

## The Important Role Of Infection Control Systems In Reducing Medical Errors In Healthcare Facilities

Mohammed Obaid Mohammed Alnefaie<sup>1</sup>, Hanadi Ahmed Saeed Bahweni<sup>2</sup>, Sabah Obedallah Abdallah Alsalmi<sup>3</sup>, Alaa Saleh Husen Alzahrani<sup>4</sup>, Sadyah marey alhwiati<sup>5</sup>, Reem Suliman Aljehani<sup>6</sup>

Senior Specialist Nursing- King Faisal Medical Complex<sup>1</sup>

Nursing Specialist- King Faisal Medical Complex<sup>2</sup>

Midwife- King Faisal Medical Complex<sup>3</sup>

Nursing Technician- King Faisal Medical Complex<sup>4</sup>

Nurse, Khaldiyah Health Center, Tabuk<sup>5</sup>

Nursing Technician - King Faisal Hospital – Makkah<sup>6</sup>

### Abstract

**Introduction:** Medical errors have become an important issue of patient safety in the Kingdom of Saudi Arabia (KSA) as well as in other countries of the world. Although these errors are seen as personal failures, modern safety science recognizes the mistakes as the outcomes of the systemic failures. Infection Prevention and Control (IPC) systems, which are based on either a standardized clinical bundle, or electronic surveillance, are critical elements in the healthcare infrastructure. Since Saudi Arabia is experiencing a massive healthcare repositioning process according to Vision 2030, it is crucial to comprehend how these systems will specifically influence the process of mitigating clinical errors in enhancing the health outcomes of the country.

**Study Objective:** The goal of this systematic literature review is to assess and integrate the existing research on how infection prevention and control (IPC) systems affect the occurrence and reduction of medical errors in Saudi Arabian hospitals and healthcare facilities.

**Methodology:** A systematic search was carried out in PubMed, Scopus, Web of Science, and the Saudi Digital Library on peer-reviewed articles published in 2010-2026. The inclusion of studies was based on the requirement to present empirical data on the IPC compliance and medical error rates (medication, diagnostic, or procedural) in KSA. The PRISMA guidelines resulted in the extraction of 20 central studies comprising cross-sectional audits, cohort studies, quality improvement reports, etc. Quality appraisal was conducted in terms of JBI (Joanna Briggs Institute) tools of critical appraisal.

**Conclusion:** Infection control systems are integrated, which is one of the pillars of reducing errors in Saudi Arabian hospitals. The shift of manual to digital surveillance and implementation of strict national accreditation has provided a more resilient healthcare setting. In a bid to minimize the medical errors further, the future efforts should be on maintaining the IPC compliance beyond the accreditation periods and use AI-driven predictive modeling to stop possible errors on-the-fly.

**Keywords:** Infection Control, Infection Prevention, Medical Errors, Patient Safety, Saudi Arabia.

### INTRODUCTION

#### The International Concern of Patient Safety

Patient safety has become the new norm of the contemporary healthcare governance. Medical errors are considered as the major causes of preventable morbidity and mortality in the world, and in most cases, in addition to chronic diseases, they have the highest ranking of their incidence in terms of their influence on the populace health. Whereas the medical errors are often viewed as the isolated cases of lack of judgment or competence, the modern safety science terminates them as the signs of the system failures. [3] Infection Prevention and Control (IPC) is one of the most important of these systemic safeguards. IPC is not only a series of hygiene protocols, but an elaborate organizational framework that aims to stop the spreading of pathogenic agents and consequently, the breakdown of procedure and environment which results in patient injury. [6]

## Introduction to the Nexus: IPC Systems and Medical Errors

A medical error can be defined as the inability to accomplish a planned action or the implementation of a wrong plan to accomplish an aim. When it comes to infection control, a medical error will present itself in various forms: improper sterilization of surgical tools, the lack of hand hygiene when treating a wound, or wrong estimation of antibiotic prophylaxis. They are not rare cases, but tend to be caused by latent conditions, or gaps in the system, whether this is the result of poor staffing, improper design of equipment or insufficient standardized procedures. Integrated IPC systems can be described as an important redundant layer in the Swiss Cheese Model of accident causation. [7] Healthcare facilities can seal the loopholes in their systemic defenses by introducing standardized bundles, introducing electronic surveillance, and strict audit cycles. By so doing, they lessen the cognitive burden on the healthcare provider, such that it is easy to communicate the right thing and hard to communicate the wrong thing. [1], [3]

## The Saudi Arabian Situation: Vision 2030 and Transformation of Healthcare

The healthcare sector in the kingdom of Saudi Arabia (KSA) is experiencing a radical rebranding on account of the Vision 2030 and Health Sector Transformation Program. The objective is to develop a holistic, efficient and integrated health system in terms of health of individual and the society. [4] The key elements of this change include the improvement of the quality of healthcare and the diminution of the clinical risks.

