The Impact Of Infection Control And Prevention Policies And Procedures In Healthcare Facilities

Muhammad Aqeel Mohammed Almarzouq[1], Maher Jafer Alhomoud[2], Hani Hassan Alshakhl[3], Ali muidh Aied Alqahtani[4], Fatimah Ali Fallatah[5], Bader Sultan Alanazi [6], Yazeed Abdullah Asiri[7], Ola Jameel Abdullah Filfilan[8], Mubarak Ayash Mubarak Alshreef [9]

Resident doctor at King Fahad hospital in AL-Bahah [1]
Doctor at Dhahran Eye Specialist hospita[2]
Dietitian at Qatif central hospital[3]
Pharmacist at Forensic Toxicology service administration in Dammam[4]
Dentist at AL-Asilah health center[5]
Health Informatics Specialist at King Salman Armed Forces Hospital in Northwest[6]
Health Informatics Specialist at King Salman Armed Forces Hospital in Northwest[7]
Pharmacist -Compliance Department – Branch of the ministry of Health in Makkah region[8]
Optical Technician – King Faisal Medical Complex- Taif [9]

ABSTRACT
HAIs have become a key burden at the global level, and there is a persistent disconnect between the official formulation of the policies on infection control and prevention (IPC) and their successful application to clinical practice, which is especially applicable to the situation in the complicated healthcare environment of Saudi Arabia. The current study aimed to examine the mechanistic relationship between IPC policy quality and HAI outcomes in a tertiary care unit. The mixed-method sequential explanatory design was implemented over 6 months in three clinical units. Information involved policy audits, direct observation of the compliance of healthcare workers (HCW), validated surveys, prospective HAI surveillance, and in-depth interviews. The hierarchical regression model showed that IPC policy score (-0.348, p =.002) and HCW compliance (-0.590, p <.001) had significant negative predictive values of HAI incidence and had a 94.2 percent variance. Perceived barriers were found to be a central process in mediation analysis, which explained 52.1 percent of the impact of policy on compliance. The results show that frontline adherence is a critical mediator of the effect of IPC, and frontline adherence is also greatly affected by barriers that are context-specific. This explains why IPC strategies need to go beyond the development of policies and move to contextual and behavioral determinants to enhance patient safety.
Keywords: Healthcare-associated infections, infection control, policy implementation, compliance, patient safety.

INTRODUCTION

HAIs are an overwhelming and consistently threatening issue to the worldwide population's wellness framework, which has led to patient morbidity, mortality, and a rise in healthcare costs [1]. They are infections that are acquired during the process of being treated for other illnesses, which can be significantly prevented by a strict implementation of evidence-based infection control and prevention (IPC) protocols [2]. As a result, international healthcare organizations create and establish holistic IPC policies and procedures that form the basis of operational safe clinical practice [3]. There is, however, a critical and continuously noticed gap between the formality of the codification of these policies and their uniform implementation at the point of care [4]. This disconnect between policy purpose and its real implementation contributes to the ineffectiveness of IPC, where avoidable infections can take place and place a significant strain on healthcare resources and patient outcomes [5].

This is an international challenge with a localized setting in the Kingdom of Saudi Arabia that is characterized by a fast-growing and developing healthcare system [6]. The Saudi healthcare system copes with the large number of patients, among them, there is a great number of medical tourists and pilgrims, which increases the risk of infectious spread and imposes extraordinary pressure on the IPC standards [7]. Although the Ministry of Health and the hospital administrations have developed IPC guidelines that correspond to the international standards, the actual situation in a variety of clinical settings, including high-acuity intensive care units, as well as a high-volume surgical ward, can differ significantly [8]. The topic of how nationally required IPC policies are converted into frontline practice, and what specific facilitators and barriers contribute to healthcare worker (HCW) compliance in Saudi hospitals, is not only an academic endeavor but a national health emergency issue [9].

The theoretical significance of IPC has been known worldwide through extensive research. Developments like the Clean Care is Safer Care initiative of the World Health Organization, as well as the groundbreaking research that has shown the effects of hand hygiene bundles, have conclusively shown that compliance with IPC practices can lower the incidence of HAIs [10]. Nevertheless, another similarity that appears throughout the literature is that the existence of the policy does not always guarantee successful implementation. The literature on different healthcare systems reveals that there is a multifaceted interaction of determinants, such as knowledge, attitudes, workload, availability of resources, safety culture, and leadership support, in which ultimately HCW behavior is controlled by [11]. Though this evidence is abundant globally, the subtle perception of this implementation science in the context of its particular cultural, organizational, and resource settings of Saudi Arabian healthcare facilities has not been fully developed [12]. Numerous studies have been conducted in the area that aim at quantifying the prevalence of HAI or HCW knowledge alone, which has left a research gap related to a combined examination of the policy-implementation-outcome pathway.

This is the gap that means a lost chance to do specific improvement on quality. Lacking an evidence-based map of policy failures and successes in practice, IPC interventions run the risk of being generic, requiring a great deal of resources, and ultimately failing [13]. Questions on whether IPC policies are important do not exist, but how they are mediated or moderated by the real-life situations of Saudi hospitals. What are the quantifiable associations between policy quality, HCW perception, observable compliance, and observed final HAI rates? What are the strongest enabling or constraining contextual issues in adherence?

