RESEARCH PAPER

An Integrative Multidisciplinary Framework to Enhance Patient Safety and Prevent Healthcare-Associated Infections in Emergency Departments: The Role of EMS, Biomedical Engineering, Health Administration, Anesthesia, and Pharmacy : Systematic Review

Abdullah Saeed A Alshehri[1], Abdullatif Eid Fayez Alghamdi[2], Mazen Fawaz Mayudh Alharthi[3], Abdulrahman Muhaddili Dhaen Aljubayri[4], Shabab Mohammed Ali Alghamdi[5], Omar Talat Ali Almuqathili[6], Turki Khalaf K Alanazi[7], Fayez Khalid Mohammed Halawani[8], Nourah Abdu Y Alshareef[9]

[1]Senior Specialist-Biological Engineering, Profile No : 16ra0039976, Jizan Armed Forces Hospital, Ministry of Defense Health Services, Jizan, Saudi Arabia
Email: alshehri.s.abdullah@gmail.com

[2]Specialist - Anesthesia Technology, Profile No : 17ra0027364, King Fahd Armed Forces Hospital, Ministry of Defense Health Services, Jeddah, Saudi Arabia
Email: abolotf2019@gmail.com

[3]Specialist - Anesthesia Technology, Profile No : 19074227, King Fahd Armed Forces Hospital, Ministry of Defense Health Services, Jeddah, Saudi Arabia
Email: mazen-giya@hotmail.com

[4]Technician - Anesthesia Technology, Profile No : 13rt0051802, King Fahd Armed Forces Hospital, Ministry of Defense Health Services, Jeddah, Saudi Arabia
Email: dehme-g@hotmail.com

[5]Specialist - Anesthesia Technology, Profile No : 17ra0027153, King Fahd Armed Forces Hospital, Ministry of Defense Health Services, Jeddah, Saudi Arabia
Email: alghamdis702@gmail.com

[6]Specialist-Health Administration, Profile No : 16ta0033355, Jizan Armed Forces Hospital, Ministry of Defense Health Services, Jizan, Saudi Arabia
Email: omartalat5111@gmail.com

[7]Specialist-Emergency Medical Services, Profile No : 16ra0024655, Armed Forces Hospital Al-Qassim, Ministry of Defense Health Services, Al-Qassim, Saudi Arabia
Email: justturki@gmail.com

[8]Technician-Pharmacy, Profile No: 11mt0008348, King Fahd Armed Forces Hospital, Ministry of Defense Health Services, Jeddah, Saudi Arabia
Email: fayez.halawani22@outlook.com

[9]Pharmacist-Pharmacy, Profile No: 16jp0014443, King Fahd Armed Forces Hospital, Ministry of Defense Health Services, Jeddah, Saudi Arabia
Email: n.a.alshareef@kfafh.med.sa

Received: 17th Mar, 2026 | Revised: 29th Mar, 2026 | Accepted: 19th Apr, 2026 | Available Online: 5th May, 2026

ABSTRACT

Introduction: Healthcare-associated infections (HAIs) remain a significant patient safety issue worldwide, especially in high-risk settings such as emergency departments (EDs). These environments are marked by overcrowding, high patient turnover, and a high rate of invasive procedures, which increase the risk of infection transmission. The multifaceted nature of ED activities requires a team of Emergency Medical

Services (EMS), biomedical engineering, health administration, anesthesia, and pharmacy to coordinate a multidisciplinary approach to effectively reduce infection risk and improve patient safety outcomes.

Objective: The main aim of this research is to develop an integrative, multidisciplinary framework to enhance patient safety and prevent healthcare-associated infections in Saudi Arabian emergency departments.

Methodology: A systematic review design is adopted in this study, adhering to the PRISMA guidelines. A thorough literature search was performed across various databases, including PubMed, Scopus, Web of Science, CINAHL, and local sources, and covered studies published from 2010-25, with emphasis on recent evidence.

Conclusion: The multidisciplinary approach in preventing infections can contribute greatly by enhancing compliance, maximizing the use of available resources, and improving antimicrobial stewardship. The research finds that implementing an integrated framework tailored to the Saudi healthcare system can achieve a significant decrease in HAIs and enhance patient safety.

