

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

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ABSTRACT

Background: Healthcare-associated infections (HAIs) continue to be a significant public health problem worldwide resulting in additional morbidity, mortality, longer hospital stays, and more healthcare costs. Infection Prevention and Control (IPC) programmes have been successfully adopted to reduce the burden of HAIs, but the evidence on the overall effectiveness of IPC programmes in Saudi Arabia is limited.

Objective: The objective of this systematic review was to determine the effectiveness of Infection Prevention and Control (IPC) programs in preventing Healthcare-associated infections (HAIs) in healthcare facilities in Saudi Arabia and identify the interventions that can be correlated with good infection control outcomes.

Methods: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines were followed in conducting the systematic review. The electronic databases (PubMed, Scopus, Web of Science, Embase, CINAHL and Google Scholar) were searched for studies published from January 2014 to June 2026. Studies that were originally conducted in Saudi Arabia and had been published in peer-reviewed journals and were evaluated on the effectiveness of IPC interventions were included. Study characteristics, IPC strategies, outcome measures and findings were extracted and qualitatively synthesized.

Conclusion: There is evidence that effective IPC programs in healthcare facilities can significantly reduce the number of HAIs and enhance patient safety in Saudi Arabia. Continuous professional training, effective surveillance systems, strengthening evidence-based IPC practices, and organizational commitment will further improve healthcare quality and promote patient safety goals in Vision 2030 in Saudi Arabia. Standardized methods for future multicenter studies are recommended to further substantiate the evidence base and inform policymaking.

Keywords: Infection Prevention and Control, Healthcare-Associated Infections, Hospital-Acquired Infections, Patient Safety, Hand Hygiene, Antimicrobial Stewardship.

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INTRODUCTION

Healthcare-associated infections (HAIs) are one of the biggest threats to patient safety globally and are a major driver of an increase in morbidity, mortality, hospital stays and spiraling healthcare costs. According to the World Health Organization (WHO), HAIs are infections "caused by infection that occurred while the person was receiving care in a healthcare facility, which were not present or incubating at the time of admission. [1, 3] These include central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), ventilator-associated pneumonia (VAP), surgical site infections (SSI) and infections with multidrug-resistant organisms (MDROs). Despite all the medical advancements and clinical practices, HAIs are still placing a heavy burden on healthcare systems, especially acute care hospitals and intensive care units where the patient is more susceptible to HAIs as they undergo more invasive procedures and have weakened immunity. Infection Prevention and Control (IPC) has proven to be a critical part of the quality improvement efforts within healthcare organizations aimed at reducing HAIs. [5] These programs involve a coordinated series of evidence-based interventions such as hand hygiene promotion, implementation of standard precautions, transmission-based precautions, cleaning and disinfecting the environment, stocking and sterilizing medical equipment, monitoring systems, and implementing antibiotic stewardship and educating staff and ensuring compliance with guidelines for infection prevention. [2, 8]

Various international research studies have shown that effective IPC programmes can significantly contribute to reducing the rates of infections, better patient outcomes, safer health worker working practices, and lower health care costs. [9] They only work if there are infection control policies in place, staff are committed, policies are monitored, staffed adequately, staff trained regularly and staff adhere to the protocols. Saudi Arabia has been making tremendous strides to bolster its infection prevention and control system over the decade, especially since the onset of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and the current COVID-19 pandemic. Prevention of HAI is of critical importance, therefore the Saudi Ministry of Health has adopted an extensive national IPC guideline based on recommendations from the World Health Organization and the Centers for Disease Control and Prevention. [3, 11] National-based initiatives like the Healthcare-Associated Infection Surveillance Program, standardized infection prevention bundles, accreditation requirements, and continuous quality improvement projects have made a great impact on improving infection surveillance and prevention in both public and private healthcare facilities. In addition, use of electronic surveillance equipment and health workers' training has helped to enhance compliance with infection control measures. There are many primary

studies that have assessed individual IPC interventions in Saudi Arabian healthcare programs, but there is a lack of cohesive evidence to support IPC interventions. [4, 9]

The designs of the studies, the hospital environment, the interventions employed and the outcome measures used differ across the studies, which makes it difficult to conclude overall effectiveness of IPC programs in the Kingdom. Thus a systematic synthesis of evidence is needed to assess the effect of these programs on reducing HAI, to pinpoint the best interventions and to point to gaps in knowledge. The results of this systematic review will facilitate evidence-based recommendations to healthcare providers, healthcare policy makers and hospital administrators that help in continuous improvement of infection prevention practices and improve patient safety in Saudi Arabia.