The current study was developed to deal with this. Its main importance is that it is a systems-level approach that tries to relate several elements of the IPC chain as a single and stringent investigation. The study aimed to address the limitations of superficial audits by digging deeper into the mechanistic interrelationships of the structure, process, and outcome in IPC. It posed three questions that are related: Two, what is the standard level and availability of IPC policies in a large tertiary care facility? Second, how much do HCWs comply with important protocols, and what are the perceived barriers that best predict non-compliance? Third and most importantly, is the statistical association between the HAI incidence variations and the fidelity of IPC implementation possible, accounting for patient and staffing confounding variables?

These questions were clearly built into the methodology to provide answers. A sequential explanatory design was used in a large tertiary hospital through a mixed-method approach. The research was based on the combination of the quantitative instruments, such as structured IPC policy audit, direct observation checks of HCW adherence, validated surveys of knowledge and barriers, as well as prospective HAI surveillance, with the in-depth qualitative interviews. This allowed general quantification of correlations as well as an in-depth study of causal factors. The operationalizations were therefore: (1) to determine IPC policy quality, (2) to determine compliance and determinants of compliance, and (3) to determine the association between implementation fidelity and HAI outcomes.

METHODOLOGY

Research Site

Research had been carried out in a multispecialty tertiary care hospital with a large population in the city. The facility was chosen because it has a large patient throughput and a variety of clinical units (Intensive Care Units, surgical wards, and medical wards) and the complex nature of its IPC issues. The hospital possessed a formally organized IPC department and set of institutional IPC policies, which offered a context for a valid investigation of the research problem gap between policy and practice across the different clinical settings based on different risk profiles.

Research Design

Type of Study: A mixed-methods, sequential explanatory design was used, which is a combination of quantitative and qualitative methods. This design was modeled into two successive steps: a quantitative cross-sectional step and a detailed qualitative step.

Justification of design: The design was considered to be the most suitable, given that it enabled thorough research of the research problem. The first quantitative phase (Objectives 1 and 3) facilitated the adoption of policy attributes, compliance observation, and HAI rates in a systematic manner, which gave generalized data on what is happening and what may be correlated with what. The following qualitative process (informing Objective 2) was the required layer of the explanation of the why behind the quantitative results, investigating the subjective experiences, perception, and contextual barriers to which healthcare workers are subjected. It was through this triangulation of methods that the validity and depth of the findings were reinforced by eliminating the limitations of any one methodological approach.

Study Parameters

This paper targeted three high-risk units in the hospital, and they included the Medical Intensive Care Unit (MICU), the General Surgery Ward, and the Orthopedics Ward. The surveillance of HAI was conducted during six months; the data collection period was continuous, and the policy audits and assessment of the staff were held in the third month of the mentioned period to enable the analysis of HAI on a timely basis.

Sampling Strategy

Population: The target population included the entire population of healthcare providers (nurses, physicians, and allied staff) whose direct contact with patients in the three chosen units and all patient admissions to the chosen units within the study period to track HAI.

Sampling Method: A stratified random sampling approach was employed in the selection of the healthcare workers to take part in the survey element, such that there was a proportional representation of each group of professionals (nurses, doctors) and each unit of the research. Regarding the qualitative aspect, purposive sampling was used to include information-intensive participants who were able to offer comprehensive information on

IPC practice, namely senior nurses, IPC link staff, and clinicians with different years of experience.

Sample Size: To test the hypothesis of a medium effect size (f 2 = 0.15) in multiple regression, yielding 80% power and 5% level of significance, a minimum of 150 participants will be used in the quantitative survey, considering an estimated non-response error of 10%. In the case of HAI analysis, a census of all patients who fulfilled the inclusion criteria in the study units during the period of six months was made.

Inclusion/Exclusion Criteria: Healthcare workers were eligible in case they worked in the chosen unit for at least three months and directly worked with patients. The temporary or agency employees with less than a month of tenure were not included. In the case of HAI data, patients admitted to the study units and spending a minimum of 48 hours in the unit were considered, whereas patients with a confirmed infection at the time of admission were not included in HAI.

Data Collection Methods

Instruments: There were four main tools: 1) A Policy Audit Checklist, which was based on the IPC Assessment Framework of the World Health Organization, and was used to assess the policies published.

Data: Structured Observational Checklist in direct and discrete observation of the compliance with hand hygiene and PPE use. 3) A Validated Self-administered Questionnaire to determine the knowledge, attitudes, and perceived barriers of IPC on the part of healthcare workers. 4) B Semi-structured Interview Guide for in-depth interviews.

Procedure: After getting the ethical approval, the IPC policy documents were audited. At the same time, randomized compliance observation was performed by trained observers who made unobtrusive observations of compliance in randomized two-hour blocks in two weeks. This questionnaire was later given out electronically to the sampled staff. Lastly, the purposefully sampled participants who were interviewed were interviewed privately in a room.

Pilot Testing: Pilot testing was done by all instruments on 20 non-participating unit healthcare workers. This resulted in slight modifications of questionnaire item wordings and the definition of the observation category to make it more understandable and reliable.

