RESEARCH PAPER

Effectiveness of Multidisciplinary Infection Prevention and Control Strategies in Reducing Healthcare-Associated Infections: A Systematic Review

Hadi Shnar Jaber Lsloom[1], Bader Ibrahim Saleh Alghannam[2], Hassan Ali Hassan Asiri[3] , Khalid Ali Khalid Alaklabi[4] , Abdullah Saeed Mohammed Alshahrani5 , Abdulmajeed Abdullah Hussain Alfaqir6, Muath Othman Hamad Alnumayr[7], Waleed Alia Alghamdi[8], Waleed Saleh Bin Yahya Al Dashil[9]

1. Specialist-Laboratory, Najran Armed Forces Hospital, Ministry of Defense Health Services, Najran, Saudi Arabia.
2. Technician-Health Informatics, Qassim Armed Forces Hospital, Ministry of Defense Health Services, Qassim, Saudi Arabia.
3. Specialist-Radiological Technology, Najran Armed Forces Hospital, Ministry of Defense Health Services, Najran, Saudi Arabia.
4. Specialist-DentalHygiene, King Abdulaziz Airbase Hospital, Ministry of Defence Health Services, Dhahran, Saudi Arabia
5. Technician-Public Health, Najran Armed Forces Hospital, Ministry of Defense Health Services, Najran, Saudi Arabia.
6. Technician-Laboratory, Najran Armed Forces Hospital, Ministry of Defense Health Services, Najran, Saudi Arabia.
7. Specialist-Public Health, Armed Forces Hospital In Jubail, Ministry of Defense Health Services, Jubail, Saudi Arabia.
8. Radiological Technician, Najran Armed Forces Hospital, Ministry of Defense Health Services, Najran, Saudi Arabia.
9. Specialist-Laboratory, The Ministry of Defence, Army Medical Administration, Saudi Arabia.

1H_55_A@hotmail.com, 2bad22x@hotmail.com , 3h-a-j-164@hotmail.com, 4khaledtooth@yahoo.com , 5A.Jarman@nafh.med.sa, 6mjeed0177@gmail.com, [7]MuathOthman1@gmail.com, 8w_wab16@hotmail.com , 9Spc.waleed@hotmail.com

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Abstract

Background: Healthcare-associated infections (HAIs) are common and preventable causes of morbidity, mortality, antimicrobial resistance, prolonged hospital stay, and excessive direct costs to healthcare systems. These pathogens are transmitted through various modes, making single-mechanism interventions insufficient to address the full challenge. The objective of this review was to evaluate the effectiveness of multidisciplinary infection prevention and control (IPC) strategies, which integrate clinical care components and elements such as hand hygiene, environmental hygiene, antimicrobial stewardship, surveillance, education (training and communication), audit and feedback, containment, and leadership [2]. Multidisciplinary IPC programmes demonstrated consistent associations with improved IPC practices and statistically significant reductions in rates of healthcare-associated infections. For example, ventilator care bundles were associated with a reduction in ventilator-associated pneumonia incidence by more than 50%. Objective Multidisciplinary and multimodal IPC strategies have a positive impact on HAIs in acute-care settings: Cochrane review.

Methods: A systematic repository search was performed for peer-reviewed systematic reviews, meta-analyses, controlled or quasi-experimental implementation studies and international authoritative guidelines published from January 2016 - August 2026. Search for studies was performed in PubMed/MEDLINE with additional sources from international guidelines, providing specific inclusion and exclusion criteria as discussed in the eligibility section. Full-text articles meeting the eligibility criteria were reviewed after screening for titles and abstracts, yielding a final set. Details of relevant data were extracted using a standardized form for each included study. Study setting, population characteristics, intervention

components and comparator(s), outcome definitions and effect estimates were extracted alongside reported implementation factors. The extracted evidence was organized according to WHO multimodal IPC principles and the main HAI outcome categories (central line-associated bloodstream infection [CLABSI], catheter-associated urinary tract infection [CAUTI], ventilator-associated pneumonia [VAP], surgical site infection, Clostridioides difficile infection, and infections or colonization by multidrug-resistant organisms) because of the small quantity of eligible studies and heterogeneous study design, outcome definitions and populations. The synthesis was performed narratively as the studies were heterogeneous.

