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Challenges and Effect in Implementation of Isolation Precaution Measures in Alnoor Specialist Hospital, Makkah Cluster, Ministry of Health (MOH), Kingdom of Saudi Arabia (KSA)

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Abstract:

Background: Healthcare associated infections endure a main reason for morbidity, mortality and cost globally despite advances in infection prevention and control. Understanding temporal shifts in causative organisms is essential for surveillance, resource allocation and challenges faced by Nurses.

Methods: We conducted a retrospective study to find out challenges faced by nurses and all culture-positive infections from 2022–23 to 2024–25. Organisms were classified by year and clinical service (surgical vs medical). Chi-square tests assessed temporal change in organism distribution and service allocation. Effect sizes were estimated using Cramér's V with 95% CIs.

Findings: A total of 800 nurses were subjected. All domains showed significant imbalance ($p < .001$). Largest burden was limited resources $V = 0.54$ (95% CI ≈ 0.49–0.59) organizational issues $V = 0.49$ (95% CI ≈ 0.44–0.54) and Lowest burden was Patient care limitations $V = 0.16$ (95% CI ≈ 0.10–0.20). A total of 1,930 infections were recorded. Annual infections declined from 829 (2022–23) to 497 (2024–25). The allocation of organisms varied substantially across years (χ^2 (34) =82·69, p<0·001; Cramér's V=0·15, 95% CI≈0·09–0·20). Klebsiella pneumoniae declined most markedly (238→110 cases). The proportion of infections managed in surgical versus medical services did not change significantly (χ^2 (2) =2·60, p=0·27; Cramér's V=0·04, 95% CI≈0·00–0·07). No organism demonstrated a statistically significant shift in service allocation over time.

Interpretation: Structural/system barriers dominate severely (resources, coordination, protocols). Whereas operational barriers dominate moderately (workload, compliance). However, care interaction barriers dominate smaller (patient care limitations). Therefore, the main difficulty is system capacity rather than nurse willingness. Total infections declined substantially over three years while the distribution of causative organisms changed significantly. Proportionally there is a reduction in surgical and medical departments, that is suggestive of system wide drivers rather than unit specific effects. There must be continual surveillance, especially for Klebsiella pneumoniae, MRSA, and Escherichia coli.

Conclusion: This study shows the challenges that nurses face in implementation of isolation precautions measures at Alnoor Specialist Hospital that is affected by clinical, organizational, and psychological factors. By implementing IPC precautions there is a significant decline in total infections and a substantial shift in the distribution of causative organisms over time.

Introduction

In response to the pandemic, healthcare organizations and professionals globally have implemented a range of infection prevention and control measures, including the widespread deployment of Personal Protective Equipment (PPE) [1]. Face masks, gloves, gowns, googles and other PPE serve as a protection between healthcare workers and infection, hence reduce risk of transmission in healthcare settings [2]. Prior to the pandemic, the literature suggests 55% of all HAIs can be prevented through effective infection control methods [3]. The pandemic, however, has brought about substantial changes in the epidemiology of HAIs [4]. Heightened measures for infection prevention and control, including the enhanced use of PPE, by healthcare workers in facilities. The shift in resources may have inadvertently impacted the rates and types of HAIs [5]. Understanding these active changes is crucial for enhancing infection prevention strategies [6]. One of the key measures in prevention and controlling the spread of infection is the implementation of isolation precaution strategies [7]. Isolation precautions are supported in major countries to curb the spread of multi-drug-resistant organisms. It includes Standard, Contact, Droplet and Airborne Precautions. Additional measures include hand hygiene, timely response and visits by Infection Prevention and Control (IPC) physicians to the infected patient on the same day of isolation whenever possible and active screening on admission. Furthermore, hand placement of warning signs for isolation precaution and social distancing, implementation of triage area for the body temperature, restrictions of the inpatient visits, efforts for a hospitalization of patients with respiratory symptoms in isolated rooms [8].

Healthcare-Associated Infections (HAIs) account for millions of preventable illnesses worldwide annually and are associated with prolonged hospitalization, antimicrobial exposure, costs and mortality [9]. Gram-negative organisms including Klebsiella pneumoniae and Acinetobacter baumannii and Gram-positive organisms such as MRSA remain key contributors to HAIs in acute-care settings [10]. Trends in pathogens can shift in response to antimicrobial stewardship policies, infection prevention programs, case-mix changes and diagnostics. Surveillance is therefore critical to guide infection control strategy [11]. We aimed to first examine the challenges in implementing isolation precautions, followed by effectiveness of isolation precautions in controlling the spread of infections in healthcare facility. This paper will evaluate three-year trends in culture-positive infections overall, by organism, and by clinical service (surgical vs medical) in a tertiary-care center. By identifying factors influencing the successful implementation of these measures, the study will contribute to improving infection control practices and patient outcomes. Furthermore, it will assist policymakers in formulating evidence-based guidelines to enhance healthcare safety.