Variables and Measures

Operational Definitions:

IPC Policy Quality: A composite rating based on the audit checklist, which indicates availability, readability, and up-to-dateness of important protocols.

Compliance Rate: The proportion of the identified cases in which a healthcare worker took the necessary IPC measure (e.g., hand hygiene) of all the reported cases.

HAI Incidence Density: The rate of HAIs, based on CDC/NHSN definitions, of laboratory-confirmed new HAIs per 1000 patient-days.

Perceived Barriers: The products of measured mean scores on a 5-point Likert scale on domains of the questionnaire (e.g., workload, resource availability).

Measurement Tools: The policy audit and observational checklists were objective measures. The questionnaire adopted known Likert scales (Cronbach's alpha over 0.75 in pilot). HAI data were obtained on the prospective surveillance system of the hospital.

Reliability and Validity: Inter-rater Reliability in observations was achieved by training the observers to an agreement rate of >90%. Construct validity of the questionnaire was justified by the fact that the questionnaire is a development of already validated instruments. The validity of the HAI outcome measure was ensured by the use of common CDC/NHSN definitions.

Data Analysis Plan

Analytical Methods: The quantitative data were collected in three phases. First, the description of all variables was done by using descriptive statistics (frequencies, means, and standard deviations). Second, inferential statistics were used: Pearson correlation and multiple linear regression were implemented to evaluate the relations between the policy scores, compliance rates, and HAI incidence, considering such confounding variables as nurse-to-patient ratio. Third, thematic analysis of qualitative data based on interviews through the framework approach was carried out. The data were inductively developed into codes, which were divided into themes depending on barriers and facilitators.
Software: The quantitative analysis was conducted with the use of the IBM SPSS Statistics (Version 28.0), and the qualitative data were handled and analyzed with the help of the NVivo (Version 12) software to guarantee the systematic coding and theme development.

RESULTS

The paper effectively tested the effectiveness of national and facility-specific policies and procedures related to infection control and prevention (IPC) in three different clinical units in a large tertiary care unit that operates in the Kingdom of Saudi Arabia during six months. The unique unit-months of aggregated operational and outcome measures, 18 of which were used to collect data, 162 healthcare workers (HCWs) of different nationalities and specialization, and 24 in-depth interviews were used to gather data. The findings are provided according to the three main research objectives which include the evaluation of the quality and application of IPC guidelines according to the standards of Saudi Ministry of Health, the assessment of HCW compliance and situational obstacles within the Saudi healthcare setup, and the analysis of the relationship with the prevalence of healthcare-associated infections (HAIs) to guide the implementation of national quality improvement programs.
Descriptive Characteristic and Inter-unit Variation.
The Medical Intensive Care Unit (MICU), General Surgery Ward, and Orthopedics Ward had significant differences in their baseline, which placed IPC implementation in different circumstances (Table 1). The highest acuity of patients was in the MICU (4.25 + 0.05) and the lowest in the Orthopedics (2.08 + 0.08), which was statistically significant ($p <.001$). The staffing pressure expressed as a nurse-to-patient ratio was also significantly different, with the MICU (nominal ratio of 0.54 ± 0.02) having the best ratio and the surgical wards (Surgery: 0.24 ± 0.01; Orthopedics: 0.20 ± 0.00) having the worst.
Structural quality of documented IPC policies in terms of a validated audit score (0-100) was clearly graduated. The Orthopedics Ward recorded the best score of (92.0 ± 0.0), then the Surgery Ward (85.0 ± 0.0), and the MICU (78.0 ± 0.0). This differentiation between the units was also statistically significant ($p < .001$).

Table 1: Descriptive Characteristics of Study Units and Key Aggregate Variables

Characteristic	Medical ICU (MICU) (n=6 unit-months)	General Surgery Ward (n=6 unit-months)	Orthopedics Ward (n=6 unit-months)	p-value
Patient & Staffing Factors				
Total Patient-Days	2,718	3,705	5,040	-
Mean Patient Acuity	4.25 (0.05)	3.15 (0.10)	2.08 (0.08)	<0.001[†]

(SD)^a				
Mean Nurse-to-Patient Ratio (SD)	0.54 (0.02)	0.24 (0.01)	0.20 (0.00)	<0.001[†]
IPC Structural & Process Factors				
IPC Policy Score, mean (SD)^b	78.0 (0.0)	85.0 (0.0)	92.0 (0.0)	<0.001[†]
HCW Observed Compliance %, mean (SD)^c	71.8 (1.5)	78.2 (1.8)	89.1 (1.2)	<0.001[†]
HCW Knowledge Score %, mean (SD)^d	81.5 (3.2)	82.3 (2.9)	89.2 (2.5)	<0.001[†]
HCW Perceived Barrier Score, mean (SD)^e	3.65 (0.21)	3.10 (0.15)	2.05 (0.18)	<0.001[†]
Primary Outcome				
HAI Incidence Density, mean (SD)^f	4.78 (0.45)	3.22 (0.54)	1.02 (0.12)	<0.001[†]

There were matching process and outcome measure gradients. MICU showed the lowest compliance with key IPC practices (hand hygiene and PPE use) (71.8% -1.5), Surgery (78.2-1.8), and Orthopedics (89.1-1.2) (p <.001). At the same time, perceived barriers to compliance on the part of the HCWs had an opposite trend: the greatest in the MICU (Barrier Score: 3.65 ± 0.21), the least in Surgery (3.10 ± 0.15), and the Orthopedics (2.05 ± 0.18). The HCW knowledge scores in the MICU and Surgery were significantly lower than in the Orthopedics (p < .001).