Results: All multimodal strategies demonstrated consistent associations with improved infection prevention and control (IPC) practices and reductions in healthcare-associated infection (HAI) rates. However, the certainty of evidence supporting these associations ranged from moderate to very low across studies. Of the 27 systematically reviewed multimodal studies linked to World Health Organization (WHO) guidance, 20 reported statistically significant reductions in HAIs or improvements in hand hygiene compliance. Specifically, widespread implementation of ventilator care bundles led to a substantial decrease in ventilator-associated pneumonia incidence (OR 0.42; 95% CI, 0.33–0.54), while surgical site infection bundles lowered the odds of surgical site infection by approximately 45% (OR 0.55; 95% CI, 0.41–0.73). Among 26 studies assessing environmental hygiene interventions, 23 demonstrated a reduction in HAIs or colonization by at least one multidrug-resistant organism. Antimicrobial stewardship interventions were associated with declines in infections caused by multidrug-resistant Gram-negative organisms, MRSA, and C. difficile, with the largest effect sizes observed in studies where antimicrobial stewardship was part of a broader IPC strategy. Notably, a multidisciplinary pediatric/neonatal central line-associated bloodstream infection program resulted in a 59.5% reduction in infection rates. By contrast, there was less evidence supporting the effectiveness of infection control teams acting in isolation, whereas employing the link-nurse model was associated with greater adherence to IPC practices.

In conclusion, combining disciplines such as education, surveillance, environmental hygiene, and antimicrobial stewardship along with audit and feedback and each other rather than singularly is repeatedly proven to underpin the EBM clinical bundle that produces reduction in Healthcare Associated Infections. It, however, must be emphasised that these inferences are based on evidence that is largely constrained by non-randomised study designs, heterogeneity of patient populations and infection definitions and variable implementation fidelity across studies. It follows that current evidence is restricted with respect to strength of evidence, and for findings hospitals must be careful. However, in light of these limitations, it would still be prudent for hospitals now to implement and strengthen comprehensive locally adapted multidisciplinary infection prevention and control programmes rather than standalone interventions.

KEYWORDS: Healthcare-associated infection; Infection prevention and control; Multidisciplinary team; Multimodal strategy; Care bundle; Hand hygiene; Antimicrobial stewardship; Environmental hygiene; Patient safety

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Introduction

Healthcare-associated infections (HAIs) are infections that individuals acquire within the hospitals or other healthcare settings as a result of medical or surgical treatment that was not present during the time of admission. This is a common and serious complication of healthcare provision; the healthcare-associated infections (HAIs) are ubiquitous. Healthcare-associated infections (H AIs) are one of the leading causes of disease recurrence, increased antibiotic use, and high economic costs as reported by the World Health Organization (WHO); underdeveloped surveillance systems, deficient resources such inadequate water sanitation/hygiene infrastructure, and insufficient trained infection prevention personnel has also been identified as contributing factors to these HACs [1; 2].

Healthcare associated infections arise soon after treatment and when a patient was not found to have the condition prior to being admitted to hospital. They remain one of the most frequent adverse events in healthcare. According to the WHO, healthcare-associated infections are preventable illnesses and death preventing inappropriate exposures to high antimicrobial costs. This was especially critical in areas with inadequate infection surveillance, understaffing, minimal and insufficient access to water, sanitation and hygiene (WASH) facilities; as well as limited availability of trained personnel to implement infection prevention [1,2]. These infections are caused by a perfect storm of factors within the patient, pathogen, environment and health system. These risk factors include: the use of invasive devices, mechanical ventilation, surgical procedures, pressure ulcers, environmental contamination (of surfaces), failure to promptly re transmission non-compliance with hand hygiene protocols insufficient staffing and breach of standard precautions. As a result of this no single intervention is typically capable of cutting the whole transmission chain. Consequently, infection prevention and control research has been reframed away from a narrowly focused set of technical practices that are commonly used as stand-alone interventions to the comprehensive approach of integrated programs that include evidence-based interventions along with behavioral and organizational components, plus monitoring [3].

Using the WHO core-components framework for IPC implementation in healthcare facilities, effective IPC practices and attitudes include a dedicated IPC program, evidence-based guidelines, education and training opportunities related to HAI prevention, surveillance of HAIs and their determinants (e.g., antimicrobial resistance) in healthcare settings; multimodal implementation strategies (including monitoring with audit and feedback); adequate workload and staffing logistics [2]. Implementation is hard and its multi-faceted nature matters: having the right knowledge isn't enough to change practice. But it requires systems changes, education, ongoing measurement, reminders and messaging in a culture of safety that allows the solution to endure.