Methodology

Study Design

A mixed-methods approach was employed; we undertook a retrospective review of all culture-positive isolates from inpatients between 2022–23 and 2024–25. Identical isolations from the same patient and organism in an episode were eliminated. This study will involve both quantitative and qualitative data collection to provide a comprehensive understanding of the effect of isolation precaution measures.

1. Quantitative Component: A three year data will be used to compare infection rates before and after the implementation of isolation precaution measures in surgical and medical wards.

2. Qualitative Component: Semi-structured interviews will explore nurses' perceptions, adherence, and challenges related to isolation precaution practices.

Data Collection

1. Infection Rate Data: Infection rates for common hospital-associated infections (e.g., MRSA, C. difficile, VRE) will be collected from hospital records and compared across periods of time (pre- and post-implementation).

2. Healthcare Worker Adherence: Surveys and audits will assess the adherence of healthcare workers to isolation protocols.

3. Interviews: Semi-structured interviews will be conducted with healthcare workers to understand their perspectives on the barriers to and benefits of isolation precautions.

Data Analysis

1. Quantitative Analysis: Statistical methods (chi-square tests) will be used to compare infection rates before and after isolation precautions.

2. Qualitative Analysis: Thematic analysis will be used to analyze interview data and identify common themes and patterns related to the implementation and effectiveness of isolation precautions.

Research Sample

1. Study Population: The study population will consist of patients admitted to Al Noor Specialist Hospital who are at risk of developing healthcare-associated infections (HAIs), particularly those admitted to Surgical & Medical wards. A purposive sampling method will be employed

to ensure inclusion of patients and staff most relevant to the study objectives.

2. Patients: All individuals admitted during the study period who meet inclusion criteria will be enrolled (census-based sampling).

3. HCWs: A stratified random sampling approach will be used to select staff across different shifts and wards for observation of isolation adherence. Patients admitted to Alnoor Specialist Hospital during the study period. Patients who were placed under isolation precautions (Contact, Droplet, or Airborne) due to confirmed or suspected infectious diseases.

Inclusion Criteria

1. Hospitalized Patients: Patients were admitted to Alnoor Specialist Hospital during the study period. Patients who were placed under isolation precautions (Contact, Droplet, or Airborne) due to confirmed or suspected infectious diseases.

2. Healthcare Workers (HCWs): Nurses; directly involved in the care of patients under isolation precautions. Nurses trained in IPC protocols, particularly on isolation measures. Nurses working in inpatient departments, including Medical-Surgical units.

3. Departments: Clinical areas where isolation precaution measures are actively implemented and monitored. Units with documented compliance and infection surveillance data (e.g., Infection Control Department).

Data Records

Medical records and IPC log that document patient infections, isolation practices, and compliance with IPC guidelines during the study period.

Exclusion Criteria

1. Outpatients: Patients treated in outpatient clinics, emergency rooms (without admission), or day-surgery units.

2. Short-Stay Admissions: Patients are admitted for less than 24 hours unless they are isolated from infectious diseases and relevant data are available.

3. Non-clinical Staff: Administrative or support staff are not involved in direct patient care.

4. Departments Without Active Surveillance: Units or wards where isolation precautions are not systematically implemented or infection control data is incomplete or unavailable.

5. Incomplete Records: Cases with missing data related to infection diagnosis, type of isolation precaution applied, or compliance documentation.

Sample Size

The estimated sample size will be determined using infection incidence rates from previous surveillance data. For example, assuming an HAI incidence of 10% with a 95% confidence level and 5% margin of error, the required patient sample size is approximately ~140–150 patients per ward/unit, giving a total of ~1930 patients and 800 nurses over the study period.

Study Period

The study will cover 36 months to capture both routine and peak admission periods (including Hajj/Umrah seasons), ensuring seasonal variations in patient load and isolation practice fidelity are included.

Statistical analysis

Data was written into a spreadsheet and cleaned prior to analysis. Descriptive statistics were used to summarize the yearly number of culture-positive infections by organism, clinical area (surgical vs medical), and study year (2022–23, 2023–24, 2024–25). Categorical variables were matched using the chi-square (χ^2) test of independence. First, a global chi-square test was used to examine whether the overall distribution of organisms differed across the three study years (organism × year contingency table). Second, a chi-square test was used to compare the proportion of infections occurring in surgical versus medical services across years. Third, organism-specific chi-square tests were conducted to assess whether the distribution of surgical versus medical infections for each organism changed over time (year × clinical area tables for each pathogen). For organisms with very small cell counts or zero rows/columns, tests were not performed and results were described descriptively because chi-square assumptions were violated. All tests were two-tailed, and a p-value $< .05$ was considered statistically significant. Statistical analyses were conducted using standard statistical software (e.g., SPSS, R, or equivalent).

Variables

Organisms were grouped at species level. Each case was categorized by study year and by clinical service (surgical vs medical).

Descriptive statistics summarize infection counts. Chi-square (χ^2) tests of independence

examined:

1. Organism × year distribution
2. Service (surgical vs medical) × year distribution
3. Per-organism service distribution across years

Effect size was estimated using Cramér's V,

$$V = \sqrt{\frac{\chi^2}{n(k-1)}}$$

Where k is the smaller dimension of the table and n the total sample. Approximate 95% CIs for Cramér's V were derived using asymptotic variance estimates appropriate for categorical data. Statistical significance was defined as p<0·05 (two-sided).

