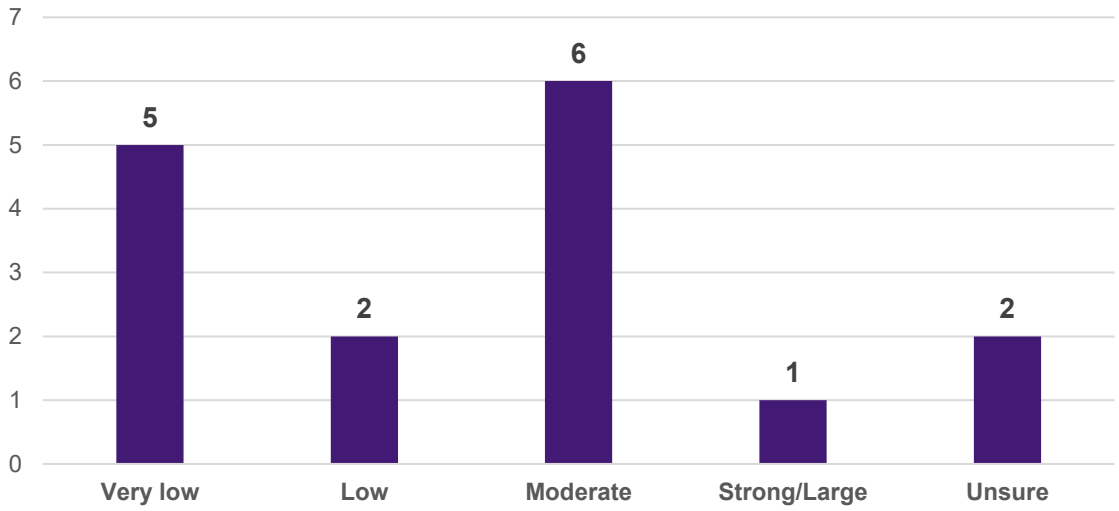


Figure 26 Does the intervention (waterless models of care without sink removal) apply to all clinical settings or specific settings?

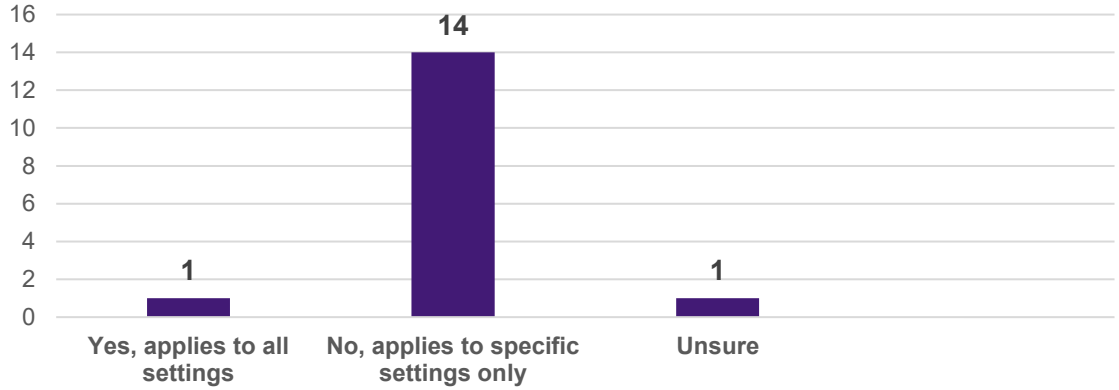


Figure 27 Would the intervention (waterless models of care without sink removal) be generally acceptable to patients, healthcare workers and healthcare consumers?