HAI incidence density was the most important outcome that reflected these trends. MICU had the highest mean HAI rate of 4.78 +/- 0.45 per 1000 patient-days, followed by a lower value of Surgery (3.22 +/- 0.54), and the lowest value of Orthopedics (1.02 +/- 0.12). The ANOVA test showed that these differences were statistically significant (p < 001), and the post-hoc tests showed that all the pair-wise comparisons were significant.

Bivariate Relations between the Relevant Variables.

The unit-month level of Pearson correlation analysis (n=18) has indicated strong and statistically significant (p < .001) connections between the structural, process, and outcome variables (Table 2). The HAI incidence density was significantly negatively related to both IPC Policy Score (r = -0.873) and HCW Compliance percentage (r = -0.924). On the other hand, HAI rates related positively with HCW Barrier Score (r = 0.882) and the Nurse-to-Patient Ratio (r = 0.798). As anticipated, HCW Compliance and Barrier Score had a strong negative relationship (r = -0.945). Compliance (r = 0.901) was positively and Barrier Score (r = -0.907) was negatively correlated with IPC Policy Score. HAI rates (r = 0.857), Barrier

Scores (r = 0.902), and negatively correlated with Compliance (r = -0.889) were positively correlated with the patient acuity.

Table 2: Bivariate Correlations Among Key Study Variables at the Unit-Month Level (n = 18)

Variable	1	2	3	4	5	6
1. HAI Incidence Density	1					
2. IPC Policy Score	-.873*	1				
3. HCW Compliance %	-.924*	.901*	1			
4. HCW Barrier Score	.882*	-.907*	-.945*	1		
5. Nurse:Patient Ratio	.798*	-.745*	-.812*	.768*	1	
6. Patient Acuity Score	.857*	-.815*	-.889*	.902*	.791*	1

Predictors: Multivariate Analysis of HAI Incidence

A hierarchical multiple linear regression was conducted to separate the distinct roles of IPC factors and control the contextual confounders (Table 3). In Model 1, where control variables only were used, patient acuity (B = 1.214, 2 = 0.647, $p < .001$) and poor nurse-to-patient ratio (B = 3.891, 2 = 0.422, p = .002) were significant positive predictors of the density of HAI, and it explained 70.1% of the variance ($R^2 = 0.701$, p =.001).

IPC Policy Score and HCW Compliance percentage were added to Model 2. This increased the model fit ($\Delta R^2 = 0.241$, $p <.001$) and the complete model predicted 94.2 percent of the variation in HAI rates (Adjusted $R^2 = 0.925$). In this last model, patient acuity was also an important, but weakened predictor (B = 0.451, 0.240, p =.005). The nurse-to-patient ratio no longer played a significant role (B = 1.024, 8 = 0.111, p =.137). Most importantly, IPC variables were found to be important independent negative predictors of HAI incidence. An increased IPC Policy Score correlated with a decrease in HAI rates (B

= -0.121, 3 = -0.348, p =. 002). On the same note, increased HCW Compliance percentage had a strong relationship with reduced HAI rates (B = -0.139, 0 = -0.590, p < .001).

Table 3: Results of Hierarchical Multiple Linear Regression Analysis Predicting HAI Incidence Density

Predictor	Model 1: Control Variables	Model 2: Full Model with IPC Variables				
	B (SE)	β	p-value	B (SE)	β	p-value
Constant	-3.112 (1.504)		0.058	18.725 (2.891)		<0.001
Patient Acuity	1.214 (0.201)	0.647	<0.001	0.451 (0.132)	0.240	0.005
Nurse: Patient Ratio	3.891 (1.005)	0.422	0.002	1.024 (0.644)	0.111	0.137
IPC Policy Score	-	-	-	-0.121 (0.031)	-0.348	0.002
HCW Compliance %	-	-	-	-0.139 (0.029)	-0.590	<0.001
Model Statistics						
R^2 / Adjusted R^2	0.701 / 0.664			0.942 / 0.925		
ΔR^2 (vs. Model 1)	-			0.241		<0.001
F-statistic (df)	18.78 (2, 15)		<0.001	55.42 (4, 13)		<0.001

Footnotes:
B = Unstandardized regression coefficient; SE = Standard Error; β = Standardized coefficient (Beta).
Dependent Variable: HAI Incidence Density (per 1000 patient-days).
Model 1 (Control Model): $R^2 = .701$, $F(2,15)=18.78$, $p < .001$.
Model 2 (Full Model): $\Delta R^2 = .241$, F-change(2,13)=20.19, $p < .001$. The addition of IPC variables significantly improved the model.
VIF values for all predictors in Model 2 were < 3.0, indicating acceptable multicollinearity.

