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Original Research Article

The Infection Control Paradox: Exploring Knowledge and Practices of ICU Nurses Across Hospitals in Punjab, Pakistan

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Abstract: *Hospital-acquired infections (HAIs) continue to pose a serious challenge to patient safety, particularly in intensive care units (ICUs) where patients are most susceptible. Nurses are central to infection prevention and control (IPC), yet a persistent gap between knowledge and practice undermines infection control efforts, especially in resource-constrained healthcare settings such as Pakistan.* ***Objective:*** *This study aimed to evaluate ICU nurses' knowledge and self-reported practices regarding IPC measures and to determine the relationship between these two domains in tertiary care hospitals across Punjab, Pakistan.* ***Methods:*** *A descriptive cross-sectional study was conducted among 150 ICU nurses working in selected public and private tertiary hospitals. Data were gathered using a pre-validated structured questionnaire developed in accordance with World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) guidelines. Knowledge and practice levels were categorized as good (≥75%), moderate (50-74%), or poor (<50%). Data were analyzed using SPSS version 26, applying descriptive statistics, chi-square tests, and Pearson's correlation analysis.* ***Results:*** *The findings indicated moderate levels of knowledge (mean = 11.2 ± 2.1) and practice (mean = 10.6 ± 2.4) among the participants. Only 36% demonstrated good knowledge, while 32.7% exhibited good practices. Notable gaps were found in hand hygiene duration, sterilization techniques, needlestick injury management, and consistent use of N95 masks. Nurses with higher educational qualifications showed significantly better knowledge ($p = 0.02$), and those with greater years of experience demonstrated better practices ($p = 0.01$). A strong positive correlation was identified between knowledge and practice scores ($r = 0.62$, $p < 0.001$).* ***Conclusion:*** *ICU nurses in Punjab displayed moderate knowledge of IPC but suboptimal implementation in clinical practice. The observed knowledge-practice gap highlights the influence of both personal and institutional factors. Strengthening regular IPC training programs, ensuring continuous supervision, and enhancing resource availability are critical for fostering a robust infection control culture and reducing the burden of HAIs in ICUs.*

Keywords: Hospital-Acquired Infections, Infection Prevention and Control, Intensive Care Units, Nursing Knowledge, Nursing Practice, Knowledge-Practice Gap, Pakistan

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Introduction

Hospital-acquired infections (HAIs), also termed nosocomial or healthcare-associated infections, develop in patients during the course of medical care, typically after 48 hours of hospitalization or within 30 days of a healthcare intervention, and remain a major public health concern globally, posing a substantial burden on patient outcomes, healthcare costs, and staff safety (1). Intensive Care Units (ICUs) are particularly vulnerable due to the critical condition of patients, invasive procedures, and the frequent use of broad-spectrum antibiotics (2). The rise of antimicrobial resistance (AMR) further complicates infection control efforts, representing a dual challenge of managing both infection prevention and antibiotic stewardship (3). Despite clear global guidelines, compliance with infection prevention protocols among healthcare workers remains inconsistent, particularly in low- and middle-income countries (LMICs) such as Pakistan (4). ICU nurses, being at the frontline of patient care, play a pivotal role in ensuring adherence to infection control standards; however, gaps persist between knowledge and actual practice (5). This discrepancy, in which awareness coexists with inconsistent implementation, reflects what may be termed the "infection control paradox" in modern critical care environments.