Results

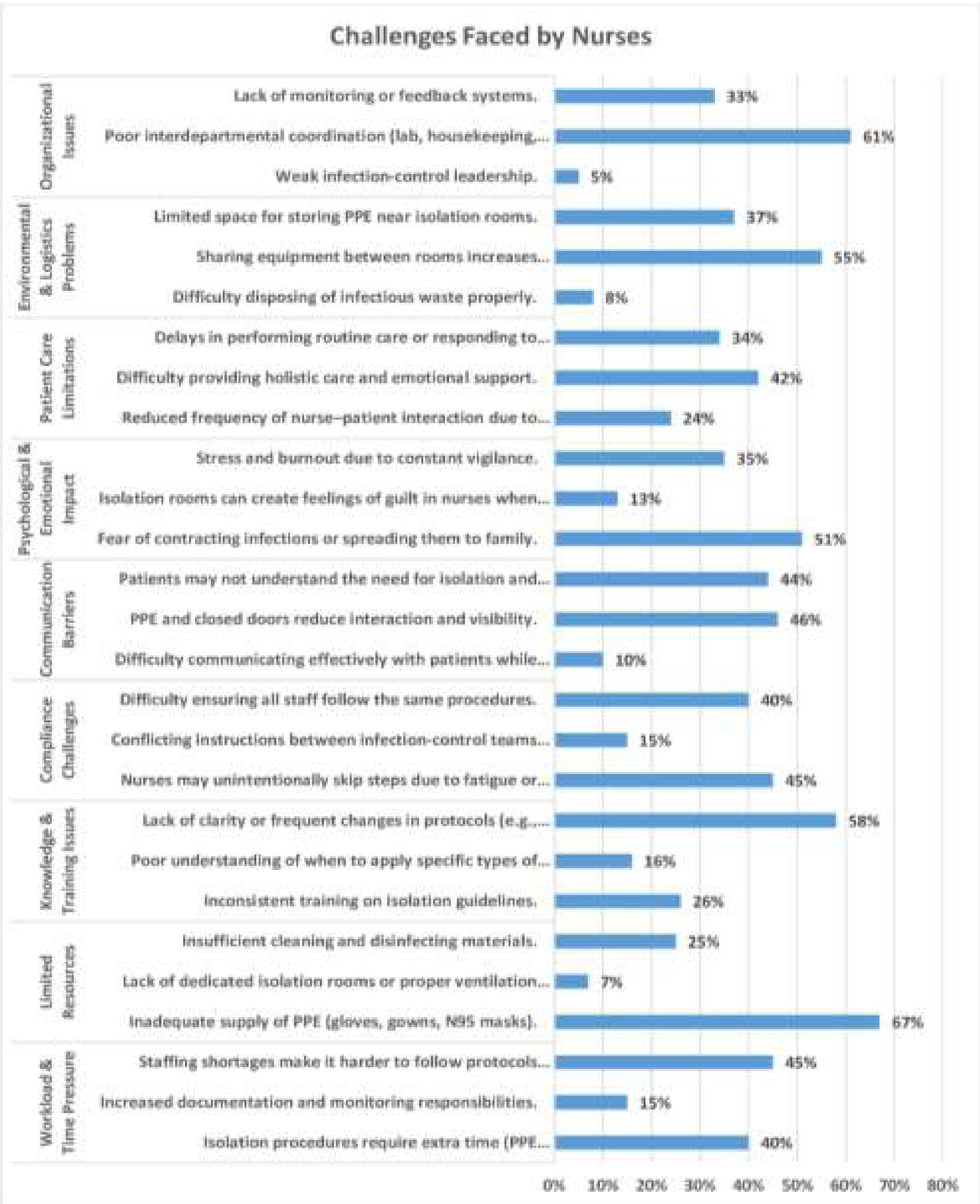

Chart 1

Chart 1: Challenges Faced by Nurses in Implementation of Isolation Precaution Practices.

Table 1: Challenges Faced by Nurses Effect size (Cramér's V).

Domain	χ^2	p	Cramér's V	Interpretation
Limited resources	462.8	<.001	0.54	Large
Organizational issues	384.8	<.001	0.49	Large
Environmental & logistics	269.9	<.001	0.41	Large
Knowledge & training	231.0	<.001	0.38	Moderate-large
Communication barriers	196.5	<.001	0.35	Moderate
Psychological impact	178.2	<.001	0.33	Moderate
Compliance challenges	124.0	<.001	0.28	Moderate
Workload & time pressure	124.0	<.001	0.28	Moderate
Patient care limitations	39.0	<.001	0.16	Small

Table 2: Total Infections by Year and Service.

Year	Surgical	Medical	Total
2022–23	461	368	829
2023–24	317	287	604
2024–25	255	242	497
Total	1,033	897	1,930

Table 3: Organism Specific Infection Counts by Year (Surgical, Medical, Total).