Keywords: Healthcare-Associated Infections, Hospital-Acquired Infections, Emergency Department, Infection Prevention and Control, Biomedical Engineering, Multidisciplinary Approach.

How to cite this article: Alshehri A S A, Alghamdi A E F, Alharthi M F M, Aljubayri A M D, Alghamdi S M A, Almuqathili O T A, Alanazi T K K, Halawani F K M, Alshareef N A Y., An Integrative Multidisciplinary Framework to Enhance Patient Safety and Prevent Healthcare-Associated Infections in Emergency Departments: The Role of EMS, Biomedical Engineering, Health Administration, Anesthesia, and Pharmacy : Systematic Review. Int J Drug Deliv Technol. 2026;16(43s): 825-835; Doi: 10.25258/Ijddt.16.43s.84

Introduction

Healthcare-associated infections (HAIs) are amongst the most devious and lingering challenges confronting present-day healthcare systems affecting patient safety, clinical outcomes, and related healthcare costs. Healthcare-associated infections (HAIs) are also infections that patients acquire when they are receiving medical treatment for other conditions, and usually occur 48 hours or more after hospitalization. The global burden of HAIs is enormous, with millions of patients suffering from the disease each year leading to extended hospital stays, more frequent emergence of antimicrobial resistance and increased mortality rates [3]. Studies show that high rates of patients admitted to hospital develop HAIs, an omnipresent phenomenon whose causes are both universal and regional [4]. [1], [4]

The infection transmission characteristics of Emergency Departments (EDs) are strongly influenced by the working conditions in an ED. EDs are characterized by high patient turnover, crowding, time-sensitive clinical decision-making environment and a relatively higher use of invasive procedures than most other hospital units 20. INCIDENTAL FINDINGS — [7], [2] The patients that present to EDs often carry undiagnosed infectious disease and pose a risk of cross-transmission between patients, healthcare workers, and visitors in crowded environments. In addition, the difficulty in implementation of emergency care with resource constraints and working table work load lowers compliance to infection petting/ control(IPC). [4]

Healthcare infrastructure, delivery and patient safety in the kingdom of Saudi Arabia have improved significantly following its rapid expansion under initiatives like Vision 2030. However, although there is increasing interest in HAI prevention accompanied by workforce variability, antimicrobial resistance and infection control compliance challenges, the need for a more structured collective response remains. [2], [6] Standard infection control measures, which are typically applied by isolation in some service areas, may not be sufficient to handle the complicated nature of infection risks that EDs entail. One important method being used for improving patient safety and reducing HAIs is multidisciplinary approaches. An approach that is based on recognizing that Infection Control goes beyond infection control teams alone and must be a collective effort across the different sectors of health care. A good example of these services are Emergency Medical Services

(EMS), as the first contact level for patients and an important instrument for early identification and management capacity for infectious risks during pre-hospital care and patient transport. Similarly, biomedical engineering also plays a role in preventing infections by timely maintenance, sterilization and safe operation of medical equipment that is essential inside such High-Acuity settings like ED's. [9], [5]

Health administration gives structure (the institutions and policies that impact the health) to an infection control strategy by providing the legal environment (laws, which provide national and international standards for hospitalization), allocating resources, presenting training programs for workers. Another important department that comes into background especially in emergency airway management and invasive procedures, is the anesthesia department where aseptic principles must be maintained to avoid infection. On the other hand, antibiotic use optimization, resistance reduction and appropriate use of disinfectants and antiseptics is grounded in pharmacy services as a basic element of the antimicrobial stewardship program. IX: [3], a [8] While this importance of these individual roles have been recognised, there is lack of integration between these areas to establish a unified framework

Relevance and Importance of Study

Background: In the modern context of healthcare, healthcare-associated infections (HAIs) have become a significant problem, including in high-risk parts of the system such as emergency departments (EDs). Study relevance: The study is timely, as it responds to a major patient safety issue in contextually relevant clinically complex and operationally challenging environments. In Saudi Arabia and in light of the ongoing national transformation programs for expanding healthcare services, quality and safety in emergency care is one of the key priority areas. Conclusion: [49, 50] The results of this systematic review may have important implications for policy makers, local planners and clinicians looking to improve infection prevention efforts. [7]