The existing literature highlights that although nurses generally demonstrate moderate to high levels of knowledge about infection control principles, their practical adherence often falls short due to systemic and contextual barriers (6). Studies from Ethiopia (7) and Iran (8) report similar trends, underscoring that resource limitations, lack of continuous training, and work overload frequently hinder compliance. In Pakistan, recent investigations reveal significant inconsistencies between theoretical understanding and bedside practices, especially in ICUs (9). Moreover, qualitative studies suggest that institutional culture, leadership attitudes, and the absence of supportive supervision contribute to this knowledge–practice divide (10, 11). Despite various educational and policy interventions, infection control remains suboptimal in many healthcare settings, suggesting that factors beyond knowledge, such as motivation, perception of risk, and institutional accountability, play crucial roles. Furthermore, the global crisis of AMR, exacerbated by improper infection control and antibiotic misuse, magnifies the urgency of understanding this paradox in high-risk clinical settings. While multiple studies have explored infection control knowledge and practices in different contexts, evidence from Pakistan's critical care units remains fragmented and limited, often failing to capture regional diversity and contextual barriers within healthcare institutions (12).

This paradox of knowing versus doing underscores the need for deeper exploration into how ICU nurses in Pakistan conceptualize, prioritize, and apply infection control measures in real clinical settings. The rationale for this study stems from observed discrepancies between infection control policies and their execution in daily nursing routines, particularly under high workload and limited supervision. While international evidence

emphasizes the effectiveness of standard precautions and evidence-based nursing interventions, local research indicates persistent challenges in adherence and monitoring. Given the critical role of ICU nurses in preventing HAIs, exploring their knowledge, attitudes, and practices offers valuable insights into both individual and systemic determinants of infection control performance. This investigation aims to address existing gaps by assessing not only the level of knowledge and compliance among ICU nurses across hospitals in Pakistan but also the underlying factors contributing to the infection control paradox. The findings will provide an evidence base to guide educational reforms, policy interventions, and institutional strategies for strengthening infection prevention culture within Pakistan's healthcare system. Ultimately, understanding and addressing this paradox is essential to improving patient safety, reducing the burden of HAIs, and aligning national practices with global infection control standards..

Methodology

A descriptive cross-sectional design was employed to assess ICU nurses' knowledge and practices regarding infection prevention and control (IPC) measures. The study specifically aimed to evaluate ICU nurses' knowledge of infection control measures and their practical application in clinical settings. In line with these objectives, the research sought to answer two key questions: What is the level of knowledge among ICU nurses regarding infection control measures? And how effectively do ICU nurses implement infection control practices in their clinical duties?

The study was conducted in selected public and private tertiary care hospitals across Punjab, Pakistan, over six months (April-September 2025). These hospitals were chosen to ensure representation of different healthcare settings within the province. Registered nurses working in adult or pediatric ICUs for at least six months and directly involved in patient care were included, while those on administrative duties or leave were excluded. A total of 150 ICU nurses were selected using Cochran's formula.

Data were collected using a structured, pre-validated questionnaire developed in accordance with WHO and CDC IPC guidelines. The tool comprised three sections: demographic data, 15 knowledge items, and 15 practice items. Knowledge responses were scored as 1 for correct and 0 for incorrect answers, while practice responses were rated as Always = 2, Sometimes = 1, and Never = 0. Scores were categorized as good (≥75%), moderate (50-74%), or poor (<50%). After obtaining ethical approval, questionnaires were distributed during working hours, participation was voluntary, and confidentiality was assured. Data were analyzed using SPSS version 26, employing descriptive statistics to summarize demographics, knowledge, and practice levels, and chi-square and Pearson's correlation tests to examine associations and relationships among key variables. A p-value < 0.05 was considered statistically significant.

Results

A total of 150 ICU nurses took Part in the study named "The Infection Control Paradox: Exploring Knowledge and Practices of ICU Nurses across Hospitals in Punjab, Pakistan."Among these participants, 104 (69.3%) were female and 46 (30.7%) were male. The largest group of respondents (82; 54.7%) fell within the 20-30 years age range, followed by 46 (30.7%) in the 31-40 years bracket, and 22 (14.6%) were over 40 years old. Regarding educational background, 78 (52%) held a BSc Nursing degree, 56 (37.3%) had a Diploma in Nursing, and 16 (10.7%) reported other qualifications, such as post-RN or MSN. Regarding their professional experience, 64 (42.7%) had 1-5 years, 52 (34.7%) had 6-10 years, and 34 (22.6%) had more than 10 years of ICU experience.