Organism	2022–23 Surgical	2022–23 Medical	2022–23 Total	2023–24 Surgical	2023–24 Medical	2023–24 Total	2024–25 Surgical	2024–25 Medical	2024–25 Total
Klebsiella pneumoniae	110	128	238	67	90	157	38	72	110
MRSA	93	28	121	91	43	134	85	28	113
Escherichia coli	77	43	120	54	54	108	49	45	94
Acinetobacter baumannii	55	62	117	39	39	78	33	42	75
Pseudomonas	33	34	67	16	17	33	16	11	27
	11	27	38	12	16	28	11	22	33
Proteus	17	19	36	9	11	20	5	10	15
Enterobacter	29	6	35	22	8	30	10	6	16
Providencia	9	4	13	1	2	3	0	0	0
Serratia	7	4	11	0	1	1	2	3	5
Morganella	4	4	8	0	0	0	3	0	3
Streptococcus	5	1	6	0	0	0	0	0	0
Citrobacter	2	4	6	4	5	9	2	1	3
Enterococcus	6	0	6	0	0	0	1	0	1
	1	1	2	2	0	2	0	0	0
Candida famata	2	1	3	0	1	1	0	0	0
Candida auris	0	2	2	0	0	0	0	2	2
Clostridium difficile	0	1	1	0	0	0	0	0	0

Table 4: Organism Specific Chi-square Tests (Surgical vs Medical across years).
Note: Tests compare the distribution of surgical vs medical infections across years for each organism. For organisms with extremely sparse data (only one non-zero year or one clinical area), chi-square could not be calculated (shown as "–").

Organism	χ^2	df	p	Interpretation
Klebsiella pneumoniae	4.19	2	.123	ns
MRSA	2.96	2	.227	ns
Escherichia coli	5.39	2	.067	ns (trend)
Acinetobacter baumannii	0.55	2	.759	ns
Pseudomonas	0.90	2	.637	ns
Mycobacterium tuberculosis	1.41	2	.495	ns
Proteus	0.85	2	.654	ns
Enterobacter	2.55	2	.280	ns
Providencia	0.25	1	.620	ns
Serratia	1.97	2	.374	ns
Morganella	0.69	1	.406	ns
Streptococcus	–	–	–	too sparse
Citrobacter	0.90	2	.638	ns
Enterococcus	–	–	–	too sparse
Staphylococcus (non-MRSA)	0.00	1	1.000	ns
Candida Famata	0.00	1	1.000	ns
Candida auris	–	–	–	too sparse
Clostridium difficile	–	–	–	too sparse

(ns = not statistically significant at α = .05)

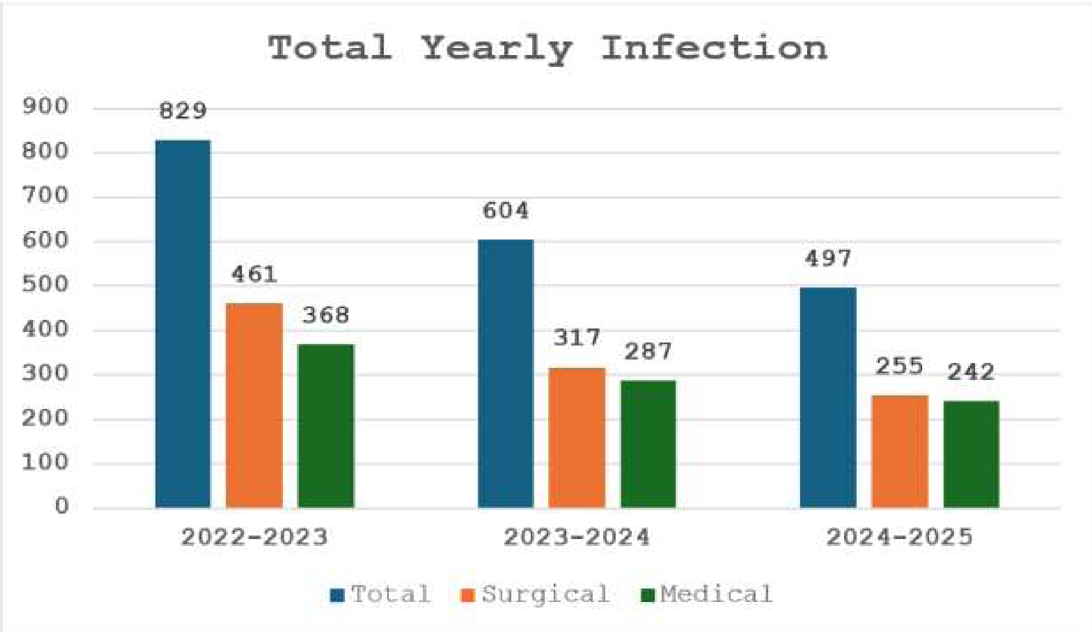

Chart 2

Chart 2: Trend in total infections by year.