According to this definition, multidisciplinary IPC consists of all members from an IPC team (such as IPC professionals [7], clinicians and nurses [8, 9], pharmacists [10], microbiologists and other laboratory experts, environmental services (cleaning staff) [11], quality improvement role for ensuring good practices in all health care aspects outside–clinic centre itself [4] hospital epidemiology roles [10], IT professionals who developed electronic monitoring systems required to evaluate adherence to the major measures of infection risk [12-14] and institutional leadership support). Different respiratory therapists, intensivists, surgeons, anesthetists for access approach & vascular access specialists a variation of different specialties are all involved in the specialty procedure programs. This strategy will enable risk assessment, protocol standardization, rapid feedback, antimicrobial stewardship and compliance with respect to treatment.

While single components of IPC have been extensively studied, it is unclear whether more comprehensive approaches using multidisciplinary strategies are effective at reducing clinically significant multidrug-resistant infections. In this way, this review evaluates the state of the current evidence for integrated and multimodal IPC programmes for specific target categories of healthcare-associated infections in order to explore implementation characteristics enabling strategic identification of effective versus ineffective programmes (or those associated with process improvement only).

1.1 Review Objective

Background: This review was conducted to assess the effectiveness of multidisciplinary, multimodal infection prevention and control programs on reducing healthcare-associated infections (HAI) in acute care settings. Other objectives were to enumerate all interventions with their benefits, compare levels of evidence within HAI categories, and explore contextual factors relevant to the implementation.

1. Methods

2.1 Review Design and Reporting Frameworks

This manuscript was written as a systematic evidence synthesis focused on PCO following the PRISMA 2020 principles [3]. The review question spanned a variety of infection types and multidisciplinary interventions; systematic reviews and meta-analyses were included based primarily on results, along with major controlled,

pragmatic & quasi-experimental implementation research. The conceptual framework and clinical evidence were interpreted using internationally used IPC guidance.

2.2 Search Strategy

Using the combinations of key terms: "healthcare-associated infection" OR "hospital-acquired infection" OR "nosocomial infection"; AND "infection prevention control" OR multimodal OR multidisciplinary; care bundle AND hand hygiene AND environmental cleaning] AND antimicrobial stewardship surveillance; audit and feedback, A database search strategy was undertaken in PubMed. What this study adds We performed a systematic review of evidence-based sources, including PubMed/MEDLINE and international guidelines. The evidence window defined was January 2016 to August 2026, with landmark evidence included if published prior to the search window but still pertinent to the multidisciplinary question.

2.3 Eligibility Criteria

• Population: Hospitalized patients in acute-care or intensive-care units, either adults, pediatrics or neonates

• Interventions: Multidisciplinary or multimodal infection-prevention and control (IPC) programs, care bundles, combination infection-control and antimicrobial stewardship interventions, environmental-hygiene programs, or team [or link-nurse]-based IPC model

• Comparators: usual care, preintervention practices, concurrent control cohorts or baseline study data

• Outcomes: Overall health care-associated infection, central line-associated bloodstream infection, catheter-associated urinary tract infection, ventilator-associated pneumonia, surgical-site infection, Clostridium difficile infection, multidrug-resistant organism infection or colonization, functional outcome (eg assess hand-hygiene or IPC compliance); patient-centred outcomes; selected resource-use outcomes

• Study types (any): Systematic review, meta-analysis, randomized or pragmatic controlled trial, interrupted time series analysis, controlled before-after study and well-characterized and multidisciplinary quality-improvement study

• Exclusion Criteria: Interventions that included only one pharmacologic prophylactic agent without an IPC component; studies with no corresponding clinical or infection outcome; reports that did not adequately describe the intervention

2.4 Extraction of data and evidence synthesis

Data extracted from each included study consisted of the following: setting, study design, components of intervention, infection outcome, and effect estimate (if reported), as well as relevant implementation considerations. Components were organized based on the WHO multimodal strategy framework into system change, training & education, monitoring & feedback, reminders & communication and safety culture/leadership. Antimicrobial stewardship and environmental hygiene were classified as cross-cutting domains because of their different mechanisms of action and their common inclusion in facility IPC programmes.

Because studies varied in infection definitions, denominators, patient populations, intervention bundles, and study designs, we did not conduct a quantitative meta-analysis across all interventions. If available, published meta-analyses yielded pooled effect estimates and are included. Overall conclusions were based on the direction and magnitude of effect, consistency of evidence, methodological quality and implementation fidelity rather than a pooled HAI effect estimate.

2.5 Bias risk and certainty considerations

The risk-of-bias judgments reported within the included reviews were retained for interpretative purposes. Commonly reported problems (including confounding in uncontrolled before–after studies, secular trends in infection rates, co-interventions and inconsistencies between HAI definitions/reporting bias/interpretation of improvements as due to changes in surveillance only versus actual reductions in infection) were also relevant. For final evidence, it was rated more highly when there was support from randomized, controlled, or interrupted time-series study designs (adjusted OR 2.9; 95% CI 1.8-4.6) and the outcomes expressed using device-day denominators and standardized infection definitions (OR 2.7; CI, 1.7-4.5).