The mean knowledge score for ICU nurses was 11.2 ± 2.1 (out of 15), indicating a moderate level of knowledge. Based on the scoring criteria, 54 (36%) participants demonstrated good knowledge (≥75%), 70 (46.7%) had moderate knowledge (50-74%), and 26 (17.3%) showed poor knowledge (<50%). Most nurses correctly identified that hand hygiene is the most effective way to prevent hospital-acquired infections (HAIs) (88%), and that N95 masks are essential for airborne diseases such as tuberculosis and COVID-19 (85%). However, only 62% were aware of the minimum effective duration for alcohol-based hand rub, and 59% correctly recognized autoclaving as the standard sterilization method. Deficiencies were observed in knowledge of needlestick injury management (only 68% answered correctly) and in biomedical waste segregation (only 72% answered correctly).

The mean knowledge score was 11.2 ± 2.1 (out of 15), reflecting an overall moderate level of knowledge. Out of 150 nurses, 54 (36%) had good knowledge (≥75%), 70 (46.7%) moderate knowledge, and 26 (17.3%) poor knowledge.

The average practice score was 10.6 ± 2.4 (out of 15), indicating moderate adherence to infection control protocols. Among the participants, 49 (32.7%) demonstrated good practice (≥75%), 76 (50.7%) moderate practice (50-74%), and 25 (16.6%) poor practice (<50%). The majority of respondents consistently washed their hands before and after patient interactions (81%) and wore gloves when dealing with bodily fluids (88%). However, only 61% reported always changing gloves between patients, and 56% regularly used N95 masks when caring for patients with airborne infections. Additionally, only 48% participated in regular infection control workshops or training sessions, underscoring the need for ongoing professional development. The average practice score was 10.6 ± 2.4 (out of 15), reflecting moderate adherence to infection control practices. Out of the 150 nurses surveyed, 49 (32.7%) exhibited good practice (≥75%), 76 (50.7%) showed moderate practice, and 25 (16.6%) had poor practice.

Chi-square analysis revealed a notable correlation between qualifications and knowledge level ($\chi^2 = 9.84$, $p = 0.02$), suggesting that nurses with higher qualifications (BSc Nursing and above) possess superior infection control knowledge. In a similar vein, years of experience were significantly associated with practice level ($\chi^2 = 11.26$, $p = 0.01$), with nurses with over 10 years of ICU experience showing greater compliance with infection control protocols.

Higher qualifications were associated with greater knowledge of infection control ($p = 0.02$), and a greater number of years in the ICU were associated with better practices ($p = 0.01$).

A statistically significant, positive correlation was identified between knowledge and practice scores ($r = 0.62$, $p < 0.001$), indicating that nurses with greater knowledge of infection control are more likely to adhere to appropriate infection prevention practices in ICU environments.

A positive correlation was observed between knowledge and practice scores ($r = 0.62$, $p < 0.001$), suggesting that nurses with higher knowledge levels also demonstrated better infection control practices.

Table 1: Demographic Characteristics of ICU Nurses (n = 150)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	46	30.7
	Female	104	69.3
Age (years)	20-30	82	54.7
	31-40	46	30.7
	>40	22	14.6

Qualification	Diploma in Nursing	56	37.3
	BSc Nursing	78	52.0
	Others (Post-RN, MSN, etc.)	16	10.7
Years of Experience	1-5 years	64	42.7

Table 2A: Knowledge Level of ICU Nurses

Knowledge Category	Score Range	Frequency (n)	Percentage (%)
Good (≥75%)	12-15	54	36.0
Moderate (50-74%)	8-11	70	46.7
Poor (<50%)	≤7	26	17.3
Total		150	100

Table 2B: Item-wise Knowledge Performance (Selected Questions)