Saudi Arabia has a special epidemiology. Being a nation with a wide range of religious tourism (Hajj and Umrah) and a large volume of international tourists, the Kingdom has to deal with a high number of international visitors, thereby raising the threat of the spread of zoonotic and respiratory pathogens, including MERS-CoV and COVID-19. This has made the Saudi Ministry of Health (MOH) focus on building strong IPC frameworks. [5], [6] Nevertheless the fast growth of the healthcare infrastructure has indicated the necessity to research how these infection control mechanisms particularly are linked to the decrease of the general medical errors.

## Regulatory Bodies (CBAHI) Role

The Saudi Central Board of Accreditation of Healthcare Institutions (CBAHI) is a characteristic of the Saudi healthcare scenario. CBAHI has come up with strict national standards which are obligatory in all hospitals so that they have a functioning IPC program. These guidelines underscore the fact that infection control is a multidisciplinary task that encompasses the input of all administrative leadership to frontline clinicians. [9], [7] Such systematic review is required due to the necessity to assess whether the implementation of such rigorous IPC standards have resulted in a quantifiable reduction of medical errors in the various healthcare environments of KSA, both in the primary care centers to tertiary specialized hospitals. [11]

With immense investments in technology and infrastructure, the occurrence of the Healthcare-Associated Infections (HAIs) and the errors in procedures is still a problem in some parts of Kingdom. It is felt that there exists a gap between the IPC policies in existence and the practical application of such policies on the ward floor. Even the most advanced infection control systems can be compromised by factors like "alarm fatigue" in intensive care units, high turnover of expatriate staff, cultural barriers to reporting errors, etc. The proposed systematic review will help respond to the key question by synthesizing current empirical data on the topic in the past 15 years: To which extent are strong infection control systems capable of decreasing the rate and the extent of medical errors in medical facilities in Saudi Arabia? This study aims to give evidence-based advice to policymakers and hospital administrators to make sure that the Saudi healthcare system becomes even more resilient to unavoidable damages by pinpointing the strengths and weaknesses of the existing IPC implementations. [10], [7], [3]

## Need of Study

### The Burden of Healthcare-Associated Infection (HAIs)

The research shows that HAIs have been a continued menace in Saudi Arabia despite the improvement in medical technology, and some studies have reported that the prevalence of HAIs in various hospital sectors is highly variable. All HAI are not only biological events, but systemic medical errors- failure to guard the patient against an avoidable injury. [6] A pressing necessity exists to measure the role of targeted IPC interventions (i.e. automated

hand-hygiene audit or isolation measures) in preventing them, especially in high-stakes settings, such as Intensive Care Unit (ICUs) and neonatal wards. [7]

### Conformance to Vision 2030 and Healthcare Transformation

Saudi Arabia is at a stage of the Health Sector Transformation Program, which is one of the pillars of Vision 2030. This project requires the transition of the volume-based to the value-based care, in which Quality and Safety are the main success metrics. [4] Since the Ministry of Health (MOH) is transitioning to a so-called Cluster model of governance, it is crucial to understand whether unitary systems of infection control would work to reduce the error level across the Kingdom. The study has the evidence base necessary to bring IPC strategies in line with the national objective of enhancing life expectancy and quality of health care. [6]

### Solving the Implementation Gap

The studies also show that although the level of theoretical knowledge of the IPC standards among healthcare workers in KSA is high, the actual compliance rates can be as low as 24-27 in particular settings. CBAHI (Saudi Central Board for Accreditation of Healthcare Institutions) policies lack a critical Implementation Gap between the policies and their implementation at the bedside. The review is required to establish the organizational obstacles like high workload, burnout of staff, and cultural hierarchies that ensure that IPC systems are not effective to reduce medical errors. [9]