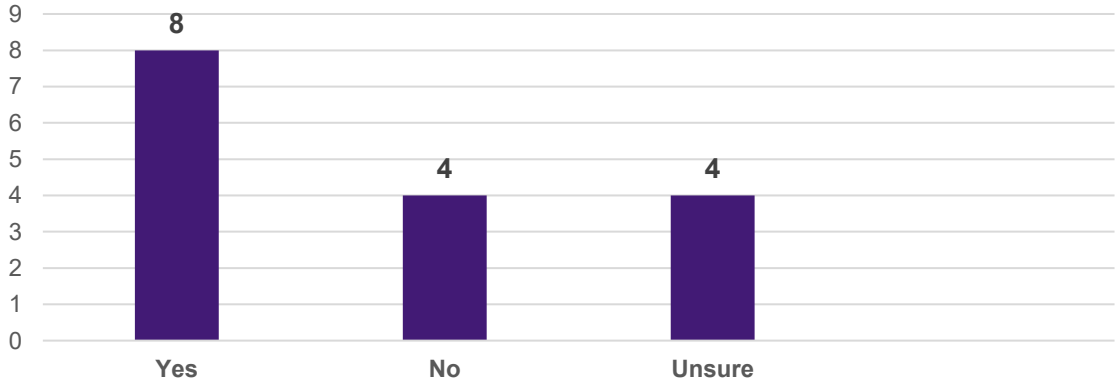


Figure 28 How much resourcing/support would be required to implement the recommendation?

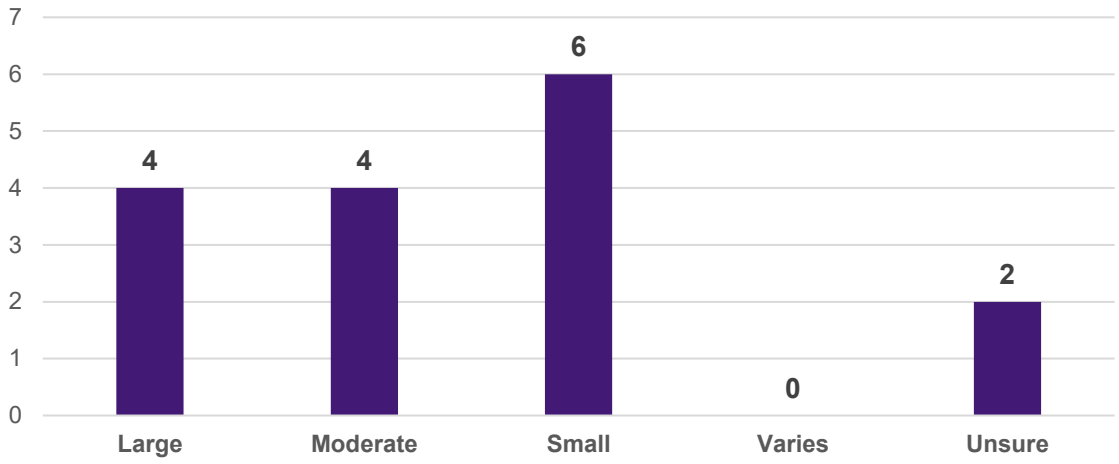


Figure 29 Is it feasible to recommend the sink removal/avoidance?

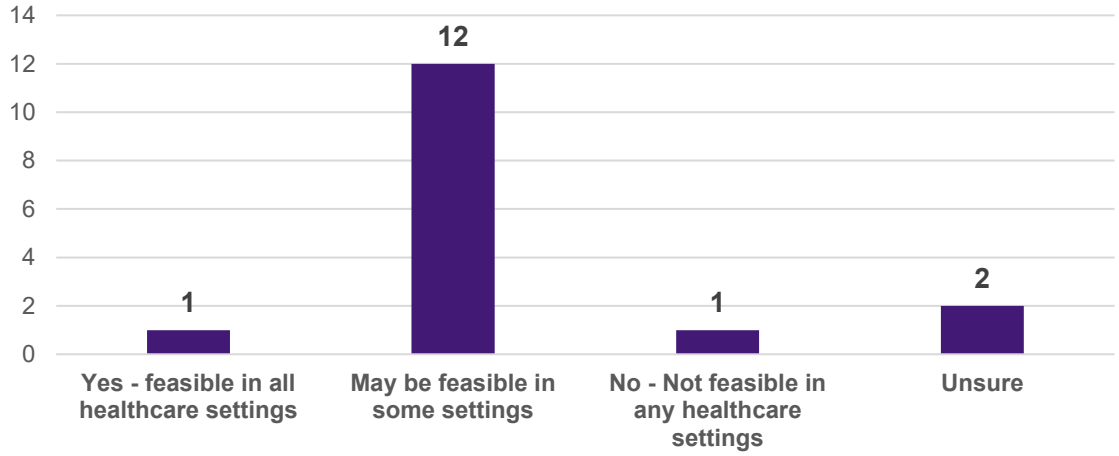


Figure 30 Is the intervention (waterless models of care without sink removal) economically sustainable?