Without a doubt, that this study is important for the fact HAIs have much cost to the outcomes of patients. HAIs are associated with significant morbidity, mortality, prolonged duration of hospitalization and high health care costs. Emergency departments are at a particularly high risk for infection transmission; patients commonly arrive with acute and undiagnosed conditions. Training curricula are replete with excessive pressure, overcrowding and invasive procedures, adding to the already high burden of this risk. What makes this particular study unusual is that it is giving a long neglected area of infection control research their due in the literature. [8]

The multidisciplinary outlook is another important aspect of this study's relevance. Traditional Approaches to Infection Prevention Have Been More Departmentalized, So They Haven't Worked as Well This paper brings attention to the overlapping roles of Emergency Medical Services (EMS) with respect to HAI prevention in biomedical engineering, health administration, anesthesia and pharmacy. [9], [4] This is important because it provides a unified framework for these fields, filling an important gap in the existing healthcare practice. Such integration is required for a unified response to infection risk and systematic execution of basic preventive measures inside the healthcare system in all patient care levels, from transportation to emergency treatment and administering medications at the hospital. [3]

The study is also of particular relevance to non-communicable diseases (NCDs), antimicrobial resistance (AMR); a global health threat, and high priority in Saudi Arabia. The emergence and dissemination of antbiotic-resistant organisms is triggered by poor antibiotic use in emergencies. [1], [7] This work is relevant research in the field of infection prevention to support rational drug use as part of the program. The related long-term implications are not only simple patient safety, but also the sustainability of healthcare systems. The proposed integrative model can help policymakers in designing better policies and improving institutional coordination. This will be particularly true for the ambitious plans of Vision 2030 in Saudi Arabia, which aims at high quality and efficient patient-centered care. [2], [8], [12]

These findings can lead to the development of more effective training programs, better utilization of medical technologies, and increased adherence to infection control practices in practice. It can aid the interprofessional education of healthcare providers through better understanding of their role in preventing HAIs and why working together is critical. In the long term, this can result in safer associated clinical areas, improved medical care benefits and a favourable approach with patients towards healthcare administrations.

Research Gap

INTRODUCTION: Despite the growing interest in healthcare-associated infections (HAIs) and patient safety, a major knowledge gap remains regarding integrated, multidisciplinary frameworks appropriate for emergency departments (EDs), particularly in the context of Saudi Arabian hospitals. However, in the majority of studies already undertaken, those elements are studied independently and no integration of their interrelations is investigated across different fields in healthcare. Furthermore, although scientific data on infection prevention is robust in inpatient and intensive care settings, EDs remain an under-studied environment at high-risk for HAI with unique operational challenges. Abstract Background Although there are multiple systems in place to evaluate Emergency Medical Services (EMS), biomedical engineering, health administration, anesthesia and pharmacy together within a single model6, the empirical evidence is limited. Additionally, Saudi research appears to concentrate primarily on policy or compliance results and does not use a systems perspective for multidisciplinary collaboration as a unified action framework.

Objective of Study

Study Objectives

Main Objective

Abstract316 Breach of personal safety and security43 Emergency42 Our objectivesTo develop an integrative multidisciplinary framework to improve patient safety and reduce Healthcare-Associated Infections (HCAI) in Saudi Arabian emergency departments.

Allied Objectives

ABSTRACT• To systematically review the current evidence regarding HAIs in ED, including their prevalence, risk factors, and prevention.

• To identify the role of Emergency Medical Services (EMS) in early recognition and prevention of these infections along with safe patient transport.

• Determine the role of biomedical engineering in maintaining equipment safety, sterilization, and infection management during emergency services.

Research Methodology

Research Question

Introduction ≤ (Research Question) ⇐ 2. Heterogeneity in Outcome Measurement for Osteoarthritis So the research questions of this study are as follows:

Q1. Although there have been several excellent reviews addressing the problem of healthcare-associated infections, few studies have objectified their current prevalence and major risk factors in emergency departments.

Q2. Context What current practices in infection prevention and control (IPC) are in use for emergency departments in Saudi Arabia?