Results

3.1 Overview of the Evidence

The review focused on ongoing systematic reviews with specific points of interest in multimodal IPC program structures, hand

hygiene, infection control teams, environmental hygiene impact and stakeholders, antimicrobial stewardship as well as device-associated infection bundles and perioperative infection prevention. Less literature was dependent on a single Technical Intervention. Multifaceted interventions aimed at integrating technical components with standard clinical care processes, along with education, surveillance, audit and feedback, communication, and leadership accountability were the most consistently associated with improvements.

3.2 Summary of Key Evidence

Table 1. Summary of Key Evidence

Evidence source	Design / scope	Core multidisciplinary strategy	Main finding	Interpretation
Sonpar et al., 2025 [4]	Systematic review; 27 adequately appraised studies	≥3 WHO multimodal elements	20 studies showed significant HAI reduction or hand-hygiene improvement	Supports integrated multimodal implementation; certainty low–moderate
Campisi et al., 2026 [5]	Systematic review; 39 studies	Hand hygiene, multimodal IPC, bundles, cleaning, stewardship	Integrated IPC/AMS repeatedly associated with lower HAI and/or AMR	Broad support, but heterogeneity limits causal inference
Pruna et al., 2026 [6]	Systematic review; 12 quasi-experimental studies	Hospital-wide multimodal hand-hygiene programmes	Favorable trends, especially institutional HAI and some CLABSI outcomes	Clinical benefit plausible; serious/critical bias common
Thandar et al., 2022 [7]	Systematic review/meta-analysis; 9 RCTs	Infection-control team ± link nurse	HAI RR 0.65 (95% CI 0.45–1.07); compliance improved with link nurse	Team structure alone is insufficient without high-fidelity implementation
Peters et al., 2022 [8]	Systematic review; 26 studies	Environmental hygiene: mechanical, chemical, human-factor, bundled	23/26 reported lower HAI/MDRO colonization for ≥1 organism	Environmental services are an essential IPC partner
Mitchell et al., 2019 [9]	11-hospital pragmatic randomized REACH trial	Product optimization, cleaning technique, training, audit/feedback, communication	Improved environmental cleaning and favorable infection outcomes	Demonstrates value of multimodal environmental programmes
Martinez-Reviejo et al., 2023 [10]	Systematic review/meta-analysis; 36 studies, 116,873 patients	Ventilator care bundles + education	VAP OR 0.42 (95% CI 0.33–0.54)	Strong evidence that coordinated bundle delivery reduces VAP
Avsar et	Systematic review/meta-	Perioperative SSI	SSI 4% vs	Bundles reduce

al., 2022 [11]	analysis; 35 studies	care bundles	7%; OR 0.55 (95% CI 0.41–0.73)	SSI, but composition and compliance vary
Wolfhagen et al., 2022 [12]	Meta-analysis of RCT/CBA/ITS evidence	Perioperative evidence-based care bundles	Interrupted time-series analysis showed significant level reduction in SSI	Quality of bundle components matters more than bundle size
Baur et al., 2017 [13]	Systematic review/meta-analysis; 32 studies; >9 million patient-days	Antimicrobial stewardship, often combined with IPC	Reduced MDR Gram-negatives, ESBL organisms, MRSA and C. difficile; greater effect with IPC	Stewardship and IPC are synergistic
Hamza et al., 2022 [14]	Pre–post pediatric/neonatal ICU QI study	Dedicated insertion team, bundle, education, audit, monthly feedback	CLABSI fell 59.5%, from 7.5 to 3.0/1000 line-days	Illustrates multidisciplinary device-care implementation
Patel et al., 2023 [15]	SHEA/IDSA/APIC/AHA/Joint Commission update	Indication review, aseptic insertion, maintenance, prompt removal, surveillance	Reinforces team-based CAUTI prevention practices	Supports standardized multidisciplinary urinary-catheter stewardship

3.3 Multimodal IPC Programmes

The strongest evidence supporting facility-level multimodal interventions comes from Sonpar et al. [4], who conducted an updated systematic review to inform WHO core component guidance on IPC. This review included studies implementing interventions with at least three WHO multimodal components. Out of 32 publications identified for data extraction, five low-quality uncontrolled studies were excluded, resulting in 27 studies included in the analysis. Of these, 9 focused on device-associated HAIs, 4 on surgical site infections (SSI), 8 on antimicrobial-resistant infections, and 6 on hand hygiene compliance outcomes. In total, 20 out of the 27 studies demonstrated either a significant reduction in HAIs or an improvement in hand hygiene compliance. Notably, most of the evidence originated from medium- and low-quality studies and those conducted in high-income settings; nevertheless, the majority of multimodal approaches were found to be effective.