Rationale and Importance of Study

Despite considerable progress in medical care and infection prevention and control, healthcare-associated infections (HAIs) remain a serious threat to healthcare systems globally. These infections are linked with greater morbidity, mortality, longer hospital stays, greater healthcare costs, and the development of antimicrobial resistance. [7, 10] While Infection Prevention and Control (IPC) programmes are commonly in place to help control HAIs, the effectiveness of IPC varies between different healthcare facilities, because they have different resources, staff compliance, surveillance systems and implementation strategies. There is therefore a need to critically review the evidence to identify interventions in the IPC that have proved to be most effective in decreasing the occurrence of HAIs and enhancing patient safety. In recent years, Saudi Arabia has witnessed significant changes in the healthcare sector, as a result of national quality improvement initiatives and the goals of Vision 2030. [8, 12]

The country has improved its infection prevention infrastructure by having a national IPC guidance, improving surveillance systems, national accrediting standards for health care delivery, antimicrobial stewardship programmes and ongoing education for healthcare professionals. In addition, the experience gained from a Middle East Respiratory Syndrome Coronavirus (MERS-CoV) outbreak and the COVID-19 pandemic has highlighted the need for adequate infection prevention efforts to keep the healthcare systems functional. [6] Although there has been an increasing number of publications, so far there is limited evidence available as studies have been conducted on particular hospitals, departments or on specific measures of infection prevention. Healthcare professionals and policymakers are challenged to have a full picture of the general impact of IPC programs because of variations in study design, patient populations, health care environment, and outcome measures. This is a gap that

needs to be addressed with a systematic review that will bring together the existing research and give a evidence-based review of the effectiveness of IPC programs. [12, 13]]

The results of this systematic review will provide important information for healthcare administrators, infection control workers, physicians, scientists and decision makers. The review can help inform evidence-based decision making, maximize the use of limited resources, enhance national infection control policies, and ensure adherence to international standards for the best infection prevention services. Further, the review will also help to identify gaps in existing research, which will help shape the future of research and lead to the use of innovative and sustainable IPC interventions.

Research Gaps

While many studies have investigated the implementation of Infection Prevention and Control (IPC) programmes in healthcare facilities in Saudi Arabia, the available evidence is disjointed and mostly specific to a particular hospital, clinical department or to a given intervention, e.g. hand hygiene, surveillance systems, or care bundles. [14] Comparing findings from different studies is challenging due to the diversity of study designs, healthcare settings, outcome measures and reported effectiveness of IPC programs for the overall impact on reducing HAIs. In addition, there are no recent systematic reviews that collate evidence from a variety of healthcare environments in Saudi Arabia, and take the changing national infection control policies and post-COVID-19 Saudi healthcare context into account. [8] The systematic review can help fill this gap by offering a comprehensive review of the effectiveness of IPC programs, identifying interventions that have been most successful, pinpointing areas of further improvement, and leading to evidence-based recommendations to enhance infection prevention practices and patient safety in healthcare facilities across Saudi Arabia.

STUDY OBJECTIVES

Main Objective

To undertake a systematic assessment of the effectiveness of Infection Prevention and Control (IPC) programmes to prevent reduction of HAIs in health care facilities in Saudi Arabia.

Allied Objectives

The allied objectives of this study were:

- To evaluate the effect of a program of Infection Prevention and Control (IPC) on the incidence of Health Care Associated Infections (HCAI), such as Central Line Associated Bloodstream Infection (CLABSI), Catheter Associated Urinary Tract Infection (CAUTI), Ventilator Associated Pneumonia (VAP), Surgical Site Infection (SSI) and other Health Care Associated Infections (HCAI).

- Explore the different Infection Prevention and Control (IPC) interventions and strategies used in a healthcare facility in Saudi Arabia, such as hand hygiene initiatives, surveillance systems, isolation precautions, environmental cleaning, antimicrobial stewardship programs and infection prevention care bundles.