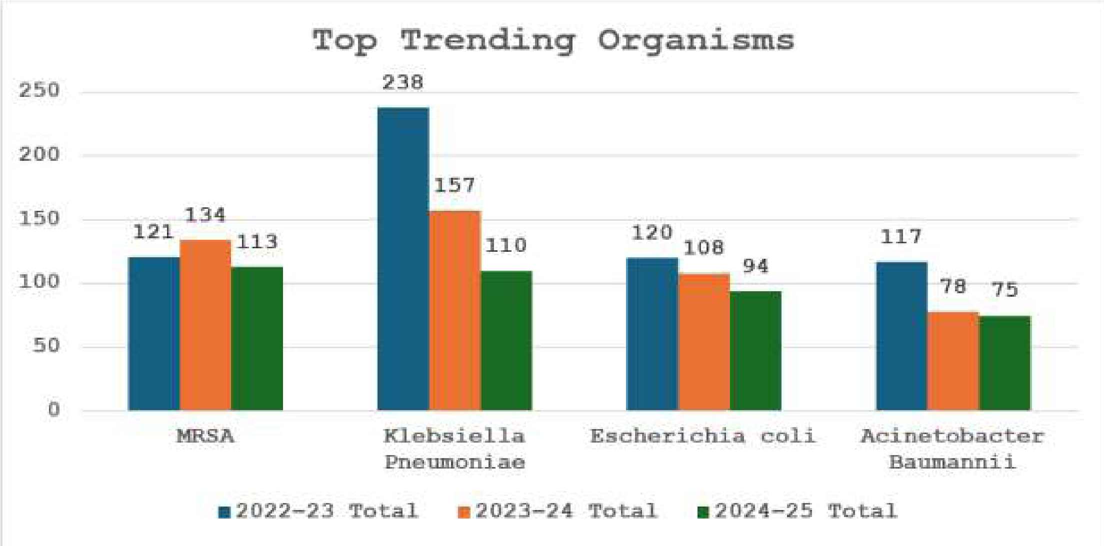

Chart 3

Chart 3: Trend of top 4 organisms (Klebsiella, MRSA, E. coli, Acinetobacter).

Discussion

Patient Care Limitations

Nurses commonly report that isolation precautions can make it difficult to provide holistic, person-centered care, particularly emotional support because infection control measures limit time at the bedside and reduce opportunities for therapeutic presence [12]. When asked about patient care limitation issues than 42 % of Alnoor Specialist Hospital (NSH), nurses were convinced that there is difficulty in providing holistic care and emotional support. Operationally, PPE donning/doffing and entry restrictions introduce measurable delays to patient contact and task completion; for example, controlled simulation evidence shows that Donning PPE as intended delays first patient contact, illustrating how protective steps can slow timely response in urgent and routine care contexts [13]. 34% of nurses of (NSH), said that there are delays in performing routine care or responding to patient needs. Frontline emergency nurses also describe physical and emotional impacts of prolonged PPE use and workflow disruption, which can reduce the frequency and quality of nurse patient interactions during isolation care [14]. However, only 24% of (NSH), nurses said that there was reduced frequency of nurse patient interaction due to PPE time (Chart 1).

Knowledge & Training

Knowledge and training were perceived as essential if full observance of standards is to be attained [15]. Nurses frequently report lack of clarity and frequent changes in isolation protocols, particularly during infectious disease outbreaks which can create confusion and reduce confidence in day-to-day practice [18]. When asked about knowledge and training issues, then 58 % of (NSH) nurses were convinced that there is lack of clarity or frequent changes in protocols (e.g., updates during out breaks). Few of the members recognized that aside from their preliminary professional education, they had no training in Infection Prevention and Control [16]; others emphasized little or inadequate training [17]. 26% of (NSH) nurses said that there is inconsistent training on isolation guidelines. Gaps in training results in meagre understanding of what, when and how to apply specific types of transmission-based precautions, such as distinguishing between airborne, droplet, and contact precautions, predominantly in multifaceted or swiftly changing clinical circumstances [19]. However, only 16% of (NSH) nurses said that there was poor understanding of when to apply specific types of precautions (airborne droplet vs contact) (Chart 1).

Organizational Issues (Leadership & Support)

Recent evidence shows that IPC implementation is strongly influenced by how well clinical and support departments communicate and collaborate, and that weak coordination contributes to inconsistent application of protocols and delays in key IPC actions [20]. When asked about organizational issues, 61% of (NSH) nurses were convinced that there is poor inter-departmental coordination (lab, housekeeping, transport). In addition, nurses and IPC personnel frequently describe gaps in monitoring, audit, and feedback for example, limited routine review of practices or lack of structured feedback loops reducing opportunities for learning and standardization across teams [21]. 33% of (NSH) nurses said that there is lack of monitoring or feedback. Weak or inconsistent IPC leadership further compounds these issues; mixed-methods evaluations of hospital IPC programs have identified limited leadership support as a major barrier to guideline implementation and sustained quality improvement, emphasizing that effective IPC requires visible leadership engagement and coordinated stakeholder involvement [22]. However, only 5% of (NSH) nurses said that there was weak infection-control leadership (Chart 1).