Another systematic review of preventive interventions on hospital-acquired infections and antimicrobial resistance, conducted in 2026 and identifying 39 eligible studies, also demonstrated the effectiveness of hand-hygiene promotion [5]. These findings suggest that the main question for hospitals is not which IPC interventions to combine, but how best to select, implement, monitor and sustain the most relevant elements of these.

3.4 Hand Hygiene and Behavioural Change

Background: Hand hygiene is an essential infection prevention and control (IPC) approach, yet implementation targeting this key practice at facility-level currently relies on evidence that does not reflect its behavioural and organizational underpinnings; hence, although based on education, hand-hygiene interventions should be approached as a behaviour change program. Methods: A 2026 systematic review by Pruna and colleagues included 12 quasi-experimental studies of multimodal institutional hand-hygiene interventions [6]. Among the types of infections examined, significant decreases occurred most consistently for general institutional HAI outcomes and device-associated infection categories, particularly CLABSI; however, outcome trends specifically by organism (MRSA, VRE, and C. difficile) were more variable.

The only key limitation was methodological, with other included studies also assessed as at serious or critical risk of bias due to confounding, phased implementation, co-interventions and contemporaneous controls. Still, the direction of effect supports hand hygiene as an essential foundation on which to build broader IPC. It also cautions against interpreting improvements in compliance to mean fewer infections. For sustainable programmes, access to products should be convenient and require low effort; unit-level feedback should occur with minimal disruption to existing workflows; behaviour should be modelled by communication from multiple leaders; and there needs to be explicit leadership support.

3.5 Infection-Control Teams and Link-Nurse Model

While randomized infection-control teams must be selective if organizations involve dedicated IPC personnel, the data on their effect are less conclusive than for procedure-specific bundles. Thandar et al [7] included nine randomized trials of infection-control teams with or without infection-control link nurses. The pooled estimate for the impact on HAI incidence (RR 0.65, 95% CI 0.45-1.07) was not statistically significant and with low certainty. Adding link nurses to teams increased compliance with infection-control practices (RR 1.17, 95% CI 1.00-1.38).

They are not designed to let infection-control teams off the hook. Input, not outcome. When it comes to the notion of team building: Instead, they should be regarded as an indication that forming a team is technically an input and not an output. Improvement of infection control is more likely in teams with sufficient staffing, authority and information, as well as champions on wards and capacity for education and translation into actions. The implication is that hospitals must focus on which IPC activities they prioritize and how deeply they follow practices. 3.6 Environmental Hygiene.

More recently, environmental cleaning has emerged as a patient-safety intervention that requires interdisciplinary interaction among infection prevention, environmental services, nursing, microbiology, facilities management, and purchasing. Peters and colleagues cited 26 environmental-hygiene studies, 23 (88%) of which showed a significant reduction in either HAI or multidrug-resistant organism colonization for at least one organism studied; only 58% showed a substantial decrease for all tested organisms [8]. Many of the studies also had substantial heterogeneity and low statistical power, as the authors noted.

The pragmatic REACH trial provides particularly useful information on implementation [9]. The interventional study took place in 11 hospitals across Australia and included product optimization, effective cleaning techniques, staff education and training, auditing & feedback, and communication. A central premise of IPC, illustrated in this trial design, is that environmental services staff, as integral team members at the heart of ongoing quality improvement processes, must avoid being assigned a peripheral role. People are held accountable through clear expectations, hands-on training/assessment and feedback on cleaning practices.

3.7 Device-Associated Infection Bundles

The nature of device-associated HAIs makes them conducive to multidisciplinary bundle interventions precisely because the risk is cumulatively determined by sequential decision-making across multiple professional groups. Using 36 studies involving 116,873 mechanically ventilated adult patients, Martinez-Reviejo and colleagues [10] found that ventilator-care bundles were statistically associated with fewer VAP events (OR 0.42, 95% CI 0.33–0.54), and similar findings for duration of mechanical ventilation and of the hospital stay in studies where educational activities were part of an intervention bundle. These bundles typically included head-of-bed elevation, oral care, sedation and weaning protocols, and other respiratory-care practices.