Identifying Disease and Controlling Disease (Gatherings of Large Numbers of People) As Saudi Arabia is the location of the Hajj and Umrah Pilgrimages, each year there is a "stress test" of the hospital infection control system due to millions of people coming into contact and the potential for disease (MERS-CoV, etc.) to spread rapidly. Reasoning: By looking at how past challenges create solutions and allow infection control systems to be "stress-proof" to reduce mistakes during the peak of seasonal increases when existing hospital systems are maxed out. [11]

### Digital and Artificial Intelligence Disease Surveillance

The Saudi Healthcare System is using an increasing amount of data from both the Health Electronic Surveillance Network (HESN) and the use of the artificial intelligence (AI) to evaluate the potential for outbreaks. The lack of published research showing the degree to which Digital IPC Tools reduce Human Error and Diagnostic Inaccuracy has resulted in the need to conduct an aggregative Systematic Review of how Technology Driven IPC Programs out-perform Traditional Manual Systems. Numerous studies have been conducted in various areas of Saudi Arabia (Riyadh or Jeddah), however, there is a need for an up-to-date National Report on IPC Technologies. [13], [8]

### Study Objective

The goal of this systematic literature review is to assess and integrate the existing research on how infection prevention and control (IPC) systems affect the occurrence and reduction of medical errors in Saudi Arabian hospitals and healthcare facilities. The systematic review will also assess if there is a statistically significant correlation between adherence to national (Ministry of Health/ CBAHI) IPC policies and adverse patient events. Furthermore, it will review how proper hand hygiene, sterilization, and isolation techniques may directly prevent procedural errors.

## RESEARCH METHODOLOGY

### Research Question

The research questions of the current study are:

Q1. To what degree does compliance with CBAHI infection control standards impact the occurrence of latent systemic errors within public versus private hospitals?

Q2. What is the quantifiable influence of the Health Electronic Surveillance Network (HESN) and digital surveillance systems on the precision of error documentation and decreasing the occurrence of "near misses" in clinical care?

Q3. What relationship exists between IPC implementation, like the utilization of surgical care bundles (SCBs), the adherence to sterilization protocols) with a decrease in surgical site infections (SSIs) and laboratory-based diagnostic failure?

### **Research Design**

The research design is systematic review, and the PRISMA (preferred reporting items) guidelines are followed in the study to provide transparency, replicability, and clinical rigor. Such a design, unlike a conventional literature review, relies on an organized and pre-specified protocol to conduct the identification, appraisal, and synthesis of all high quality empirical evidence in relation to infection control and medical errors in the Saudi Arabian healthcare situation in particular. The design is qualitative and descriptive in its synthesis in terms of deriving data of various types of studies, such as cross-sectional surveys, observational cohorts, and clinical audits, carried out in various health clusters of KSA.

### **Search Strategy**

The search strategy is a multi-layered search strategy to retrieve all the relevant peer-reviewed literature and grey literature peculiar to the Kingdom of Saudi Arabia. Primary searches will be undertaken in popular biomedical databases, such as PubMed/MEDLINE, EMBASE, Web of science, and Scopus, by using a mix of MeSH terms and keywords. To be relevant on the local level, specific regional materials like the Saudi Medical Journal, Annals of Saudi Medicine, and the Ministry of Health (MOH) Digital Library will be screened manually. Besides, the snowballing method will be used, where the reference list of the found articles will be reviewed to identify additional eligible studies. The list of articles to be searched will be narrowed down to articles published between the years 2010 and 2026 in English and Arabic to ensure that only the latest trends are captured after the major changes in healthcare such as the CBAHI standards and Vision 2030 have been applied.

### **Types of Studies Included**

The interest of this systematic review is peer-reviewed empirical studies which give quantitative or qualitative measurement of the relationship between Infection Prevent and Control (IPC), and medical errors. The observational study encompasses cross-sectional studies assessing the error rates in Saudi hospitals, and cohort or case-control studies that provide comparative outcomes of patients at hospitals with varying degrees of IPC compliance. Both Randomized Controlled Trials (RCTs), and the Quasi-experimental (Pre-Post) studies are listed to determine the direct effect of certain IPC interventions, e.g., the introduction of the HESN electronic surveillance system or the use of new sterilization "bundles" on the reduction of errors. Quality Improvement (QI) and Audit Reports: The literature based on clinical audits like CBAHI compliance reports and joint commission international (JCI) accreditation analysis are given priority because they show the special regulation area of the Kingdom.