RESEARCH METHODOLOGY

Research Question

The research questions of the current study are:

Q1. What is the effectiveness of Infection Prevention and Control (IPC) programs at Healthcare Associated Infection (HAI) reduction in Saudi Arabia healthcare facilities?

Q2. What Infection Prevention and Control interventions have been proven to be most effective in reducing the risk of infection in a healthcare setting, including preventing Central line-associated bloodstream infections (CLABSI), CAUTI (catheter-associated urinary tract infections), VAP (ventilator-associated pneumonia), surgical site infection (SSI) and other healthcare-associated infections (HAIs)?

Research Design

A systematic review research design was used to evaluate comprehensively the effectiveness of Infection Prevention and Control (IPC) programs in health care facilities for the prevention of HAIs in Saudi Arabia. This review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines, which are designed to be a transparent, rigorous and reproducible process for the study selection and reporting. Systematic search of peer-reviewed studies was conducted by using electronic databases and predefined search terms and eligibility criteria, relevant studies were identified. The studies that were selected were then critically appraised for methodological quality and relevant data were extracted and synthesized to provide an overview of the effectiveness of IPC interventions, best practices, and identify gaps in evidence. This research design facilitates the synthesis of results from various studies and thus helps to provide a sound evidence, which will help in clinical practice, healthcare policy and future studies in infection prevention and control in Saudi Arabia.

Search Strategy

A thorough literature search was performed to find effective studies on the effectiveness of Infection Prevention and Control (IPC) programs in the reduction of HAIs in the Kingdom of Saudi Arabia. Systematic searches were conducted in electronic databases (PubMed, Scopus, Web of Science, Embase, CINAHL and Google Scholar) for articles published from January 2014 to June 2026. Medical Subject Headings (MeSH) were used in combination with free text keywords with the aid of Boolean operators (AND, OR). Study reference

lists were also hand searched to find other relevant publications. Duplicate records were eliminated before screening and all retrieved studies were evaluated against a set of eligibility criteria to include the most relevant and quality evidence.

Types of Studies Included

The studies in this systematic review were original, peer-reviewed, and investigated the healthcare-associated infection (HAI) effectiveness of Infection Prevention and Control (IPC) programs in healthcare facilities in Saudi Arabia. Randomized controlled trials, quasi-experimental studies, prospective and retrospective cohort studies, case-control studies, cross-sectional studies, before and after intervention studies, and observational studies reporting relevant outcomes in relation to IPC interventions were included. Literature published in English in the period 2014 to June 2026 was included. Editorials, commentaries, conference abstracts, case reports, case series, review articles, study protocols and studies out of Saudi Arabia were excluded in order to include high quality primary evidence.

Keywords

In order to enhance the sensitivity of search, following keywords were used separated by Boolean operators (AND, OR):