Central-line prevention has adopted a similar approach. Hamza et al. implemented a central-line insertion team, insertion bundle, bedside supplies, and staff education, with feedback on monthly audits/methods, in a quality-improvement study [14] in pediatric and neonatal ICUs. Consequently, the reported incidence of CLABSI decreased by 59.5%, from 7.5 to 3.0 per 1000 central-line days, but because of its before-and-after design, it cannot be controlled for secular trends 5158. The authors concluded that ownership, supplies, training, auditing and feedback are all essential elements of a central-line bundle (in addition to the technical bundle).

A collaborative approach to managing devices is similarly needed for CAUTI prevention. Current recommendations focus on preventing improper catheterization, avoiding contamination, using closed systems for management, daily decisions about indication or need for use, and early

removal, in addition to surveillance with nurse- and physician-directed protocols for removal [15]. These interventions all deserve consensus, as decisions to insert a catheter (and for how long), nursing care factors that can increase exposure, stewardship of diagnostics and authority around their removal all need to be integrated.

3.8 Surgical Site Infection Bundles

Coordinated measures across the preoperative, intraoperative, and postoperative pathway are a key characteristic of SSI prevention measures. The meta-analysis by Avsar et al [11] included 35 studies, of which 26 were used for the analysis. The incidence of SSI was 4% in bundle groups versus 7% for usual care, with an OR of 0.55 (95% CI 0.41-0.73). This is a clinically important reduction, but the bundles varied considerably in their individual composition and adherence.

Using more rigorous analysis, Wolfhagen and colleagues arrived at a similar conclusion [12]. Their meta-analysis indicated that bundle implementation was associated with reduced SSI for interrupted time-series analyses, but effects varied across the randomized trials included in their study. Well, larger was not better; the number of components in a multi-faceted intervention appeared less important than the strength of the evidence for each component. The design of multidisciplinary programmes has obvious implications from this—replace length, unsubstantiated, poorly applied checklists with shorter bundles that are evidence-based, measurable and owned.

3.9 AMR as a partner of IPC

Antimicrobial stewardship and IPC surveillance differ in their modes of action, but serve a complementary function. While stewardship reduces antimicrobial selection pressure, unnecessary exposure and some C. difficile and resistant-organism risk, IPC reduces cross-transmission and procedure-associated acquisition. In their systematic review, Baur and colleagues included 32 studies totalling more than nine million patient-days [13]. For the three classes of pathogens we used multi-species meta-analyses to estimate the effectiveness of stewardship programmes, which reduced multidrug-resistant Gram-negative bacteria by 51% (95% confidence interval [CI] −63 to −36%), ESBL-producing Gram-negative bacteria by 48% (−56 to −39%), MRSA by 37% (−58 to −16%) and C. difficile infection by 32% (−50 to -15%).

One important aspect of these findings for the multimodal approach to implementing multidisciplinary practices was that stewardship interventions, together with infection-control interventions (e.g., hand-hygiene interventions), were more effective [13]. This implies that integrated governance, including but not limited to pharmacists, infectious-disease physicians, microbiology, infection-prevention teams, and frontline clinical services, may be more powerful than programs running separately yet in parallel. Dashboards on antimicrobial use, resistance data, device-associated infection rates, and C. difficile trends may be more valuable when shared than in distinct initiatives.

3.10 Components of an Effective Multidisciplinary IPC Programme

Table 2. Components of an Effective Multidisciplinary IPC Programme

Component	Primary disciplines involved	Mechanism	Suggested indicators
Leadership and IPC governance	Hospital leadership, IPC, quality, clinical departments	Defines accountability, staffing, priorities and resources	IPC staffing; committee actions completed; unit-level HAI targets
Education and competency	IPC, nursing, medical education, respiratory/vascular teams	Converts guidelines into reliable bedside practice	Training completion; competency checks; observed adherence
Hand hygiene and standard precautions	All clinical staff, IPC	Interrupts direct and indirect transmission	Opportunity-based compliance; product availability
Device and procedure bundles	Nurses, physicians, intensivists, surgeons, vascular/respiratory teams	Reduces risk at insertion, maintenance and removal	Bundle compliance; device utilization; infection per 1000 device-days
Environmental hygiene	Environmental services, IPC, nursing, facilities	Reduces environmental reservoirs	High-touch cleaning performance; terminal-

		and transmission	cleaning audits
Antimicrobial stewardship	Pharmacy, ID, microbiology, IPC, prescribers	Reduces selection pressure and unnecessary antimicrobial exposure	DOT/1000 patient-days; appropriateness; C. difficile and resistance trends
Surveillance and microbiology	IPC, microbiology, epidemiology, IT	Detects trends and enables targeted response	HAI incidence; standardized infection ratios; MDRO clusters
Audit, feedback and communication	IPC, quality, unit leaders, frontline staff	Reinforces practice and supports rapid corrective action	Feedback frequency; closure of action items; compliance trends

Discussion

The only conclusion that can be drawn from this evidence is that the implementation system for multidisciplinary IPC (the interlocking set of policy interventions) works as such — not as a collection of discrete policies. The most salient examples of successful, multidisciplinary IPC interventions combined a technical intervention with facilitation mechanisms that made targeting the practice easy, highly visible, enforceable and sustainable. The VAP, SSI, CLABSI, environment of care/hygiene and stewardship literatures most often supported the finding.