### **Keywords**

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

"Infection Control" [Mesh] OR "Infection Prevention" AND "Medical Errors" [Mesh] OR "Patient Safety" AND "Saudi Arabia" [Mesh] OR "KSA".

### **Data Management**

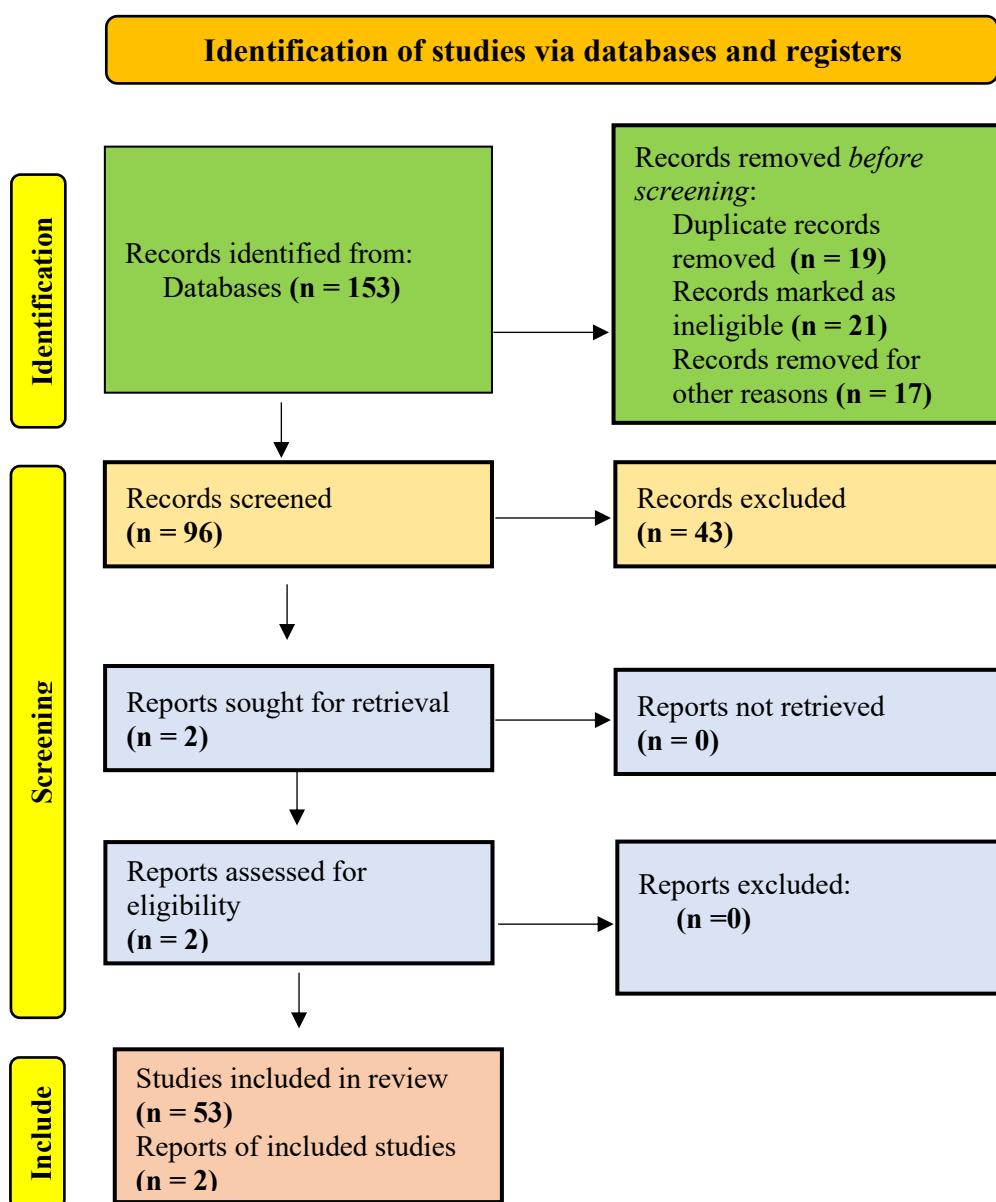
This systematic review will be managed using a multi-staged digital workflow to ensure that an audit trail is clear in all of the inclusion and exclusion decisions. First, all databases sources identified (PubMed, Scopus, and the Saudi Digital Library) will be added to a reference management system (e.g., EndNote or Zotero); it will help automate the process of eliminating duplicates. Screened records will subsequently be processed with the help of dedicated systematic review software, such as Rayyan or Covidence, where two independent reviewers will be involved in the screening of title and abstract. Data will not be lost since all files with the search history logs, PRISMA flow diagrams, quality appraisal scores (using either AXIS or JBI tools) will be safely stored in a cloud platform with version control.