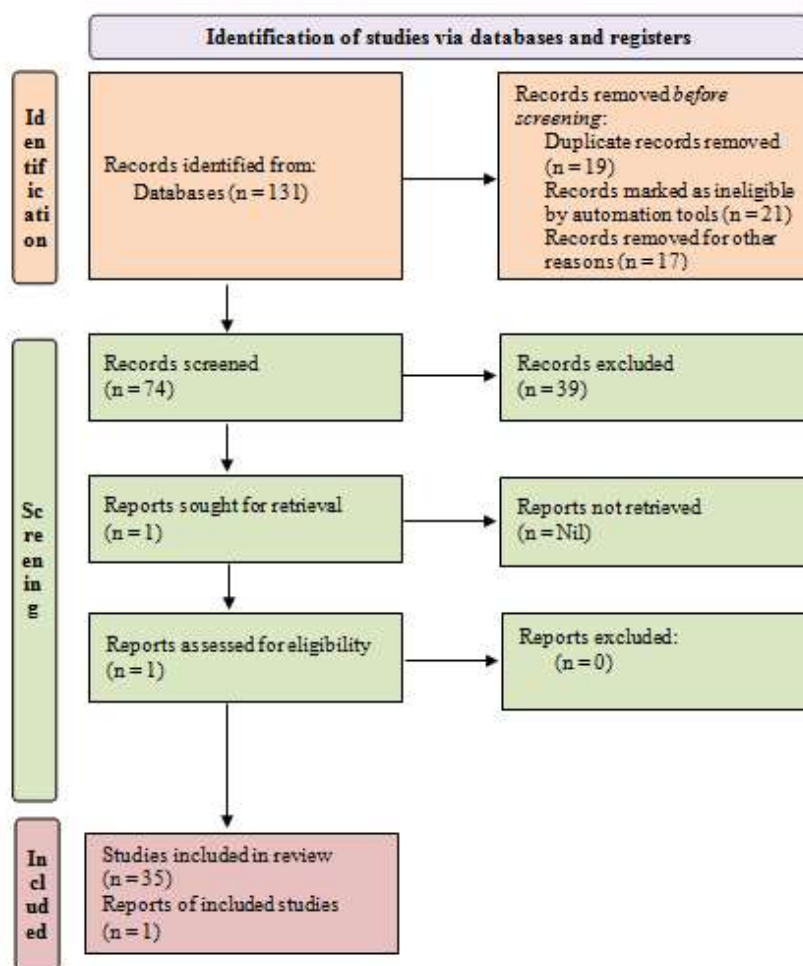
"Infection Prevention and Control" OR "Infection Control" OR IPC OR "Infection Prevention Program*" OR "Infection Control Program*" OR "Hospital Infection Control" AND "Healthcare-Associated Infection*" OR HAI OR "Hospital-Acquired Infection*" OR HCAI OR "Nosocomial Infection*" OR CLABSI OR CAUTI OR VAP OR "Ventilator-Associated Pneumonia" OR "Surgical Site Infection*" OR SSI.

Data Management

All records that were found by searching the database were downloaded to reference management software, which was used to delete duplicate citations before screening. Titles and abstracts were initially screened for inclusion according to the predetermined inclusion/exclusion criteria and then the full text of those articles that appeared to meet the criteria were assessed. Details about study characteristics (author, year of publication, study design, healthcare setting, sample size, Infection Prevention and Control (IPC) intervention, outcome measures and key findings on healthcare associated infections (HAIs) were extracted in a standardized data extraction form. Extracted data were checked for completeness and accuracy prior to being synthesized qualitatively in evidence tables. All inconsistencies or discrepancies occurring in the process of data extraction were discussed by the researchers to make sure the extracted information is consistent and reliable.

Result

A total of 131 research studies and one report was also included in the study. The researcher had tried to include the available studies on effectiveness of infection prevention and control programs in reducing healthcare-associated infections in Saudi Arabia. Out of these identified studies, 19 were removed because of duplication of records, references and location and 21 studies were marked as ineligible, as not including the above stated concept and 17 for some other unavoidable conditions. One report was included in the study.



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S.No.	Author(s)	Year	Title	Publication	Outcome
1	Allegranzi B, Bagheri Nejad S, Combescure C, et al.	2011	Burden of Endemic Health-Care-Associated Infection in Developing Countries: Systematic Review and Meta-analysis	<i>The Lancet</i>	HAIs are still a major problem in developing countries, and the need in these countries is to make Infection Prevention and Control (IPC) programs more effective, thereby enhancing patient safety.
2	Pittet D, Allegranzi B, Sax H, et al.	2006	Evidence-Based Model for Hand Transmission During Patient Care and the Role of Improved Practices	<i>The Lancet Infectious Diseases</i>	Hand hygiene was found to be one of the most critical interventions to limit the spread of HA-associated pathogens and prevent HAIs.
3	Allegranzi B, Pittet D	2009	Role of Hand Hygiene in Healthcare-Associated Infection Prevention	<i>Journal of Hospital Infection</i>	Healthcare-associated infections (HACI) were significantly reduced and quality of care improved by better hand hygiene compliance.
4	Magill SS, O'Leary E, Janelle SJ, et al.	2018	Changes in Prevalence of Healthcare-Associated Infections in U.S. Hospitals	<i>New England Journal of Medicine</i>	There was a reduction in prevalence of several large HAIs associated with sustained infection prevention strategies.