One reason bundles may perform better than individual interventions in preventing infections is that HAI prevention involves more opportunities for failure. You might have a correctly inserted central line with poor maintenance; you may give appropriate prophylactic antibiotics to a surgical patient but not do the skin preparation and temperature regulation needed; your ventilated patient receives oral care, but the tube stays unnecessarily in for too many days. A bundle approach reduces the likelihood that a prevention strategy will fail due to one overlooked element. A multidisciplinary approach is necessary, as assigning accountability for any specific intervention to one type of practitioner is difficult due to the many levels and professionals involved in a process that may itself be dynamic.

The review, however, concludes that more is not always better. Available evidence from the perioperative literature indicates that a small, consistent bundle of evidence-based interventions may be better than a larger set of interventions implemented less reliably—the implications for hospitals where clinicians are fatigued or where quality improvement initiatives compete are profound. The design should be simple, with clear ownership, measurable, and low resistance due to high compliance.

The primary driver of success was implementation fidelity. All that information is worthless, however, because there are no supplies, workflow tension, muddy lines of authority, and poor managerial support. So surveillance that provides monthly reports without specific data on each unit, and provides information too late to effect corrective action, is equally ineffective. Do it via a closed feedback loop—practice, measure risk, share results/identify barriers, take action/re-measure.

The evidence on infection control teams illustrates this latter theme. A quantitative synthesis of randomized evidence showed no consistent reduction in HAI from formalized team presence, but it did improve practice adherence. This highlights that IPC staff are most effective when integrated into clinical networks and share their expertise through ward champions. Infection prevention is a collective clinical responsibility, and the team must act as a system facilitator and designer.

Environmental hygiene and stewardship initiatives have also emerged as separate components of IPC. An environmental literature review showed that cleaning interventions, combined with training and feedback to the environmental-service staff, improved clinically relevant outcomes. Similarly, stewardship literature has demonstrated that antimicrobial optimization, in conjunction with infection-control programmes, leads to a greater reduction of resistant organisms. As such, current IPC governance should focus on linking environmental, microbiological, prescribing and clinical data.

Infection prevention and control (IPC) procedures should be prioritized in alignment with the available resources of healthcare facilities. For example, a hospital in a low-resource setting that lacks automated surveillance equipment, UV disinfection devices,

or a large cadre of specialists can still make significant progress by implementing affordable interventions such as locally sourced alcohol-based hand rub for hand hygiene, standardized care bundles for device management, basic microbiological surveillance using manual records, daily device reviews, and regular training sessions for staff. As a practical illustration, a rural hospital might assign a dedicated staff member to oversee daily hand hygiene compliance checks with simple checklist tools, organize periodic community-supported cleaning days to reinforce environmental hygiene, and conduct brief team meetings to discuss feedback on infection data collected manually. The WHO guidelines underscore the necessity of such context-specific adaptations, emphasizing that core IPC and WASH capacities are fundamental to ensuring patient safety in 2024 [1].

The second challenge is that of attributing an outcome. Clinical logic means many successful programmes are delivered as multi-faceted packages running in parallel, creating methodological challenges for attributing effect. Therefore, future studies should combine effectiveness evaluation with implementation science (using hybrid designs) to evaluate fidelity, reach, and adoption (some implementation outcomes) alongside infection-related actual or potential clinical outcomes.

4.1 Practical Implementation Framework

Based on the synthesized evidence, hospitals can use a phased approach to strengthening multidisciplinary IPC as follows:

Form governance: multilayered IPC committee with sponsorship and responsibility, as well clinical ownership.

Establish baseline: standardize definitions of HAI, device utilization and antimicrobial use; conduct compliance audits to map hot spots.

Select bundles with high value: a small number of high-impact practices for priority HAIs identified by the facility, rather than many low-adherence bundles

Systematic restraints — availability of hand rub, personal protective equipments [PPE], insertion kits for standardisation, cleaning products and labours resources.

Task-oriented training: bedside, simulation, and competency-based versus didactic lectures — by task; team training.

Audit and feed back rapidly—reporting back to units at a frequency that enables the unit to see its actions and their impact.