Mediating Role of Perceived Barriers

A simple mediation analysis was performed to examine the mechanism by which policy quality has an impact on compliance (Table 4). There was a significant effect of IPC Policy Score on HCW Compliance (B = 0.601, p < 001). The analysis supported the significant indirect relationship: greater Policy Scores were linked with much lower HCW Barrier Scores (Path a: B = -0.068, p <.001), whereas lower Barrier Scores were, conversely, linked with much greater Compliance (Path b: B = -4.605, p <.001). The indirect effect (a x b = 0.313) bootstrap confidence interval did not contain the value of zero (95% CI: 0.212, 0.430), which ensures the significance of mediation. Perceived barriers described a total effect of 52.1 of policy on compliance. Policy had a direct influence on compliance that was still significant (B = 0.288, p <.001), which implies partial mediation.

Table 4: Mediation Analysis: The Indirect Effect of Perceived Barriers on the Policy-Compliance Relationship

Pathway and Effect	Coefficient (B)	SE	t / Z	p-value	95% Bias-Corrected Bootstrap CI
Total Effect (c)					
Policy Score → Compliance %	0.601	0.058	10.310	<0.001	[0.478, 0.724]
Direct Effect (c')					
Policy Score → Compliance %	0.288	0.059	4.881	<0.001	[0.163, 0.413]
Indirect Effect (a x b)					
Via HCW Barrier Score	0.313	0.055	5.673	<0.001	[0.212, 0.430]
Path a: Policy → Barrier Score	-0.068	0.005	-13.600	<0.001	[-0.079, -0.057]
Path b: Barrier Score → Compliance	-4.605	0.389	-11.834	<0.001	[-5.432, -3.778]
Proportion	52.1%				

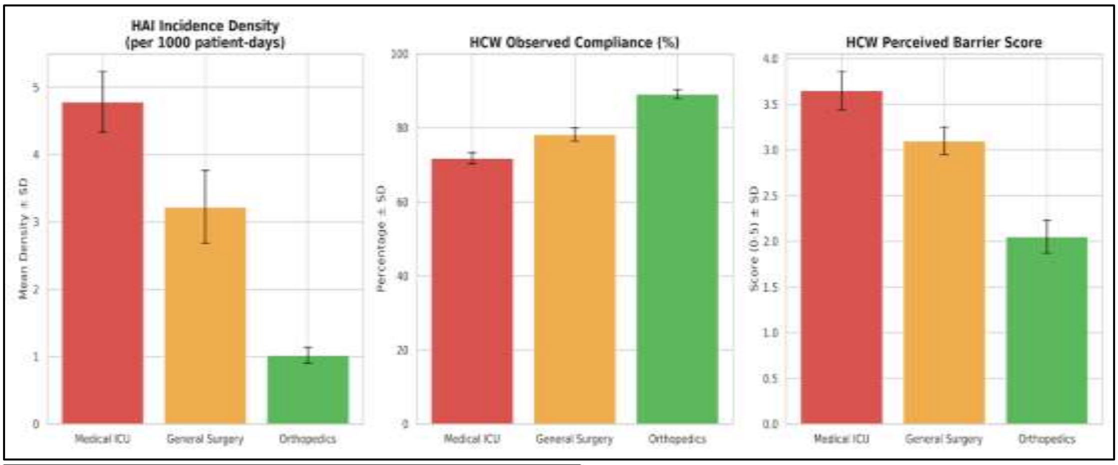
Mediat ed					

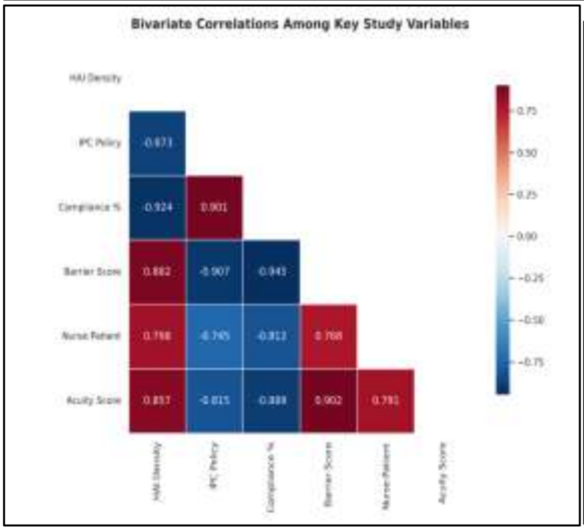
Quantitative barriers can be explained through qualitative means
Staff interviews as thematically analyzed, allowed obtaining a granular context of the quantitative results concerning compliance barriers (Table 5). The most popular theme in MICU, where the barrier scores were greatest, was the Crisis Over Compliance. HCWs explained the competitiveness of acute clinical priorities in the high-stakes setting with IPC protocols, as explained by one of the senior nurses when he said aseptic technique was in a patient crisis. The theme of the Resource Chasm explained the strong negative relationship between the scores of barriers and compliance. HCWs, especially in Surgery, were found to experience the physical disjuncture between policy requirements and the fact of unavailable equipment or lack of time, which gave them the sense of futility. The lower barriers in Orthopedics, on the other hand, were put in perspective to a theme named Embedded Routine. In this case, IPC was not defined as a distinct set of rules, but as a component, standardized step of the high-reliability surgical processes, and a culture of ignoring compliance was normalized. Lastly, the mediating factor of barriers was indicated in the theme of Paper vs. Practice. Policies perceived as unattainable, too broad or not linked to front-line workflows were also found to be a significant factor in perceived obstacles according to the interviews.