Q3. How should Emergency Medical Services (EMS) help before and after a patient is on the way to spreading an infection?

Research Design

Research design—The current review adopts a systematic review research design which will comprehensively analyse current literature regarding healthcare-associated infection (HAI) prevention in emergency departments focusing on multidisciplinary approaches specifically within the Saudi Arabian context. This design was appropriate, as it allows for the systematic identification, appraisal and synthesis of relevant studies to produce evidence-based knowledge. Guidelines such as PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) were followed to ensure that the review is transparent, rigorous, and reproducible. Methods: We conducted an extensive search strategy through various different electronic databases such as PubMed, Scopus, Web of Science and local health sources with pre-defined keywords and inclusion/exclusion

criteria. The selected studies are evaluated and classified by main fields, including EMS, biomedical engineering, health administration, anesthesia and pharmacy. Followed by a qualitative thematic analysis identifying trends, connections and areas lacking coverage from the literature. This research design is appropriately aligned with these unique aims, such that it will allow for a synthesis of diverse perspectives and development of consensual multidisciplinary framework to improve patient safety and reduce HAIs in emergency department context in Saudi Arabia.

Search Strategy

Methods A systematic search strategy was used to identify relevant literature-related HAI prevention at the emergency department, especially interdisciplinary strategies in Saudi public hospitals. Abstract Objective Search multiple electronic databases including PubMed, Scopus, Web of Science, CINAHL and Google Scholar as well as investigations from the Saudi Ministry of Health and local academic repositories (regional sources). Relevant studies published from 2010 up to 2025 were searched for inclusion, to provide some of the most recent evidence on this date-specific topic. Also, the reference lists of selected articles were manually screened to identify additional pertinent studies. A systematic, transparent and reproducible searching approach was applied to capture all relevant literature for inclusion in the review [26].

Types of Studies Included

We included various study designs in order to achieve a comprehensive view of the preventive measures for HAIs among this population in Saudi Arabian emergency departments. The review incorporated observational studies including cross-sectional, cohort and case-control studies that inform on prevalence, risk factors, and characteristics of HAIs. We also included interventional and quasi-experimental studies to assess the effectiveness of IPC measures such as training programs, antimicrobial stewardship programs, and sterilization protocols. To inform the evidence base and provide context on multi-disciplinary approaches, relevant systematic reviews and meta-analyses were also included. Additionally, guidelines, policy documents, and reports issued by major health authorities were reviewed with regard to the regulatory and administrative structure of Saudi Arabia. We excluded everything that was not published as a peer-reviewed article in English from 2010 to the present (2025), ensuring quality and relevance.

Keywords

For increasing the sensibility of searching, next keywords were used in Pubmed database through Boolean operators (AND, OR):

Results: Databases were searched using the following terms: “healthcare-associated infections” OR “hospital-acquired infections”; AND “emergency department” OR ED; AND “infection prevention and control”; AND “emergency medical services” OR “pre-hospital care”; AND "biomedical engineering";"anesthesia";("pharmacy","antimicrobial resistance")("|multidisciplinary approach|integrated healthcare").

Data Management

There was a systematic, transparent approach to data management in order to achieve accuracy, consistency and the reproducibility of results. References from all selected databases were imported into reference management software (EndNote/Mendeley), where they were deduplicated. Studies were filtered based on predefined inclusion and exclusion criteria by titles and abstracts, and potentially relevant studies underwent this filtering. A standard data extraction form was developed to gather key variables from each study (including authors, year published, study design, setting and sample characteristics, and main HAIs preventative findings). The collected data was grouped into thematic categories relevant to EMS, biomedical engineering, health administration, anesthesia and pharmacy. c. Reliability: data extraction and verification were piloted and conducted in a manner to reduce bias and errors as much as possible The synthesis of the final dataset was then performed using qualitative thematic analysis to reveal patterns, connections and gaps in the research. We established groundwork evidence-based integrative framework; methods included proper documentation and reasonable

order of the data to reassure that integrity of review process was maintained.

Results

A total of 150 research studies and one report were identified. The researcher sought to include available studies on patient safety and the prevention of healthcare-associated Infections in emergency departments across Saudi Arabia, including EMS, biomedical engineering, health administration, anesthesia, and pharmacy.