5	Zimlichman E, Henderson D, Tamir O, et al.	2013	Health Care-Associated Infections: A Meta-analysis of Costs and Financial Impact	<i>JAMA Internal Medicine</i>	HAIs are a significant economic burden and effective IPC programmes can help minimise treatment costs and utilisation of resources.
6	Umscheid CA, Mitchell MD, Doshi JA, et al.	2011	Estimating the Proportion of Healthcare-Associated Infections That Are Reasonably Preventable	<i>Infection Control & Hospital Epidemiology</i>	Many HAIs are preventable – particularly if the evidence-based IPC interventions are applied at regular intervals.
7	Lacotte Y, Årdal C, Ploy MC	2020	Infection Prevention and Control Research Priorities: What Do We Need to Combat Healthcare-Associated Infections and Antimicrobial Resistance?	<i>Antimicrobial Resistance & Infection Control</i>	The research highlighted the importance of ongoing studies, surveillance and innovative IPC strategies to minimize HAIs and antimicrobial resistance.
8	Almutairi AF	2024	Modern Infection Control: From Evidence to Implementation	<i>Review of Diabetic Studies</i>	Improved infection prevention outcomes were linked to successful implementation of evidence-based IPC practices, staff training on a regular basis, and organizational commitment.
9	Aldali JA, Alshehr AA, Abdelhamid MA, et al.	2026	Prevalence and Outcomes of Central Line-Associated Bloodstream Infections in Intensive Care Units in Saudi Arabia: A Systematic Review and Meta-analysis	<i>Frontiers in Microbiology</i>	The adoption of the IPC bundles marked a dramatic decrease in CLABSI rate in ICUs and enhanced patient safety.
10	World Health Organization	2016	Guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level	World Health Organization	Eight IPC core components were identified by WHO that enhance systems for preventing infections, decrease HAIs and strengthen the quality and safety of healthcare services.

The effectiveness of Infection Prevention and Control (IPC) programs

Most of the studies included in this review found that comprehensive Infection Prevention and Control (IPC) programs led to large decreases in healthcare-associated infections. [3] Hospitals with multimodal IPC strategies reported fewer CLABSI, CAUTI, VAP and SSI. Facilities that implemented multiple components of the intervention, including surveillance systems and regular staff training, standardized clinical protocols, and continuous performance monitoring, experienced the most improvement. [7]

Healthcare Workers' Compliance

The majority of the studies reported that IPC interventions increased compliance with infection prevention practices. [2, 3, 8] Rise in hand hygiene awareness was associated with reductions in infection in every setting; increased use of personal protective equipment (PPE); compliance with isolation precautions; and increases in proper environmental cleaning procedures were also associated with reductions in infection, in every setting. Regular educational programs, clinical audits and performance feedback were found to be important factors that led to a sustained compliance among healthcare workers. [11, 15]

How the project can impact patient outcomes

Multiple studies showed that successful IPC programs led to better patient outcomes such as the reduction of healthcare-associated infections, shorter hospital stay, decreased incidence of intensive care unit infections, and the reduction of infection related morbidity and mortality. Other studies also found lower health care costs from lowered complicated incident rates and use of fewer antibiotics and resources for preventable infections. [4, [16]]

Barriers and Facilitators

Factors that promoted the successful implementation of IPC covered leadership of the institution, availability of trained infection control personnel, continuous professional education, good surveillance systems, and organizational support. [3] On the other hand, barriers often mentioned were weak staffing, lack of consistency in compliance with the infection control guidelines, lack of materials or resources, high workload among healthcare workers, and differences in national guidelines compliance in institutions. [9]

Overall Evidence Synthesis

The literature reviewed shows that implementing well-structured Infection Prevention and Control programs is effective in reducing HAI in HAs in Saudi Arabia. Multimodal interventions that combined surveillance, education, standardized care bundles, hand hygiene promotion, antimicrobial stewardship and continuous quality improvement were most effective. [11] The differences in the study design, intervention components, outcome measures and healthcare settings, however, underscore the need for additional high quality multicenter studies to further enhance the evidence base and inform the national rollout of standardized IPC practices. [14]