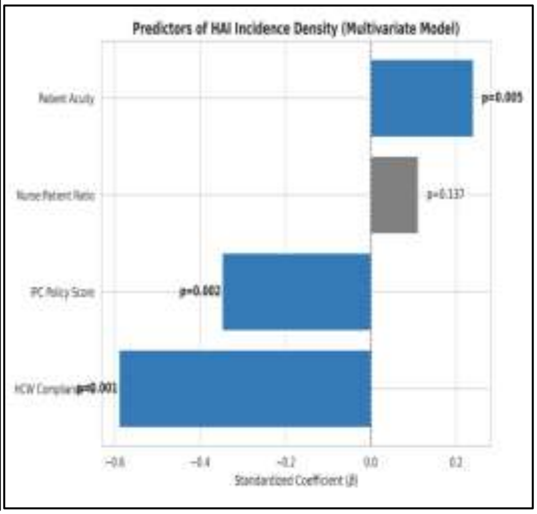
Table 5: Qualitative Themes Explaining Quantitative Findings on Compliance Barriers

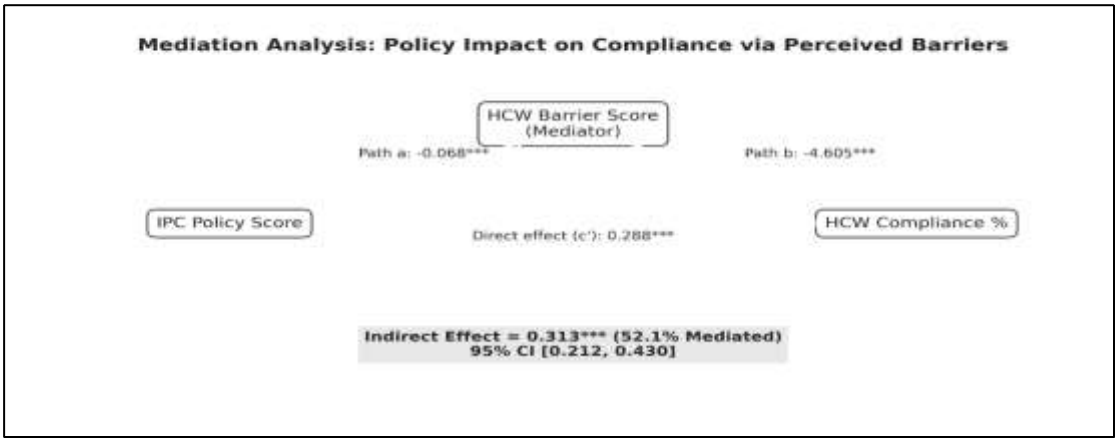
Quantitative Finding	Emergent Qualitative Theme	Illustrative Participant Quotations (Role, Unit)	Implication for IPC
Highest Barrier Score in MICU (3.65)	"Crisis Over Compliance": Competi ng clinical priorities in high-acuity settings.	"When a patient is crashing, you have ten things to do at once. The aseptic non-touch technique for a central line becomes a secondary thought." (Senior Nurse, MICU)	Time pressure and clinical urgency directly override protocol adherence.
Strong negative correlation between Barriers and Compliance (r = -.945)	"The Resource Chasm": Disconnect between policy mandates and available equipment/time.	"The policy says 'perform hand hygiene between every patient contact.' But when you have 8 patients and the alcove dispenser is empty for the 3rd time this week, what is the real policy?" (Staff Nurse, Surgery)	Perceived futility and system failure erode motivation to comply.
Lower Barriers in Orthopedic s (2.05)	"Embedded Routine": Procedural standardization in elective settings.	"In joint replacement, the entire process from pre-op to discharge is a checklist. IPC isn't an extra step; it's step one, two, and three of the list. It's the culture." (Surgeon, Orthopedics)	High-reliability processes and strong safety culture normalize compliance.

Barriers mediate Policy-Compliance link	"Paper vs. Practice": Policy accessibility and practical relevance.	"The 50-page IPC manual is in the manager's office. What I need is a one-page guide for my specific ward's top three infection risks, posted where I actually do the work." (Charge Nurse, MICU)	Policies must be context-specific, accessible, and actionable to reduce perceived barriers.









DISCUSSION

The paper presents a critical analysis of the application of the policies, Infection Prevention and Control (IPC), into clinical practice in a tertiary hospital in Saudi Arabia to validate and put into perspective the issue of healthcare-associated infections (HAIs) in the context of the healthcare sector in the Kingdom [14]. The results shed some light on a critical pathway: IPC policies' structural quality affects healthcare worker (HCW) behavior not directly, but rather by decreasing the perceived barriers to compliance, which in turn is a dominant predictor of HAI outcomes.

We strongly find that IPC policy scores and compliance rates observed were negative predictors of HAI incidence density, even when we factored out patient acuity and staffing ratios [15]. This goes directly to the main research issue, as it confirms that the effect of IPC is achieved through the quantifiable adherence and not the presence of policies alone. The trend of units (high acuity, high barrier environment, such as MICU, to standardized, lower barrier, such as Orthopedics) underscores the significant impact of clinical context. The mediating role of HCW-perceived barriers was the most significant finding that accounted for over half (52.1%) of the impact of policy on compliance [16]. This implies that even well-intended policies are curtailed by too much contextual opposition, like time constraints and conflicting clinical needs in complex settings like the MICU, which is not as strong in elective care environments.