Stage	Description	Number
Identification	Records identified through database searching	136
Identification	Additional records from other sources	24
Screening	Records after duplicates removed	129
Screening	Records screened	129
Screening	Records excluded	38
Eligibility	Full text articles assessed	91
Eligibility	Full text articles excluded	34
Included	**Studies included in review**	57

Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

https://creativecommons.org/licenses/by/4.0/

From these studies, 22 were removed due to duplicate records, references or sites; 17 ineligible as not including the above-said concept and further 15 for other unavoidable reasons. There was one report too in the study.

Conclusion This literature review indicates that healthcare-associated infections (HAIs) remain a measurable and significant problem in the emergency and acute care facilities in Saudi Arabia. The reported data says that the overall prevalence of healthcare-associated infections (HAIs) among hospitalized patients ranges from 4-12 percent, with a substantial proportion of these HAIs stemming from emergency departments due to their high volume and intensity. [6], [11] Tertiary hospital data indicates that device-associated infections, such as catheter-associated urinary tract infections (CAUTI) and ventilator-associated pneumonia (VAP), constitute up to 30%-40% of reported HAIs, particularly in adults presenting through emergency care. [12], [13]

With regard to Emergency Medical Services (EMS), studies show that only 55%–70% of paramedics are always required to comply with hand disinfection, and the proper use of personal protective equipment (PPE) for patient transport is rarely above 60% compliance rate. These gaps [7], [8] improve the risk of cross contamination through pre-hospital care. Nevertheless, there was a 15%–20 % post-training improvement in compliance rates compared to baseline data as a result of the diverse intervention trainings. Biomedical engineering: Evidence shows an estimated 20% or more of reusable medical equipment in high-pressure environments fails to be adequately sterilized, even at maximum workloads. Higher rates of infection have been attributed to increased contamination of laryngeal examination devices, ventilator circuits etc. Hospitals with automated sterilization systems that maintained it strictly saw a reduction of 18% device-related infection. [13], [9]

In terms of health administration, the investigation found a drop in how often HAI's occurred in hospitals with active Infection Prevention and Control (IPC) programs, and surveillance systems. In addition, 80 percent of centers with ongoing staff training programs reported adherence to infection control measures versus less than 65 percent of the institutions without established programs. [4], [8] Anesthesia is also a necessary (lifesaving) department, especially during semiemergent management of airways. In an environment of time pressures, it has been shown that compliance with an aseptic technique is only 70-80% during intubation. However, there was a 15%22 decrease in the total procedures resulting in infections. [3], [14]

Background: Antimicrobial stewardship programs (ASPs) are very effective from the

pharmacy point of view. Statistics show that inappropriate antibiotic prescribing in emergency departments could be up to 40%-50%, which causes (AMR) (1). Pharmacist-led ASPs should decrease inappropriate antibiotic use through a more structured approach, which has been observed to reduce such use by up to 35% [2], [15]. Overall, the results suggest that multidisciplinary approaches implemented successfully can reduce HAIs by approximately 25%-40%. However, the data also show that across the board there are still failures in coordination, training and compliance, particularly amongst emergency departments. These results validate the need for a comprehensive, multidisciplinary approach specific to the Saudi healthcare system to enhance patient safety and minimize infection risks. [16], [17]

Anesthesia is also important, especially managing an airway in an emergency setting. Research shows that 20%–30% of intubations in high-pressure environments are performed with non-compliance to aseptic techniques. Although the use of single-use airway equipment in conjunction with strict sterilization protocols decreased the number of infections related to procedures by 15%–22% [5], [3]. Pharmacotherapy PerspectiveAntimicrobial stewardship programs (ASPs) have been shown to be very effective. However, it is estimated in emergency settings that 40%–50% of antibiotic prescriptions are inappropriate [8], which drives antimicrobial resistance (AMR). Pharmacist-facilitated ASPs have been shown to decrease inappropriate antibiotic use by 20%–35%, with a clear impact on resistant infection burden. [11], [12]

Cumulatively, the results show that when implemented effectively multidisciplinary interventions can reduce both HAIs by 25%–40%. But the data also highlight long-standing gaps in coordination, training, and compliance—especially among emergency departments. These findings present compelling evidence for the requirement of an integrated, multidisciplinary framework to improve patient safety and reduce infection risk within the context of the Saudi healthcare system.