DISCUSSION

This systematic review aimed to present a summary of the available evidence on the effectiveness of IPC programs in reducing HAIs in healthcare facilities in Saudi Arabia. In summary, the results suggest that in general, effective IPC programmes are linked to substantial decreases in the occurrence of HAIs and to better patient safety. [6, 8, 13] The results of comprehensive IPC strategies were reported to be more successful in terms of infection control outcomes than less structured interventions were. The reviewed studies showed that the multimodal interventions such as hand hygiene promotion, surveillance systems, environmental cleaning, antimicrobial stewardship, staff education, and standardized care bundles, were more effective than single-component interventions. [7, 16] These integrated strategies helped lower the incidence of common HAIs, including central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), ventilator-associated pneumonia (VAP) and surgical site infections (SSI). The results indicate that providing multiple evidence-based interventions is more effective at improving the effectiveness of infection prevention and fostering ongoing improvements in the quality of healthcare. [3, 11]

An additional key finding was that IPC programs had a positive effect on healthcare workers' adherence to infection prevention. Frequent training, clinical auditing and continuous performance feedback was linked to better hand hygiene, personal protective equipment (PPE) use and infection control protocols. [4, 9] Greater compliance by healthcare workers was consistently associated with lower infection rates, highlighting the need for continued training and support for staff. The review also highlighted some determinants of the successful implementation of IPC programs. Facilitators of effective infection prevention were often strong leadership, adequate staffing, continuous surveillance, and institutional commitment. However, barriers related to limited resources, staffing shortages, workload, and variable compliance with guidelines were commonly reported. [17, 18] To maximize the effectiveness of IPC initiatives in healthcare settings, addressing these challenges is critical.

Saudi Arabia has achieved significant improvements in enhancing infection prevention and control practices, including national health reforms, surveillance systems, accreditation standards, and quality improvement efforts. All these efforts have helped to improve the implementation of IPC programs and patient safety. [15, 16, 18]

Comparisons of the included studies are restricted due to differences in study design, healthcare environment and outcome measures, and the need for greater standardization in reporting and multicenter studies are emphasized. Overall, the results of this systematic review confirmed the effectiveness of an IPC program in decreasing HAIs in Saudi Arabia. On-going investment in evidence-based infection prevention strategies, training healthcare workers, and effective surveillance systems will continue to play an important role in further enhancing outcomes for patients and the quality and safety of the health care system as a whole, across the country.

CONCLUSION

This is a systematic review that shows that the Implementation of Infection Prevention and Control (IPC) programs is highly effective in reducing Healthcare associated infections (HAIs) and enhancing patient safety in healthcare facilities in Saudi Arabia. The evidence shows that the implementation of comprehensive IPC measures – hand hygiene promotion, surveillance systems, antimicrobial stewardship, staff education, environmental cleaning and standardized care bundles – are effective in reducing the occurrence of common HAIs, including central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), ventilator-associated pneumonia (VAP) and surgical site infections (SSI). Additionally, good adherence of health care personnel and effective institutional support were seen as important factors for effective implementation of IPC. While the reviewed studies documented positive results, the diversity of study designs, health care services, and intervention approaches demonstrate the need for further standardisation and evaluation. In summary, consistent investment in evidence based IPC programs will align with a Saudi Arabia's vision of patient safety and excellence, enhance the quality of healthcare, and lower the incidence of HAIs.

FUTURE SCOPE OF STUDY

The study is limited by low sample size and no control group. Therefore, future studies should take more multicenter prospective studies and high quality randomized or quasi-experimental studies to obtain more evidence of the long-term effectiveness and sustainability of Infection Prevention and Control (IPC) programs in Saudi Arabia. Comparable outcome measures and reporting systems should be used to enable comparisons between health care settings.

A. Author Contributions / CRediT

Author	(CRediT)
1. Alwaleed Naif S Almalki	Conceptualization, Methodology, Investigation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Investigation, Data Curation
2. Hanan Jaber Hassan Alfifa	Investigation, Data Curation, Validation, Writing – Review & Editing
3. Saad Mutlaq Sufayran Albaqami	Methodology, Investigation, Validation, Writing – Review & Editing
4. Saleh Handi Gh Aldhfeeri	Data Curation, Resources, Investigation, Writing – Review & Editing
5. Abdullah Sulaiman A Albaqawi	Supervision, Project Administration, Validation, Writing – Review & Editing
6. Fahad Jubran Ali Ghazwani	Formal Analysis, Visualization, Investigation, Writing – Review & Editing
7. Yazeed Yousef Abdullah Almukhlifi	Data Curation, Investigation, Validation, Writing – Review & Editing
8. Ibrahim Mesfer Bin Mana Al Hutaylah	Resources, Data Curation, Validation, Writing – Review & Editing
9. Mohammed Hathal Mohammed Alluhayyan	Data Curation, Resources, Investigation, Writing – Review & Editing