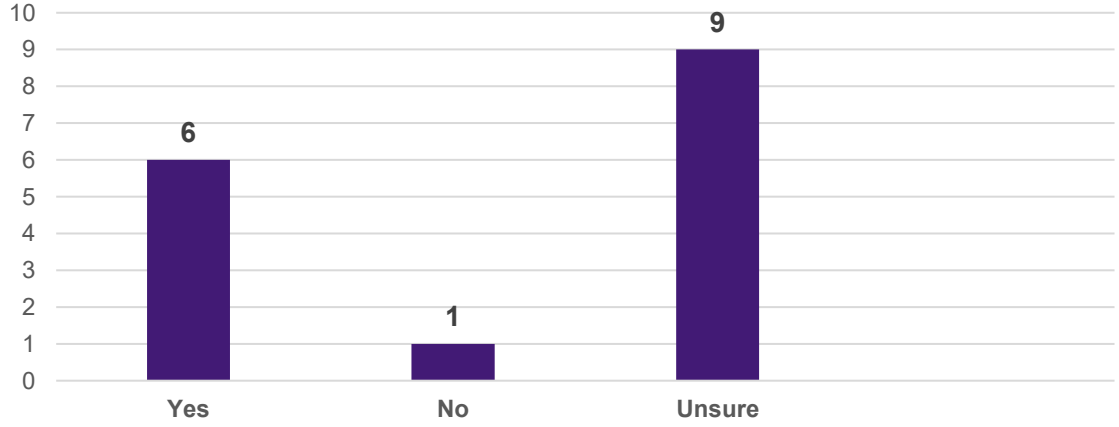
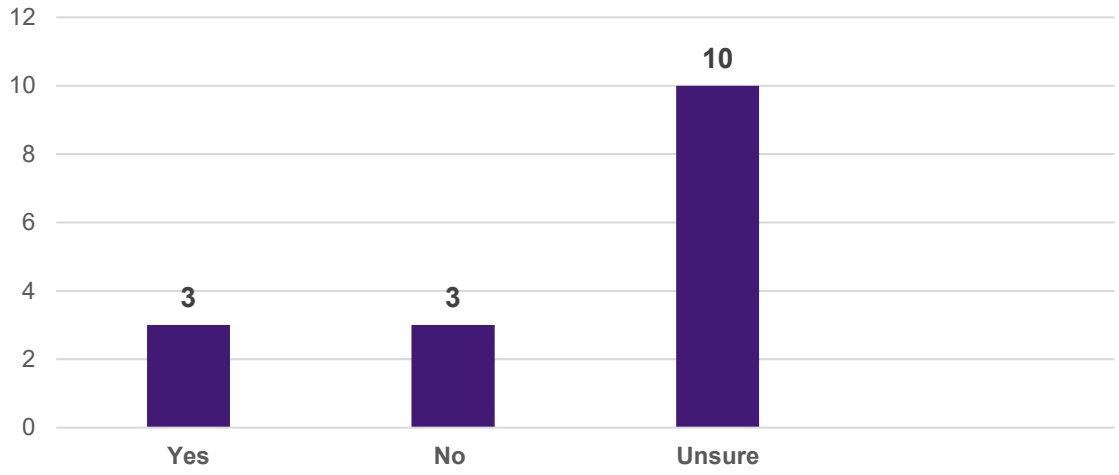


Figure 31 Is the intervention (waterless models of care without sink removal) environmentally sustainable?