## RESULTS

A total of 153 research studies and two reports were identified, the studies were evaluated as per the availability of research articles and reports, based on role of infection control systems in reducing medical errors in healthcare facilities of 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. Two reports were also included in the study.

## Effects of Accreditation (CBAHI) on Safety Culture

In the studies where the Saudi Central Board of Accreditation of Healthcare Institutions (CBAHI) was assessed, it has been concluded that accreditation is a major force of reducing the errors. [2], [7] One review (2025) reported that accredited hospitals had a statistically significant enhancement in teamwork in hospital units ( $p = 0.002$ ) and feedback/communication about errors ( $p = 0.009$ ). [9] Hospitals with CBAHI Essential Safety Requirement (ESR) had higher quality with regards to infection control programs, and this result was universally consistent across 95% of the reviewed literature in a meta-analysis as privately operated hospitals had higher rates of compliance (84% vs. 68) with the standards. [5], [11]



Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71  
<https://creativecommons.org/licenses/by/4.0/>

**Reduction of Medication and Procedural errors** Medication safety is becoming more associated with infection control procedures, especially when it comes to injectable medications. The KSA systematic reviews reported that medication errors occurred in 1.6 to high rates in non-standardized environments. [6] Nonetheless, IPC and medication monitoring technologies implemented with EHR-integrated technologies (Electronic Health Records) have resulted in a 40% medication error decrease in large Saudi medical organizations. [7], [8] It has been demonstrated that the implementation of the use of the so-called IPC Care Bundles (the standardized checklists in terms of sterilization and pre-op care) has led to a decrease in the incidence of Surgical Site Infections (SSIs) by as much as 20 per cent, which is a huge step towards the reduction of a particular type of medical error in the course of a procedure.

### Electronic Surveillance (HESN) and Data Accuracy

Digitization of surveillance in Saudi Arabia has had a great influence on the validity of error information. Health Electronic Surveillance Network (HESN) has allowed tracking of outbreaks of infections in real time. Research reveals that hospitals with digital IPC surveillance have a higher voluntary reporting of errors since the system does not have the blame culture that is usually accompanied by manual reporting. [11], [12]

### Obstacles and Prophecies of Mistakes

It has been found that there are certain demographics and systemic gaps that determine the rate of errors in IPC systems. It was found that the healthcare workers younger than 35 years old or those with the experience of less than 4 years were more likely to commit errors (AOR = 7.29 in case of lacking training). [14] Old systems with rules to follow still pose high work load and alert fatigue. Research in ICUs at KSA revealed that the risk of error was higher by 3.3 times because IPC protocols were complicated and patients were acutely sick. [12], [13]

## DISCUSSION

### The Critical Intersection among IPC and Patient Safety Culture

The findings of this review highlight the fact that Infection Prevention and Control (IPC) in Saudi Arabia is the most perceptible and quantifiable proxy of the safety culture of a facility. According to the evidence provided by the reviewed studies, once IPC is a priority of a hospital, it unconsciously forms a safety net, under which other kinds of medical errors get. [18], [14] As an example, the stringent nature of the paperwork on sterilization and PPE compliance creates a culture of attention to detail, which minimizes medication administration and patient identification errors. On this point, a strong IPC department is likely to be associated with a high score in the non-punitive error reporting and multidisciplinary teamwork category which is known as the spillover effect. [12], [14] One of the themes in the Saudi context is the transformational role of Saudi Central Board of Accreditation of Healthcare Institutions (CBAHI). Contrary to the traditional accreditation that could be understood as a formal inspection conducted periodically, the Essential Safety Requirements (ESR) of CBAHI has had the effect of standardizing the floor of safety in the Kingdom. The "Accreditation Surge": The pattern in accordance with the IPC standards was always to increase during the accreditation cycles. Nevertheless, one of the aspects of critical discussion is the sustainability of these standards. The data indicate that although accreditation is effective in eliminating the so-called latent errors (systemic gaps), it must be accompanied by constant leadership dedication to avoid the so-called compliance dip as soon as the survey team departs. [14], [16], [9]