Availability of Limited Resources

Studies on limitation to IPC execution in healthcare services have acknowledged some of the key barriers to active application of IPC: insufficient personal PPE, hand hygiene facilities, controlled human resources, insufficient resource provision and deficiency of isolation rooms [23]. When asked about availability of resources issues, 67 % of (NSH) nurses were convinced that there is inadequate supply of PPE (gloves, gowns, N95 masks). Furthermore, inadequate accessibility of cleaning and disinfection supplies has been acknowledged as a substantial barrier to maintain environmental hygiene, thus increasing the risk of environmental contamination and cross-transmission of pathogens [25]. 25% of nurses of (NSH) said that there are insufficient cleaning and disinfecting materials. Organizational restrictions, such as the lack of dedicated isolation rooms, added these challenges by compelling cohort or late isolation, which decreases IPC efficacy and retains further burden on nursing staff (World Health Organization (26). 7% of (NSH) nurses said that there was lack of dedicated isolation rooms (Chart 1).

Workload Staffing and Time Pressure

Limited human resources and high nurse patient ratios increase workload and contribute to missed or delayed care activities [28]. When asked about workload and staffing issues, 45% of (NSH) nurses were convinced that there are staffing shortages that make it harder to follow protocols strictly. In an observational study of transmission-based precautions, donning and doffing added an average of 3.9 minutes per patient encounter and was extrapolated to ~1.3 hours of additional time per 12-hour shift, illustrating how PPE processes reduce available bedside time and can delay routine responses [29]. 40% of (NSH) nurses said that isolation procedures require extra time (PPE donning/doffing, equipment preparation, room entry restrictions). Collectively, constrained staffing, time-intensive isolation workflows, and expanded monitoring/documentation demands can make consistent protocol adherence more difficult in everyday practice [27]. 15% of (NSH) nurses said that there is increased documentation and monitoring responsibilities (Chart 1).

Compliance Challenges

Compliance with Infection Prevention and Control (IPC) protocols is frequently challenged during periods of staff fatigue and clinical emergencies, when heavy workloads and time pressure may lead nurses to unintentionally omit required steps to deliver urgent patient care [30]. When asked nurses of Alnoor Specialist Hospital about compliance challenges, then 45% were convinced that nurses may unintentionally skip steps due to fatigue or emergencies. Furthermore, achieving consistent compliance across all staff members is further complicated by organizational and system-level factors, as inadequate institutional support and unclear or inconsistently applied protocols reduce adherence to established IPC guidelines [31]. 40% of (NSH) nurses said that there is difficulty in ensuring all staff follow the same procedures. However, nurses are less likely to follow the rules when they get unclear or conflicting instructions from the IPC team and hospital administration. This makes it unclear what the normal practices are and makes nurses less confident in following the rules [32]. 15% of NSH nurses said that there are conflicting instructions between infection-control teams and management (Chart 1).

Environmental & Logistics Problems

The exchange of non-dedicated medical equipment between patient rooms has been recognized as a significant factor in environmental contamination and an elevated risk of healthcare-associated infections, especially when cleaning and disinfection are limited by workload or time constraints [24]. When asked nurses of Alnoor Specialist Hospital about environmental and logistics issues, 55% of (NSH) nurses said sharing equipment between rooms increases contamination risks. Restricted storage capacity for Personal Protective Equipment (PPE) next to isolation rooms exacerbates compliance issues, as insufficient or poorly situated storage correlates with incorrect PPE utilization and workflow interruptions among nursing personnel [33]. 37% of (NSH) nurses said that there was limited space for storing PPE near isolation rooms. Moreover, challenges in the secure segregation, management, and disposal of infectious waste aggravated by the heightened amount of waste produced during isolation care present occupational and environmental hazards and may compromise compliance with infection prevention and control measures [34]. Only 8% of (NSH) nurses said that there was difficulty in disposing of infectious waste properly (Chart 1).

Psychological & Emotional

Impact

Nurses providing care to patients under isolation precautions frequently experience fear of contracting infections and anxiety about transmitting pathogens to their family members, which significantly contributes to psychological distress [35]. 51% of (NSH) nurses were feared of contracting infections or spreading them to family. Evidence from infectious disease outbreaks validates insistent exposure to high-risk clinical settings, collective with the necessity for continual observance and stern observance to infection-control protocols, consequences in increase stress levels, emotional tiredness, and exhaustion among nurses [36]. 35% of (NSH) nurses said that they were stressed and burnout due to constant vigilance. Qualitative studies have stated that nurses may practice feelings of blame and moral pain when they are incapable of stipulating satisfactory emotional care or devoting passable time to isolated patients, despite understanding the importance of isolation for infection prevention [38]. 13% of nurses of (NSH) said that isolation rooms can create feelings of guilt in nurses when patients feel lonely (Chart 1).