Summary of Member feedback on Reflective question 4

- **Evidence base and relevance**

Members noted that much of the cited evidence relates to daily chlorhexidine gluconate bathing in intensive care units, with reported reductions in healthcare-associated bloodstream infections. However, they questioned its relevance to waterborne pathogen outbreaks, which typically involve gram-negative organisms. Members observed that the documented benefits largely relate to gram-positive organisms and methicillin-resistant Staphylococcus aureus control, rather than gram-negative outbreak management. While water avoidance may plausibly reduce gram-negative colonisation, Members noted that the evidence does not directly address this.

- **Scope and intent of the recommendation**

Members emphasised the need for clear scope and careful framing. They considered waterless approaches potentially appropriate in specific high-risk settings, such as intensive care units, but not across hospital settings more broadly. Members cautioned that ambiguous wording risks unintended interpretation as universal sink removal.

- **Practice implications and feasibility**

Members raised concerns about practical feasibility, noting that waterless care models may place significant demands on nursing time and staffing. They also questioned economic sustainability outside high-risk units and highlighted the need to consider ongoing operational impacts alongside infection prevention benefits.

- **Infrastructure and maintenance considerations**

Members stressed that where sinks remain in place, services must ensure robust preventive maintenance and mitigation controls to manage bioburden and biofilms. Several Members reiterated that guidance should focus on appropriate placement, use, and rationalisation of sinks to support waterless models, rather than removal.

- **Environmental and economic considerations**

Members highlighted potential environmental impacts, including increased use and disposal of chlorhexidine products and associated materials. They called for economic analyses and comparisons of water use and plastic waste volumes to better understand trade-offs. Several Members reiterated that sink avoidance, rather than removal, appears more feasible.

- **Guidance and future work**

Members suggested that, even in the absence of strong recommendations, a good practice statement outlining the current evidence and implementation considerations may be useful. Some recommended a separate document addressing sink design, maintenance, and biofilm management outside the guideline process.

Overall position

In summary, Members expressed conditional support limited to specific, high-risk settings. They emphasised the need for clearer alignment between evidence and intent, careful framing to avoid unintended sink removal, and further analysis of workforce, environmental, and economic impacts before broader recommendations are made.

Appendix 8: Guideline Development Group – Meeting 3 Notes

Australian Guidelines for the Prevention and Control of Infection in Healthcare
Guideline Development Group

Meeting Notes

26 May 2026, 11:00 – 13:00 (AEST)

Level 2, 287 Elizabeth Street, Sydney 2000 NSW

TOPIC
1. Welcome, Acknowledgement of Country and apologies The co-Chairs welcomed Members and provided an Acknowledgement of Country. The co-Chairs emphasised that: • Members must contribute as individual experts, not as organisational representatives. • Need for timely completion of out-of-session work to avoid delays. • Meeting uses anonymous polling to test alignment on concepts before drafting recommendations. • Objective is to confirm direction and consensus, not finalise wording. Attending Members: Professor Peter Collignon AM (co-Chair), Professor Alison McMillan PSM (co-Chair), Ms Shiraz Abdulla, Ms Emma Coombs, Ms Sara Drew, Professor Lisa Hall, Ms Lucy Lehane, Mr Sean Mutchmor, Ms Angela Myers, Ms Stephanie Newell, Ms Clee Tonkin, Professor Yvonne Zurynski, Attending Commission staff: Dr Jan Gralton, Ms Jennifer Caldwell, Mr Sinisa Ristic, Apologies: Dr Kathy Dempsey, Professor Thomas Gottlieb AO, Dr Tanvir Kapoor, Ms Rebecca McCann Members agreed to record the meeting for transcription and note taking.
2. Conflicts of Interest The co-Chairs invited Members to declare any real or potential conflicts of interest, including any changes since previous declarations. Members were reminded that: • All declarations must be provided to the Secretariat for inclusion in the conflicts of interest register. • The Secretariat will manage and maintain disclosures in accordance with NHMRC requirements, including Requirement A.6 and the NHMRC Guidelines for Guidelines module on Identifying and Managing Conflicts of Interest. • Members are participating in an individual expert capacity and not representing organisational positions. • Declared conflicts do not preclude participation but must be transparently documented and appropriately managed. No new conflicts of interest were declared during this meeting.