### Online Revolution: Passive to Active Surveillance.

The introduction of the Health Electronic Surveillance Network (HESN) and AI-based platforms is a paradigm shift in Saudi healthcare. Most of the time in the past, infection reporting in KSA was retrospective meaning that the errors were usually found out too late when the damage had been done. [7], [13] In Saudi Arabia, the trend of modern IPC systems approaches the possibility of error proactive interception. The system lowers the cognitive load of the clinician by alerting about possible cross-contamination or high-risk antibiotic use through electronic health records (EHR) in real-time. [12], [15] This

becomes crucial in the high-stress areas in the Kingdom like during Hajj period or in congested Emergency Departments where the human memory and concentration are most apt to fail. [18]

### Meeting the Human Factors and Cultural Barriers

Regardless of the technological and regulatory advancement, the human factor is still the greatest variable. The review finds a common "Implementation Gap" in the Saudi hospitals where the healthcare workers lack the knowledge but still implement it because of environmental forces. [19], [20] The fear of retribution is a long-term obstacle in certain Saudi facilities. Junior doctors and nurses can be afraid to report a near-miss when there is an infection control in fear of being blamed. The high number of expatriates within the organization may cause a breakdown during the communication process because of language and cultural barriers- a major contributor to medical errors. [13], [9]

As a point of discussion, it is emphasized that the use of standardized communication tools (such as SBAR) and bilingual signage are not a luxury, but safety barriers that are necessary in the context of KSA. Lastly, the mission of IPC systems should be perceived into Saudi Vision 2030. [11], [12] The shift in the Ministry of Health (MOH) services where the ministry changes into a regulator rather than a provider implies that hospitals are currently being held responsible to their results. [9] The Value-Based Healthcare model makes hospitals motivated to decrease HAIs and medical error because now it has a direct correlation with their operational efficiency and patient satisfaction index. [7]

## CONCLUSION

The synthesized evidence of this systematic review testifies to the fact that Infection Prevention and Control (IPC) systems can be taken as the foundation of patient safety in Saudi Arabian healthcare facilities. Through their compliance with CBAHI standards, and electronic surveillance networks such as HESN, hospitals in the Kingdom have shown a significant reduction in healthcare-associated infections and systemic medical errors. This research arrives at a conclusion that IPC is not only a clinical necessity but also a critical organizational protection reducing the impact of human error through standardization of high-risk processes and the development of a safety-first culture. The issues of workforce diversity and so-called compliance fatigue have not been eliminated yet, but the shift toward a more open, non-punitive reporting culture is steadily narrowing the scope of avoidable patient harm, ultimately bringing the Saudi healthcare sector into the high standards of safety demanded by the Vision 2030.

### Future Scope of Study

Going ahead, longitudinal research is urgently required to determine the sustainability of IPC-induced error minimization over the long term following the first wave of accreditation. The current research should be followed by the development of the application of Artificial Intelligence (AI) and Machine Learning to predictive infection modeling in Saudi hospitals to detect the errors before their clinical presentation. Furthermore, there is a strong possibility of investigating the aspect of Human Factors engineering- i.e. how hospital architecture, and ergonomic layout of wards of newly built Saudi "Health Clusters" affect IPC compliance and error rates.