Communication Barriers

The use of PPE, particularly face masks and face shields, hinders facial communications, reduces non-verbal signs, and exacerbates speech precision, making it difficult for patients to identify information and for clinicians to connect with empathy and support [38]. When asked nurses of Alnoor Specialist Hospital about communication barriers 46% of (NSH) nurses were convinced that PPE and closed doors reduce interaction and visibility. Patients put in isolation may not fully identify the reasoning for these procedures, preceding to uncertainty, anxiety, or refusal to accept to isolation practices, markedly when justifications are inadequate or unreliable [37]. 44% of (NSH) nurses said that patients may not understand the need for isolation and may resist. Moreover, closed isolation room doors reduce visibility and natural communication, giving rise to physical and psychological barriers that further restrict timely and active communication between patients and healthcare staff [39]. 10% of (NSH) nurses said that there is difficulty in communicating effectively with patients while wearing PPE (Chart 1).

Descriptive Results

Most reported challenges include inadequate PPE supply = 67% (n≈536), poor interdepartmental coordination = 61% (n≈488), protocol clarity issues = 58% (n≈464), equipment sharing contamination risk = 55% (n≈440), fear of infection = 51% (n≈408). Whereas least reported challenges were weak infection-control leadership = 5%, lack of isolation rooms = 7%, waste disposal difficulty = 8%, and communication difficulty with PPE = 10%

Domain-level Chi-square (Goodness-of-fit)

Test question: Do challenges within each domain occur equally?

Expected per item = 800/3 ≈ 267

All domains showed significant imbalance ($p < .001$).

95% CI for effect sizes

Largest burden was Limited resources V = 0.54 (95% CI ≈ 0.49–0.59) and Organizational issues V = 0.49 (95% CI ≈ 0.44–0.54). Whereas Lowest burden was Patient care limitations V = 0.16 (95% CI ≈ 0.10–0.20). Structural/system barriers dominate severely (resources, coordination, protocols). Whereas operational barriers dominate moderately (workload, compliance). However, care interaction barriers dominate smaller (patient care limitations). Therefore, the main difficulty is system capacity rather than nurse willingness. Chi-square goodness-of-fit analyses demonstrated significant heterogeneity in the distribution of reported challenges across all domains (all $p<0.001$). The largest effects were observed for limited resources ($\chi^2=462.8$, V=0.54) and organizational issues ($\chi^2=384.8$, V=0.49), indicating a pronounced concentration of responses around specific structural barriers, particularly inadequate PPE supply and poor interdepartmental coordination. Environmental and logistics problems (V=0.41) and knowledge-related issues (V=0.38) also showed substantial imbalance. In contrast, patient care limitations exhibited a smaller effect ($\chi^2=39.0$, V=0.16), suggesting a more even distribution across care-related challenges. Overall, findings highlight system-level constraints as the dominant drivers of isolation precaution implementation difficulties.

Effects of Implementation of Isolation Precaution Measures in Alnoor Specialist Hospital, Makkah Cluster, Ministry of Health (MOH), Kingdom of Saudi Arabia (KSA).

Overall Infection Trends

Across 3 years period (2022–23 to 2024–25), total of 1,930 positive culture infections was acknowledged (Table 2). Yearly totals dropped from 829 infections in 2022–23, to 604 in 2023–24, and 497 in 2024–25 (Chart 2). Similar reductions in Healthcare-Associated Infection

(HAI) incidence have been reported internationally and are commonly attributed to strengthened Infection Prevention and Control (IPC) programs, antimicrobial stewardship, and post-pandemic surveillance intensification [39,40]. Of these, 1,033 (53.5%) occurred in surgical services and 897 (46.5%) in medical services. Although both surgical and medical infections declined over time, the relative distribution of infections between surgical and medical services did not differ significantly across years, χ^2 (2) = 2.60, p = .27 (Chart 6). Suggesting broadly comparable risk exposures or consistent hospital-wide implementation of IPC measures an observation consistent with multicenter surveillance findings [41]. A key finding was the significant change in organism distribution over time. Clinically important Gram-negative organisms, Klebsiella pneumoniae and Acinetobacter baumannii, presented strong declining trends, consistent with reports of decrease transmission of MDRO's ensuing persistent IPC interventions [39,42]. In compare, MRSA and E. coli persisted quite prevalent, showing that Gram positive and community linked organisms persist to pose a persistent challenge. This relationship is associated with global surveillance data recognizing E. coli as a chief cause of bloodstream and urinary tract infections regardless of overall improvements in HAI control [40,41]. Significantly, hospitals showed a substantial shift in surgical vs medical distribution, indicating that organism specific risk exposures are probably same between facilities or that interventions have been applied regularly to hospitals widely. Similar stability across clinical services has been described in large surveillance networks, suggesting that organism-specific risks may not be confined to service lines but instead reflect hospital-wide epidemiological patterns [42]. Conversely, organisms with low case count restricted statistical power for some associations, meaning subtle alterations cannot be utterly ignored. Entirely vanishing of some low frequency organisms may echo true epidemiological shift but could also be persuaded by probability variation or adjusting diagnostic procedures. The continuation but decreasing scale of MDRO's emphasizes the need for continued surveillance rather than complacency. Nonetheless, previous studies warn that such trends may also echo into stochastic deviation or alterations in diagnostic testing procedures [43].