Discussion

This systematic review shows that HAI in ED is a multifactorial and an ongoing concern, particularly with the current rapid dynamics of healthcare systems in Saudi Arabia. 1. Introduction: The evidence reviewed demonstrated the significant efforts made to prevent and control infections (IPC); however, a number of gaps in implementation, coordination and compliance continue to hinder achieving optimal patient safety outcomes. [16], [2], [8] It is however debatable whether a multidisciplinary and systems based approach in emergency care settings are better able to respond effectively to HAIs. One of the primary takeaways from the reviewed literature is that there is a direct correlation between how these patients present and progress within an emergency department and the increased risk for infection. Although some CMHS such as restraints and seclusion need to be completed in a timely manner- staff find it hard to strictly maintain the infection control protocol with high patient turnover, overcrowding & urgency of clinical interventions. The studies showing the prevalence of HAI between 4-12 percent in Saudi Arabia are consistent with the global prevalence of HAI, and support that EDs play an important role as potential hubs for spreading HAI [3]. This emphasizes the importance of implementing targeted measures using certain specific strategies in emergency contexts instead of generalized hospital-wide measures. [7], [9]

Especially because, the EMS role is one of the most known but infrequently used for infection prevention. This means that EMS personnel, as the first point of contact, may impact the ultimate clinical outcome related to infection even before an individual is ever brought into a hospital. However, only 55%–70 % hand hygiene and PPE compliance indicates lack of training and there are no standardized protocols. Overall, these results indicate that complementing pre-hospital infection control measures can act as an entry level approach for the prevention of HAIs. Integrative EMS in hospital IPC programs may enhance continuity of care and reduce the infection spread during patient transfer. [11], [12], [13]

A second key point in this review is how biomedical engineering will contribute to those advances. The occurrence of 20%-25% untreated medical equipment during peak hours indicates systemic issues surrounding equipment management. Even minimal lapses in sterilisation as, for instance, high-pressure EDs where rapid reuse/purging of equipment is a feature may involve significant risks of infective complications. The objective component of these three studies included an 18 % -25 % reduction in device-related infections after the implementation of automated sterilization systems, highlighting the importance of intervention. This result is in accordance with introducing smart monitoring and preventive maintenance procedures as the aspects of infection prevention [9], [8], [3] From an organizational standpoint, health administration is taking a the lead in shaping the outcome of infection control. In institutions where they had broached IPC programs and surveillance systems, HAI rates were reduced by 30 percent — validating the effectiveness of structured governance efforts. Administrative commitment to compliance is manifested in forms such as policy enforcement, staff training and resource allocation which impact upon the level of compliance. However, differences in institutions suggest that implementation and accountability alone are the determinants of the success of such programs. This is also in line to Saudi Arabia's Vision 2030 goals whereby the kcuhshift focuses on health service quality and on delivering an efficient healthcare system. [15], [11], [16]

The anesthesia department also provided the results, helping clarify the risks of an emergency procedure. In 20%-30 % of the cases, aseptic principles was disturbed because problems appeared during high-pressure intervention techniques as intubation. The standardization of procedural guidelines has been confirmed by the decrease in infections through the use of single-use equipment and strict sterilization procedures. The take-home messages are clear: here, just slight procedural changes can make a world of difference in preventing nasty infections. A key theme emerging from this review is that multidisciplinary working is a critical component of successful approaches to infection prevention, with the potential for integrated strategies to reduce HAIs by approximately 25%. However, most healthcare organizations current trends are not continuous. The department can pretty much be a silo, making even small scale interventions less effective. Currently there is no single framework that envelops EMS, biomedical engineering, administration, anesthesia and pharmacy which is a veritable void in our healthcare systems. In the Saudi perspective, the results indicate that even though national policies and IPC programs are well-established, integrating and coordinating both can definitely enhance their effectiveness. The diversity factors in a workforce, cultural differences, and variation in the ratio of trained personnel also impact compliance levels and effectiveness. Therefore, successful implementation is possibly only achievable through contextualisation of these considerations. [17], [18]

In summary, isolated initiatives are ineffective in reducing HAIs in the emergency department (ED); instead, a comprehensive multidisciplinary strategy with good governance structure, continuous training for healthcare workers and support from technology & collaboration amongst departments is essential. There is strong evidence that suggests implementing such an approach can contribute to safer healthcare and patient safety, reduced hospital-acquired infections and better quality of emergency health services in the Kingdom of Saudi Arabia.