These results correspond and are an extension of the international evidence base. A close relation between compliance and HAI rates is well-tested in such seminal works as the Clean Care is Safer Care program by WHO and works [17], which legitimized hand hygiene as the foundation of HAI reduction. A more sophisticated mechanistic explanation is provided by our analysis of mediation, though. It promotes the idea of the theory-practice gap that has been extensively debated in implementation science as the obstacles present in infrastructures, such as the Theoretical Domains Framework [18], including the environmental context, resources, and beliefs about consequences, are there to filter the policy and action. The barrier scores are also high in the MICU, which is consistent with the literature on intensive care units around the world, indicating that extreme workload and cognitive load are the main impediments to protocol adherence [19]. These are global issues, not peculiar to any particular health system, which is corroborated by our data from a Saudi center.

These relationships, which have been observed, can be scientifically explained by the chain of transmission of nosocomial pathogens. The primary causes of HAIs are the introduction of pathogens to vulnerable patients, which is usually through the hands of HCWs that are not properly decontaminated or poorly decontaminated equipment [20]. Adherence to hand hygiene and aseptic technique is high, and this directly breaks this physical chain of transmission. In case policies are not well applied or barriers (such as missing supplies or emergency clinical work) exist, compliance fails, providing loopholes in this chain [21]. The resultant augmented bioburden within the patient setting augments the statistical propensity of transmission events, which is indicated in an augmented HAI incidence density. Thus, our statistical model basically measures the degree to which administrative and behavioral failures at the upstream lead to downstream microbiological hazards [22].

The practice implication in Saudi Arabia and other similar places is significant. In the future, IPC program evaluations should not occur as a document audit anymore but as a systematic measurement of contextual barriers and direct compliance [23]. The allocation of resources must be based not only on policy development but also on barrier mitigation, including the provision of reliable access to alcohol-based hand rub at all points of care, efficient staffing models in units with high rates of risk, and protocols of simplified examples and specific design to high-pressure settings [24]. A safety culture should be developed by leadership in which IPC is regarded as a non-negotiable part of quality care and not an administrative attachment.

This study has limitations. Its single-center design can reduce its external validity to smaller or specialized hospitals in the varied health sector of Saudi Arabia. The compliance data is observational and, though strong, is prone to the Hawthorne effect [25]. Moreover, the HAI surveillance, which is grounded on the CDC/NHSN criteria, is vulnerable to differences in the detection and reporting intensity. To confirm these findings, future multi-center, longitudinal studies on various regions of the Kingdom are required [26]. The cost-effectiveness of particular barrier-mitigation interventions should also be studied, and the involvement of specific education, leadership involvement, and audit-with-feedback programs based on the Saudi culture and institutional context should be examined to bridge the policy-practice gap in a sustainable way.

CONCLUSION

This research was carried out in a Saudi Arabian hospital, which was of a tertiary level, and it confirmed that the reported quality of IPC policies and the consequent adherence of healthcare providers was a major independent predictor of reduced HAI rates, even after accounting the patient acuity and staffing. The results established that strong policies are required but not enough; their practical implementation is too dependent on making frontline staff feel that they have fewer obstacles to compliance. The study was able to achieve its goals as it was able to determine a direct, quantifiable connection between policy implementation faithfulness and clinical outcomes. The main scientific input is the fact that the policy-practice-outcome pathway is empirically validated in the Kingdom. Finally, it is important to go beyond policy formulation to guarantee contextual and resource-heavy implementation to succeed in the IPC. The directions of future research should be directed at designing and implementing barrier-specific interventions that address the high-risk units such as ICUs to close the gap that has been identified between policy and practice.

References

1. Al-Tawfiq, J. A. (2025). Striving for zero traditional and non-traditional healthcare-associated infections (HAI): a target, vision, or philosophy. Antimicrobial Stewardship & Healthcare Epidemiology, 5(1), e146.
2. Storr, J., Twyman, A., Zingg, W., Damani, N., Kilpatrick, C., Reilly, J., ... & Allegranzi, B. (2017). Core components for effective infection prevention and control programmes: new WHO evidence-based recommendations. Antimicrobial Resistance & Infection Control, 6(1), 6.
3. World Health Organization. (2024). Global strategy on infection prevention and control. World Health Organization.
4. Heidt, B., Siqueira, W. F., Eersels, K., Diliën, H., van Grinsven, B., Fujiwara, R. T., & Cleij, T. J. (2020). Point of care diagnostics in resource-limited settings: A review of the present and future of PoC in its most needed environment. Biosensors, 10(10), 133.
5. Abalkhail, A., & Alslamah, T. (2022). Institutional factors associated with infection prevention and control practices globally during the infectious pandemics in resource-limited settings. Vaccines, 10(11), 1811.
6. Kaiwan, O., Sethi, Y., Khehra, N., Padda, I., Chopra, H., Chandran, D., ... & Kaka, N. (2023). Emerging and re-emerging viral diseases, predisposing risk factors, and implications of international travel: A call for action for increasing vigilance and imposing restrictions