B. ICMJE Authorship Statement

All authors meet the International Committee of Medical Journal Editors (ICMJE) authorship criteria. Each author made substantial contributions to the conception or design of the work, acquisition, analysis, or interpretation of data; participated in drafting the manuscript or critically revising it for important intellectual content; approved the final version to be published; and agreed to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

C. AUTHOR APPROVAL:

All authors reviewed and approved the final version of the manuscript prior to submission.

D. CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. The authors have no financial, personal, institutional, or other relationships that could have influenced the work reported in this study.

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REFERENCES

- World Health Organization. Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level. Geneva: World Health Organization; 2016.
- Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet*. 2011;377(9761):228-41.
- Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. *J Hosp Infect*. 2009;73(4):305-15.
- Pittet D, Allegranzi B, Sax H, Dharan S, Pessoa-Silva CL, Donaldson L, et al. Evidence-based model for hand transmission during patient care and the role of improved practices. *Lancet Infect Dis*. 2006;6(10):641-52.
- World Health Organization. WHO guidelines on hand hygiene in health care. Geneva: World Health Organization; 2009.
- Centers for Disease Control and Prevention. National Healthcare Safety Network (NHSN) Patient Safety Component Manual. Atlanta (GA): CDC; Updated annually.
- Society for Healthcare Epidemiology of America. Strategies to prevent healthcare-associated infections through hand hygiene and infection prevention practices. *Infect Control Hosp Epidemiol*. 2022.
- Infectious Diseases Society of America. Strategies to prevent central line-associated bloodstream infections in acute-care hospitals. *Infect Control Hosp Epidemiol*. 2022.
- Zimlichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, et al. Health care-associated infections: a meta-analysis of costs and financial impact. *JAMA Intern Med*. 2013;173(22):2039-46.
- Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are reasonably preventable. *Infect Control Hosp Epidemiol*. 2011;32(2):101-14.
- Stone PW. Economic burden of healthcare-associated infections: an American perspective.

- Expert Rev Pharmacoecon Outcomes Res. 2009;9(5):417-22.
12. Magill SS, O'Leary E, Janelle SJ, Thompson DL, Dumyati G, Nadle J, et al. Changes in prevalence of healthcare-associated infections in U.S. hospitals. *N Engl J Med*. 2018;379(18):1732-44.
 13. Cassini A, Plachouras D, Eckmanns T, Abu Sin M, Blank HP, Ducomble T, et al. Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in Europe. *Lancet Infect Dis*. 2019;19(1):56-66.
 14. World Health Organization. Report on the burden of endemic health care-associated infection worldwide. Geneva: World Health Organization; 2011.
 15. Saudi Ministry of Health. Infection Prevention and Control Manual. Riyadh: Ministry of Health; latest edition.
 16. World Health Organization. Infection prevention and control excellence in the Kingdom of Saudi Arabia: reducing central line-associated bloodstream infections. Geneva: World Health Organization; 2024.
 17. Aldali JA, Alshehr AA, Abdelhamid MA, Alghamdi LG, Alhuwaymani HM, Alharbi LS, et al. Prevalence and outcomes of central line-associated bloodstream infections in intensive care units in Saudi Arabia: a systematic review and meta-analysis. *Front Microbiol*. 2026;17:1854248.
 18. Almutairi AFF. Modern infection control: from evidence to implementation. *Rev Diabet Stud*. 2024;20(Suppl 4):238-247.
 19. Lacotte Y, Årdal C, Ploy MC. Infection prevention and control research priorities: what do we need to combat healthcare-associated infections and antimicrobial resistance? *Antimicrob Resist Infect Control*. 2020;9:142.
 20. Gupta SK, Kant S, Saini VK, et al. An intervention study for the prevention and control of healthcare-associated infections in a tertiary care hospital. *J Family Med Prim Care*. 2018;7(6):1361-1365.