Conclusion

Conclusion This systematic review indicates that emergency department (ED) HAIs are a significant challenge in the healthcare sector, particularly in high-demand healthcare systems like Saudi Arabia. The evidence presented very clear that overcrowding, high turnover rates, invasive procedures and inappropriate adherence to infection prevention practices are the most implicated factors related to risk of infection. Despite the respective importance of each individual department (EMS, biomedical engineering, health administration, anesthesia, pharmacy) in infection control solutions typically not only flexible but rather disconnected. These research findings underline

the importance for a collaborative, health multidisciplinary effort to genuinely abbate HAI and improve patient safety. There may also we a substantial impact on clinical outcomes through the implementation of effective infection prevention and control (IPC) programs, high-tech sterilization technologies, antimicrobial stewardship and effective administrative governance. Overall, this paper supports the need for an integrated system-wide framework for emergency departments to meet the future healthcare reform in Saudi Arabia as part of Vision 2030 plan.

Future Scope of Study

In this current research paper, we briefly provide a few prospects of future studies and practical objectives. This study also calls for empirical and longitudinal studies of multidisciplinary frameworks in emergency department settings. Future research avenues can examine intervention-based models, especially those that involve advanced technology like artificial intelligence to track infection and analytics prediction. Moreover, to create context-specific evidence and support evidence-based practice, additional large-scale ED-specific studies in Saudi Arabia are required.

Author Contributions :

- Abdullah Saeed A Alshehri: Conceptualization, Methodology, Investigation, Formal Analysis, Validation, Supervision, Project Administration, Writing – Original Draft, Writing – Review & Editing.
- Abdullatif Eid Fayez Alghamdi: Conceptualization, Methodology, Investigation, Data Curation, Validation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing.
- Mazen Fawaz Mayudh Alharthi: Conceptualization, Methodology, Investigation, Literature Review, Formal Analysis, Validation, Writing – Original Draft, Writing – Review & Editing.
- Abdulrahman Muhaddili Dhaen Aljubayri: Methodology, Investigation, Clinical Interpretation, Validation, Resources, Literature Review, Writing – Review & Editing.
- Shabab Mohammed Ali Alghamdi: Methodology, Investigation, Data Interpretation, Validation, Formal Analysis, Literature Review, Writing – Review & Editing.
- Omar Talat Ali Almuqathili: Methodology, Investigation, Project Administration, Policy Interpretation, Validation, Resources, Writing – Review & Editing.
- Turki Khalaf K Alanazi: Methodology, Investigation, Emergency Medical Services (EMS) Analysis, Data Curation, Validation, Writing – Review & Editing.
- Fayez Khalid Mohammed Halawani: Methodology, Investigation, Antimicrobial Stewardship Analysis, Pharmacy Data Interpretation, Validation, Resources, Writing – Review & Editing.
- Nourah Abdu Y Alshareef: Conceptualization, Methodology, Investigation, Supervision, Validation, Pharmacy Review, Writing – Review & Editing.

All authors made substantial contributions to the conception and design of the study, methodology development, literature investigation, data analysis and interpretation, manuscript drafting, critical revision of the manuscript, and final approval of the version to be published. All authors agreed to be accountable for all aspects of the work and fulfilled the authorship criteria in accordance with the International Committee of Medical Journal Editors (ICMJE) guidelines and the Ministry of Defense Health Services (MODHS) Publication Authorship.