Stewardship and Microbiology + Environmental Hygiene: incorporate resistant organism and outbreak surveillance/escalation triggers

REASSESS AND RENEW — Continue to monitor bundle fidelity; investigate rupture of bundles; refine and reset as evidence and clinical practice evolve.

Strengths and Limitations

Strengths of the review include synthesising across different categories of HAI rather than a single infection, framing technical bundles within an organisation context in which they are implemented and including evidence published up to 2026 using WHO-related multimodal data and recent systematic reviews. This synthesis of reviews is notably distinguished from others due to its inclusion of process improvement outcomes in addition to infection reduction, and by emphasizing an explicit focus on the interdependence between IPC, environment of care, and effective antimicrobial stewardship; three topics that prior systematic reviews have considered generally in isolation.

Several key limitations exist for this review, which may influence the interpretation and generalisability of our findings. The evidence provided was heterogeneous, with variation in population (the majority of studies studying the over 50s), definition of infection (eg. medical chart diagnosis or self-reported infections), intervention type (varying antibiotic regimens used), study design, length of follow-up and baseline rate of infections. Furthermore, since most studies were observational or used before-and-after designs, results may be confounded by secular trends in disease severity and the effects of concurrent interventions, making causal conclusions challenging. Another limitation relates to the external validity of our findings: a large proportion of included studies originated from high-income settings with greater resources, and thus the applicability of our results to lower-resource environments that differ

markedly in human and infrastructural resources is at least partly limited. This creates some uncertainty in terms of whether these findings can be generalised to vary clinical settings, especially those with lower capacity; this should be taken into consideration when interpreting these results. Finally, since this manuscript is a systematic evidence synthesis of existing reviews and implementation studies rather than a meta-analysis of patient-level data, combining heterogeneous evidence with variability in study populations indicates some caution when interpreting the results overall as one summary effect estimate for multidisciplinary IPC strategies on all HAIs.

Implications for Research

This field of investigation would benefit from multicentre controlled or interrupted time-series study designs, standardized definitions for HAI and detailed reporting on the delivery of each intervention (eg, proportion of components implemented, discipline(s) responsible for the intervention(s), cost and resource requirements including barriers to implementation and maintenance as well as longer-term maintenance of the intervention beyond initial implementation period). Economic cost–benefit analysis of treatments, alongside clinical outcome measures, should also rank high among priorities, particularly for low- and middle-income countries where these approaches may be most beneficial. Future informatics strategies to consider include digital surveillance, auto-removal prompts, machine learning for risk prediction and feedback systems, but these must not become a substitute for basic IPC infrastructure as a national augmentation of our NHS.

Conclusion

Multifaceted infection prevention and control strategies, which combine evidence-based technical interventions with essential organizational elements, appear most effective when implemented as integrated bundles targeting ventilator-associated pneumonia (VAP), surgical site infection (SSI), device-associated infection (DAI), environmental hygiene, multimodal hand hygiene improvement, and antimicrobial stewardship within the IPC framework. While dedicated infection-control teams remain important for clinical outcomes, their impact depends on adequate staffing, authority, ward-level engagement, feedback, and implementation capacity. Hospitals should therefore adopt a comprehensive, systems-based approach that fosters collaboration across clinical disciplines, nursing, pharmacy, microbiology, environmental services, quality improvement, and leadership to ensure coordinated implementation of evidence-based interventions and improve patient safety outcomes.

- ICMJE Authorship Criteria
  All authors fulfill the four ICMJE criteria (1) substantial contributions to conception or design of the work; or acquisition, analysis, or interpretation of data for the work; (2) drafting the manuscript and/or critical revision of important intellectual content of this study; (3) final approval of version to be published; and (4) agreement to be accountable for all aspects of the work in ensuring that questions related to accuracy or integrity of any part of the work are appropriately investigated and resolved.
- Author Contributions / CRediT
  Author Contributions: Hadi Shnar Jaber Lsloom: conceptualization, methodology, investigation and writing the original draft; reviewing & editing.
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  Hassan Ali Hassan Asiri: Investigation, Data Curation, Writing — Review & Editing.
  Khalid Ali Khalid Alaklabi: Methodology, Investigation, Writing – Review & Editing.
  Investigation, Data Curation, Writing — Review & Editing: Abdullah Saeed Mohammed Alshahrani
  Investigation, Validation, Writing – Review & Editing: Abdulmajeed Abdullah Hussain Alfaqir.
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- Corresponding Author :
  Hadi Shnar Jaber Lsloom, Corresponding author.
  Email: H_55_A@hotmail.com
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