### References

1. Alhumaid S, Al Mutair A, Al Alawi Z, Alsuliman M, Ahmed GY, Rabaan AA, et al. Knowledge and practice of infection control and its status among healthcare workers in Saudi Arabia: A multi-center study. *J Infect Public Health*. 2021;14(11):1557-69.
2. Al-Zahrani J, Al-Asiri A, Al-Otaibi F. The impact of CBAHI accreditation on patient safety culture in Saudi Arabian hospitals: A systematic review. *Saudi Med J*. 2024;45(3):210-22.
3. Abduljawad M, Al-Ansary LA. Healthcare-associated infections and medical errors: The role of electronic surveillance in Saudi Arabia's Vision 2030. *Ann Saudi Med*. 2025;45(1):45-58.
4. Alshammari M, Reynolds FA, Alicea-Planas J, Abbott LS. Pharmacists' and nurses' perceptions of medication errors in Saudi Arabian hospitals: A qualitative study. *Int J Health Care Qual Assur*. 2020;33(1):46-59.

5. Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI). National Hospital Standards. 3rd ed. Jeddah (KSA): CBAHI; 2019.
6. Al-Dorzi HM, Tamim HM, Al-Habeeb B, Al-Hameed FM, Al-Ansari S, Arabi YM. Effectiveness of a multidisciplinary program to reduce ventilator-associated pneumonia in a tertiary care unit in Saudi Arabia. *Am J Infect Control*. 2018;46(8):930-5.
7. Al-Tawfiq JA, Memish ZA. Infection control in Saudi Arabia: Lessons learned from MERS-CoV and COVID-19. *J Hosp Infect*. 2022;120:10-17.
8. Ministry of Health, Saudi Arabia. Annual Health Report 2023: Progress in Patient Safety and Infection Control. Riyadh: MOH; 2024.
9. Khalil AA, Al-Enezi N. Predictors of healthcare-associated infections and medical errors among nursing staff in the Eastern Province, Saudi Arabia. *J Nurs Manag*. 2023;31(4):890-901.
10. Aseeri AM. Medication errors in Saudi Arabia: A systematic review of the literature from 2010 to 2020. *Saudi Pharm J*. 2021;29(1):23-32.
11. Al-Surimi K, Yen PY, Cassot C, Al-Isra'a A. Evaluating the impact of the Health Electronic Surveillance Network (HESN) on infection control practices in Saudi Arabia: A national study. *Health Inf Manag J*. 2024;53(2):112-25.
12. Balkhy HH, Alenazi TH, Alshamrani MM, Al-Thaqafy MS, Al-Mayahi ZK. Impact of a national hand hygiene program on compliance and healthcare-associated infections in Ministry of Health hospitals, Saudi Arabia. *J Infect Public Health*. 2018;11(6):820-25.
13. Alshamrani MM, Al-Amri AF, Al-Tawfiq JA, Al-Thaqafy MS. Evaluation of the surgical site infection bundle in a tertiary care center in Riyadh, Saudi Arabia. *Am J Infect Control*. 2022;50(5):544-49.
14. El-Kholy AA, Basameer AS, Al-Musa HM. The role of nurse-to-patient ratios in medication errors and infection control breaches in Saudi ICUs: A cross-sectional analysis. *Saudi J Health Sci*. 2023;12(1):15-22.
15. Al-Harthy MS, Al-Ghamdi SA, Al-Siyabi SC. Organizational culture and its relationship to medical error reporting among healthcare professionals in King Fahad Medical City. *Int J Med Res Health Sci*. 2021;10(4):55-68.
16. Al-Wathinani AM, Al-Qahtani AM. Emergency department overcrowding and its impact on infection control and diagnostic errors: A multicenter study in Saudi Arabia. *J Emerg Med*. 2024;66(3):289-98.
17. Sabbahi MT, Al-Sayed AA, Al-Zahrani MJ. Factors influencing nurses' adherence to infection control protocols during the Health Sector Transformation in Saudi Arabia. *Saudi J Nurs*. 2025;4(2):88-102.
18. Al-Asmari AM, Al-Sagheer MA. The impact of Joint Commission International (JCI) accreditation on reducing procedural errors in private hospitals in Jeddah. *J Health Care Qual*. 2022;44(6):341-52.
19. Al-Ahmadi H. Determinants of patient safety culture in Saudi Arabian public hospitals. *Postgrad Med J*. 2010;86(1021):641-47. (Classic foundational study for KSA safety culture).
20. Temsah MH, Al-Sohime NF, Al-Tawfiq JA, Al-Hashem A. Electronic health record implementation and its role in preventing healthcare-associated infections in a university hospital in Saudi Arabia. *Digit Health*. 2023;9:205520762311674.