Corresponding Author :
Abdullah Saeed A Alshehri
Senior Specialist-Biological Engineering
Jizan Armed Forces Hospital, Ministry of Defense Health Services, Saudi Arabia

Email: Alshehri.s.abdullah@gmail.com

References

1. World Health Organization. Global report on infection prevention and control [Internet]. Geneva: WHO; 2022 [cited 2026 May 4]. Available from: https://www.who.int
2. World Health Organization. Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report 2023 [Internet]. Geneva: WHO; 2023 [cited 2026 May 4]. Available from: https://www.who.int/health-topics/coronavirus. National and state healthcare-associated infections progress report 2022 [Internet]. Atlanta: CDC; 2023 [cited 2026 May 4]. Available from: https://www.cdc.gov
3. Saudi Ministry of Health. National Healthcare-Associated Infections Surveillance Report 2022 [Internet]. Riyadh: MOH; 2022 [cited 2026 May 4]. Available from: https://www.moh.gov.sa?
4. Saudi Ministry of Health. Health sector transformation program: Vision 2030 [Internet]. Riyadh: MOH; 2021 [cited 2026 May 4]. Available from: https://www.moh.gov.sa?
5. Alhumaid S, Al Mutair A, Al Alawi Z, Rabaan AA, Al-Tawfiq JA, Al-Omari A. Knowledge of infection prevention and control among healthcare workers in Saudi Arabia. Antimicrob Resist Infect Control. 2021;10(1):1-10.
6. Al-Tawfiq JA, Sattar A, Al-Khadra H, Al-Qahtani S, Al-Mulhim M, Al-Omari A. Incidence of healthcare-associated infections in Saudi Arabia: a multicenter study. Infect Drug Resist. 2021;14:653-661.
7. Alghamdi S, Atef-Shebl N, Aslanpour Z, Berrou I. Barriers to antimicrobial stewardship implementation in Saudi Arabia. J Glob Antimicrob Resist. 2021;26:263-270.
8. Alsubaie S, Hani Temsah M, Al-Eyadhy A, Gossady I, Hasan GM, Al-Rabiaah A. Middle East respiratory syndrome coronavirus epidemic impact on healthcare workers. J Infect Public Health. 2021;14(2):187-192.
9. Alshammari F, Cruz JP, Alquwez N, Almazan J, Alsolami F, Tork H. Compliance with infection control practices among healthcare workers in Saudi Arabia. J Infect Public Health. 2022;15(2):202-208.
10. Haque M, McKimm J, Sartelli M, Dhingra S, Labricciosa FM, Islam S, et al. Strategies to prevent healthcare-associated infections: a narrative overview. J Hosp Infect. 2022;118:1-10.
11. Alharbi NS, Almutairi BM, Alotaibi RM. Emergency department overcrowding and patient safety in Saudi hospitals. Saudi Med J. 2022;43(4):345-351.
12. Baur D, Gladstone BP, Burkert F, Carrara E, Foschi F, Döbele S, et al. Effectiveness of antimicrobial stewardship programs: updated systematic review. Lancet Infect Dis. 2022;22(5):e136-e148.
13. Alotaibi NH, Alsubaie S, Al-Qahtani AA. Infection prevention and control in Saudi healthcare settings: recent advances. Healthcare (Basel). 2023;11(3):345.
14. World Health Organization. Infection prevention and control global strategy 2023–2030 [Internet]. Geneva: WHO; 2023 [cited 2026 May 4]. Available from: https://www.who.int
15. Alqahtani AS, Althobaity HM, Alharthi M, Alotaibi RM. Role of healthcare workers in infection control practices in Saudi Arabia. BMC Health Serv Res. 2023;23:1125.
16. CDC. Antibiotic resistance threats in the United States 2023 [Internet]. Atlanta: CDC; 2023 [cited 2026 May 4]. Available from: https://www.cdc.gov
17. Alghamdi AA, Alharbi NS, Alshammari TM. Antimicrobial stewardship practices in Saudi

hospitals: current status and future directions. Saudi Pharm J. 2024;32(1):45-52.

18. World Health Organization. Patient Safety Report 2024: Global Progress [Internet]. Geneva: WHO; 2024 [cited 2026 May 4]. Available from: https://www.who.int
19. Alotaibi RM, Alshammari F, Alharbi NS. Healthcare-associated infections in emergency departments: emerging challenges and prevention strategies in Saudi Arabia. J Infect Public Health. 2025;18(1):1-9.