TOPIC
3. Notes and actions arising from previous meeting The co-Chairs invited Members to confirm the accuracy of the notes from the meeting held on 30 March 2026. • Members indicated agreement with the notes. • Action items from the previous meeting were noted as completed or addressed on the current agenda. Previous meeting notes Members accepted as accurate.
4. Transmission-based precautions: Outcome of polling for reflective questions The co-Chairs noted that evidence-to-decision (EtD) polling identified variation and uncertainty, particularly in relation to glove use and interpretation of precautions. The co-Chairs emphasised that standard precautions remain foundational and includes the use of gloves where there is a risk of contact with blood or body fluids. The co-Chairs proposed that routine glove use should not be required for all contact precautions and instead should align with standard precautions, supported by risk assessment. The co-Chairs also noted that recommendations should define minimum requirements, with escalation based on clinical context, and that good practice statements may be required where evidence is limited. Members discussed that: • gloves are often overused in practice and may reduce adherence to hand hygiene • but removing mandatory glove use may create confusion, particularly where there is limited understanding of the distinction between standard and contact precautions • guidance must be clear, explicit and practical, and must be understandable across a diverse workforce • the importance of reinforcing hand hygiene as the primary infection prevention measure and noted that inappropriate glove use may increase the risk of contamination. Members agreed: • on the inclusion of clinical context and explanatory guidance to assist application in different settings and professions • that risk assessment is not consistently applied across all settings and that examples will support implementation • that narrative text will be required to clearly describe when gloves should and should not be used. The co-Chairs introduced discussion on mask use within droplet precautions, outlining a minimum requirement approach, supported by escalation based on risk. Members supported this approach and noted that guidance should allow flexibility based on clinical context rather than prescribe fixed requirements. Members discussed airborne precautions and novel respiratory infections. Members noted the uncertainty associated with emerging infections and supported a risk-based, flexible

TOPIC
approach that allows for escalation and de-escalation. Members cautioned against overly prescriptive guidance where evidence is limited. Members participated in anonymous polling on questions where there was limited agreement in the first round of out-of-session voting. The polling focused on whether Members support progressing with: • aligning glove use to standard precautions rather than requiring use for all contact precautions • including clinical context and explanatory guidance to support decision-making • adopting a minimum requirement approach for mask use, with escalation based on risk • exploring more nuanced guidance for airborne precautions • developing narrative text and, where appropriate, good practice statements to support implementation The co-Chairs noted: • there was increased alignment across the group compared to initial polling responses • that Members broadly support a risk-based approach across precautions, supported by clear narrative guidance and practical examples • that further work will focus on draft guidance for consideration out of session and at a future meeting. **Action 1:** The Commission to update the current clinical practice recommendations and EtD frameworks for transmission-based precautions based on the final results from the polling on the criteria and findings from the systematic review. **Action 2:** The Commission to develop a new good practice statement and evidence to decision framework for respiratory precautions based on the final results from the polling on the criteria and findings from the systematic review. **Action 3:** The Commission will provide the draft recommendations and evidence to decision frameworks for review by the Members as out of session papers **Action 4:** The Secretariat to collate and share relevant existing and companion resources to show how the guideline aligns with broader activities. **Action 5:** The Secretariat to collate polling outcomes in a consolidated report and share with Members out of session prior to the next meeting.
5. Waterless models of care: Outcome of polling for reflective questions The co-Chairs outlined that the purpose of the discussion is consideration of alcohol-based surgical hand scrub and the role of sinks, noting that the intent is not to remove sinks but to consider appropriate use and context. Alcohol-based surgical hand scrub is distinct from routine hand hygiene products and is used in specific procedural contexts. It was clarified that these products are not interchangeable and must be considered separately in the development of guidance. Members noted:

TOPIC
• concept of waterless models of care was complex and required clarification, particularly the distinction between alcohol-based surgical hand scrub and routine hand hygiene products • products are used in different contexts and that this distinction must be clearly communicated in the guidance • sinks may present risks in certain environments and that considerations relate to placement and use. Members discussed: • strength of the available evidence and noted that it is limited and does not support development of formal recommendations • development of a good practice statement is appropriate, supported by expert consensus • any good practice statement must clearly define the scope, purpose and limitations to avoid misinterpretation or inappropriate application. • inclusion of explanatory guidance to assist decision-making, including when and how waterless approaches may be appropriate • guidance should reflect clinical context and support safe implementation across different settings with clear communication to both clinicians and consumers • economic and environmental considerations and noted that there is limited evidence to inform a clear position • available trade-offs, including water usage, product manufacturing, infrastructure and access in different settings. • acknowledgement of trade-off factors should be included in supporting text, while recognising that impacts may vary across contexts, including regional and resource-limited settings. • national guidance is required to support consistent implementation and reduce variation in practice • guidance may include consideration of sink placement, particularly in the context of new builds and renovations • additional implementation resources may be required following development of the guideline to support uptake and application in practice. Members participated in anonymous polling on questions where there was limited agreement in the first round of out-of-session voting. The co-Chairs noted that subsequent polling and discussion demonstrated improved alignment across the group. Members confirmed support for progressing with development of narrative text and a good practice statement to guide appropriate use of waterless models of care. Members also agreed that areas of uncertainty, including economic and environmental impacts, may require further consideration out of session. **Action 6:** The Commission to draft good practice statements on waterless models of care, and the use of alcohol-based surgical hand scrub and develop new evidence to decision frameworks for each statement.

TOPIC
Action 7: The Commission will provide the draft recommendations and evidence to decision frameworks for review by the Members as out of session papers **Action 8:** The Commission to develop supporting narrative text outlining clinical context, appropriate use and limitations. **Action 9:** The Secretariat to collate polling outcomes in a consolidated report and share with Members out of session prior to the next meeting.
6. Other business The Secretariat advised that a targeted public consultation process form part of the Guideline development. Members were invited to provide suggestions on relevant external stakeholders, organisations and groups to be included in consultation. **Action 10:** Members to provide suggestions of relevant external stakeholders to the Secretariat via email. **Action 11:** The Secretariat to collate stakeholder suggestions and incorporate them into consultation planning.

Australian Guidelines for the Prevention and Control of Infection in Healthcare Guideline Development Group

Actions arising from meeting held on 26 May 2026

Agenda Item	Action		Status
4	**Transmission-based precautions: Outcome of polling for reflective questions**	**Action 1:** The Commission to update the current clinical practice recommendations and EtD frameworks for transmission-based precautions based on the final results from the polling on the criteria and findings from the systematic review.	**Completed**
		Action 2: The Commission to develop a new good practice statement and evidence to decision framework for respiratory precautions based on the final results from the polling on the criteria and findings from the systematic review.	**Completed**
		Action 3: The Commission will provide the draft recommendations and evidence to decision frameworks for review by the Members as out of session papers.	**Completed**

Agenda Item	Action		Status
		Action 4: The Secretariat to collate and share relevant existing and companion resources to show how the guideline aligns with broader activities.	**Completed**
		Action 5: The Secretariat to collate polling outcomes in a consolidated report and share with Members out of session prior to the next meeting.	**Completed**
5	**Waterless models of care: Outcome of polling for reflective questions**	**Action 6:** The Commission to draft good practice statements on waterless models of care, and the use of alcohol-based surgical hand scrub and develop new evidence to decision frameworks for each statement.	**Completed**
		Action 7: The Commission will provide the draft recommendations and evidence to decision frameworks for review by the Members as out of session papers.	**Completed**
		Action 8: The Commission to develop supporting narrative text outlining clinical context, appropriate use and limitations.	**Completed**
		Action 9: The Secretariat to collate polling outcomes in a consolidated report and share with Members out of session prior to the next meeting.	**Completed**
6	**Other business**	**Action 10:** Members to provide suggestions of relevant external stakeholders to the Secretariat via email.	**Completed**
		Action 11: The Secretariat to collate stakeholder suggestions and incorporate them into consultation planning.	**Completed**

Australian
Commission on
Safety and Quality
in Health Care

T. +61 2 9126 3600
Level 5, 255 Elizabeth St
Sydney NSW 2000 Australia

safetyandquality.gov.au