Distribution of Organisms by Year

The most isolated organisms throughout all years were Klebsiella pneumoniae (505 cases), MRSA (368 cases), Escherichia coli (322 cases), and Acinetobacter baumannii (270 cases) (Table 3). Alike organism profiles have been constantly registered in hospital surveillance studies, where these pathogens report for a large percentage of HAI's worldwide [39,40]. In compare, MRSA and E. coli showed minor decreases, echoing their continued continuity in healthcare locations and the constant addition of community related reservoirs, particularly for E. coli infections [40,41]. Organisms' distribution changed widely across years, χ^2 (34) = 82.69, p < .001, suggesting major temporal shift in pathogen epidemiology (Table 4). There is a marked decline in Klebsiella pneumoniae from 238 cases in 2022–23 to 110 in 2024–25, while Acinetobacter baumannii infections drops from 117 to 75 cases. MRSA and E. coli showed smaller absolute reductions (Chart 3). Drops in Klebsiella pneumoniae and Acinetobacter baumannii are consistent with international reports unfolding drops in certain Gram-negative MDRO's following supported infection prevention and control procedures and antimicrobial stewardship programs [39,42]. Various minimal frequency organisms such as Providencia, Streptococcus, and Clostridium difficile were hardly detected in the final year. The near nonexistence of several low frequency organisms in the final year may signify true epidemiological shifts; nevertheless, surveillance literature alerts that variations in sporadic pathogens may also be influenced by stochastic variation or changes in diagnostic and testing practices [40].

Organism-Specific Trends by Clinical Service

Organism-specific chi-square analyses showed that the distribution of surgical versus medical infections for each organism remained stable over time, with no organism demonstrating a statistically significant shift in service-level distribution (all p > .05). Similar stability in organism distribution across clinical services has been reported in hospital surveillance studies, suggesting that many healthcare-associated pathogens reflect hospital-wide exposure risks rather than service-specific transmission dynamics [40,41]. For example, Klebsiella pneumoniae surgical-versus-medical distribution did not change significantly across years, χ^2 (2) = 4.19, p = .12, and MRSA similarly demonstrated no significant shift, χ^2 (2) = 2.96, p = .23. It aligns with international surveillance data indicating that these organisms commonly circulate across multiple inpatient settings when infection prevention and control measures are applied uniformly [40]. Although E. coli approached statistical significance, χ^2 (2) = 5.39, p = .07, the effect remained nonsignificant. Although Escherichia coli approached statistical significance, the lack of a definitive service-level shift is consistent with reports showing that E. coli infections often arise from endogenous or community-associated sources rather than being confined to specific hospital services [41,42]. Collectively, these findings support the interpretation that organism-specific risk exposures were broadly similar between surgical and medical services during the study period or that interventions were implemented consistently across the hospital [5].

Study Limitations

1. Attribution of outcomes: Isolation precautions are often implemented alongside other infection prevention interventions (e.g., hand hygiene, device bundles, antimicrobial stewardship). This makes it difficult to attribute reductions in infection rates solely to isolation measures.

2. Measurement of adherence: Assessing healthcare workers' compliance may be affected by the Hawthorne effect (staff modify their behavior when observed). This could overestimate true adherence levels.

3. Data quality and reporting: Reliability of infection surveillance data depends on accurate documentation, microbiology reports, and consistent application of case definitions (e.g., NHSN criteria for CLABSI, CAUTI, VAE). Variability in reporting could bias findings.

4. Generalizability: The study is conducted in a single tertiary hospital (Al Noor Specialist Hospital, Makkah). Findings may not be generalizable to other hospitals in Saudi Arabia with different resources, patient populations, or staffing levels.

5. Resource and infrastructure limitations: Limited availability of isolation rooms, PPE shortages, or staff workload constraints may affect implementation fidelity, especially during Hajj/Umrah seasons when patient volume surges.

6. Patient-related confounders: Differences in patient case-mix (severity of illness, comorbidities, immunosuppression) may influence HAI rates independently of isolation precautions, potentially confounding results.

5. Behavioral and cultural factors: HCWs' knowledge, attitudes, and perceptions about isolation precautions may vary. These qualitative aspects are harder to measure and may not be fully captured in quantitative assessments.

Conclusion

This study shows that nurses stated challenges in delivering holistic care to the patients due to less supplies of PPE, misunderstanding from repeatedly changing procedures and weak inter departmental coordination. Staff scarcities and intensified workload added to time pressure and sporadically noncompliance. Environmental restrictions and communication barriers also influenced care provision where nurses felt fear of getting infection and stress. Good supply of resources, training, leadership and staff health are vital for balanced and effective IPC implementation. Furthermore, there is a marked drop in total infections and a sizable shift in the distribution of organisms over the period, while the ratio of infections between surgical and medical facilities continued stable. Constant burden from MRSA and E. coli underlines the need for constant infection prevention vigilance and aimed interventions, specifically for high-risk organisms.

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