under the current threats of recently emerging multiple Omicron subvariants. International Journal of Surgery, 109(3), 589-591.
7. Haseeb, A., Saleem, Z., Faidah, H. S., Saati, A. A., AlQarni, A., Iqbal, M. S., ... & Sheikh, A. (2023). Threat of antimicrobial resistance among pilgrims with infectious diseases during Hajj: lessons learnt from COVID-19 pandemic. Antibiotics, 12(8), 1299.
8. Ali, M. E., Pandit, M., & Ali, M. (2024). Barriers to Implementing Infection Control Guidelines in Intensive Care Units. Mader-e-Milat International Journal of Nursing and Allied Sciences, 2(2), 36-52.
9. Tyner, B., Plunkett, T., O'Neill, M., Clyne, B., Comber, L., Walsh, K., ... & Ryan, M. Infection Prevention and Control (IPC) National Clinical Guideline No. 30: Annex A: Clinical and cost-effectiveness of healthcare-associated infection interventions: a systematic review.
10. Steinecker, H. W. (2025). Challenges and Strategies of Implementing the World Health Organization Infection Control Protocols in Rural Ugandan Hospitals (Doctoral dissertation, The Medical College of Wisconsin).
11. Guerra-Paiva, S., Lobão, M. J., Simões, D. G., Fernandes, J., Donato, H., Carrillo, I., ... & Sousa, P. (2023). Key factors for effective implementation of healthcare workers support interventions after patient safety incidents in health organisations: a scoping review. BMJ open, 13(12), e078118.
12. Almoghairi, A. M., O'Brien, J., & Duff, J. (2024). Perspectives of Policymakers on Barriers to and Enablers of the Uptake of Cardiac Rehabilitation in Saudi Arabia: A Qualitative Study. Journal of the Saudi Heart Association, 36(4), 371.
13. Alodhialah, A. M. (2025). Exploring the influence of organizational culture on evidence-based practice adoption among nurses in tertiary hospitals: a qualitative study. BMC nursing, 24(1), 1029.
14. Awal, Z. A. A. (2025). Factors influencing healthcare workers' adherence to infection prevention and control in Saudi Arabia (Doctoral dissertation, University of Glasgow).
15. Garlasco, J., D'Ambrosio, A., Vicentini, C., Quattrocolo, F., & Zotti, C. M. (2024). Impact of hospital-related indicators on healthcare-associated infections and appropriateness of antimicrobial use according to a national dataset. Scientific Reports, 14(1), 31259.
16. McKelvy, B., Cortes, J., & Keene, A. (2024). Infection Prevention Challenges in the Medical Intensive Care Unit (MICU). In Infection Prevention in the Intensive Care Setting (pp. 77-103). Cham: Springer International Publishing.
17. Amani, D. (2024). How do COVID-19 preventive measures build corporate reputation: Focus on the hospitality industry in Tanzania. International Hospitality Review, 38(1), 182-200.
18. Banks, G. C., Pollack, J. M., Bochantin, J. E., Kirkman, B. L., Whelpley, C. E., & O'Boyle, E. H. (2016). Management's science–practice gap: A grand challenge for all stakeholders. Academy of Management Journal, 59(6), 2205-2231.
19. Graham, N. (2024). Understanding the Determinants of Critical Care Nurses' Use of Sedation Interruptions for Adult Mechanically Ventilated Patients (Doctoral dissertation, Université d'Ottawa/University of Ottawa).
20. Collins, A. S. (2011). Preventing health care–associated infections.
21. Rowan, N. J., & Laffey, J. G. (2020). Challenges and solutions for addressing critical shortage of supply chain for personal and protective equipment (PPE) arising from Coronavirus disease (COVID19) pandemic–Case study from the Republic of Ireland. Science of the Total Environment, 725, 138532.

22. Smith, D. (2021). Mathematical modelling and simulation of the transmission, surveillance and control of human pathogens in healthcare settings (Doctoral dissertation, Université Paris-Saclay).
23. Alhumaid, S., Al Mutair, A., Al Alawi, Z., Alsuliman, M., Ahmed, G. Y., Rabaan, A. A., ... & Al-Omari, A. (2021). Knowledge of infection prevention and control among healthcare workers and factors influencing compliance: a systematic review. Antimicrobial Resistance & Infection Control, 10(1), 86.
24. McKnight, J. (2025). Hand hygiene. Everybody Fails But Not Everybody Learns: Why is it so hard to learn from failures?, 119.
25. Alshamrani, M. M., El-Saed, A., Othman, F., Al Zunitan, M., Noushad, S., Albadawi, A., ... & Almohrij, S. (2025). Determinants of non-compliance with hand hygiene using a covert direct observation methodology. Infection Prevention in Practice, 7(1), 100442.
26. El-Saed, A., Noushad, S., Tannous, E., Abdirizak, F., Arabi, Y., Al Azzam, S., ... & Balkhy, H. H. (2018). Quantifying the Hawthorne effect using overt and covert observation of hand hygiene at a tertiary care hospital in Saudi Arabia. American journal of infection control, 46(8), 930-935.