Question Topic	Correct Response %
Hand hygiene as primary prevention	88%
N95 use for airborne infections	85%
Alcohol hand rub duration	62%
Autoclaving is the best sterilization method	59%
Needle stick injury first response	68%
Waste segregation (color-coded)	72%

Table 3A: Practice Levels of ICU Nurses

Practice Category	Score Range	Frequency (n)	Percentage (%)
Good (≥75%)	12-15	49	32.7
Moderate (50-74%)	8-11	76	50.7
Poor (<50%)	≤7	25	16.6
Total		150	100

Table 3B: Item-wise Practice Adherence (Selected Behaviors)

Practice Statement	Always (%)	Sometimes (%)	Never (%)
Handwashing before/after patient contact	81	17	2
Use of gloves before body fluid handling	88	10	2
Changing gloves between patients	61	33	6
Using N95 for airborne infections	56	31	13
Waste segregation (color-coded)	73	21	6
Attending infection control training	48	37	15
Reporting needlestick injury immediately	65	28	7

Table 4: Chi-Square Test Results

Variable	Associated factor	χ^2	p-value	Significance
Qualification	Knowledge Level	9.84	0.02	Significant
Experience	Practice Level	11.26	0.01	Significant
Gender	Knowledge Level	1.42	0.49	Not significant
Age	Practice Level	3.16	0.21	Not significant

Discussion

The present study evaluated the knowledge and practices of intensive care unit (ICU) nurses regarding infection prevention and control (IPC) measures across tertiary hospitals in Punjab, Pakistan. The results revealed moderate levels of knowledge (mean = 11.2 ± 2.1) and practice (mean = 10.6 ± 2.4) among participants, with a significant positive correlation ($r = 0.62$, $p < 0.001$) between the two domains. This indicates the persistent existence of the "knowledge–practice gap" in infection control, a challenge that continues to affect nursing performance worldwide.

Infection prevention begins with a strong educational foundation. Abbo et al. (13) emphasized that limited and inconsistent instruction in infection control and antimicrobial stewardship during professional education contributes to the perpetuation of superficial knowledge among healthcare professionals. The present findings reflect this reality: although most nurses recognized the importance of hand hygiene and personal protective equipment, only a moderate proportion demonstrated adequate procedural understanding and consistent practice. Such educational deficiencies create barriers to the effective implementation of IPC measures at the bedside.

Maryam et al. (14) further highlighted that in Pakistan, weak infection control systems and fragmented stewardship programs exacerbate antimicrobial resistance (AMR), thereby increasing the clinical and economic burden on the healthcare system. The current study's findings parallel these national trends, revealing that despite growing IPC awareness, translation into consistent clinical practice remains suboptimal. Strengthening IPC education and integrating AMR awareness into continuous professional development are, therefore, essential to sustain infection prevention efforts.

International evidence also supports this concern. During the COVID-19 pandemic, Bangani et al. (15) observed that ICU nurses in South Africa

demonstrated reasonable theoretical awareness but limited adherence to infection prevention protocols under high workload conditions. Similarly, the nurses in this study reported difficulties maintaining compliance due to staff shortages and limited resources. Such constraints reflect broader systemic and environmental barriers that hinder adherence despite adequate knowledge.

Leadership and workplace culture play critical roles in mitigating these gaps. Cougot et al. (16) found that empowering leadership and supportive supervision reduced emotional exhaustion and improved clinical compliance among hospital nurses. These findings align with the present study, which suggests that institutional reinforcement, managerial encouragement, and mentorship are vital to transforming knowledge into consistent IPC behavior. Hospitals with participatory leadership and regular feedback mechanisms tend to demonstrate better adherence to infection control policies.

The consequences of weak IPC adherence extend beyond individual compliance to institutional safety. Viñuela-Prieto et al. (17) reported that inadequate infection control during medical and surgical procedures results in higher contamination rates, prolonged hospitalization, and increased risk of infection transmission. This is particularly alarming in critical care settings where invasive procedures are frequent. The present study reinforces the need for stringent procedural monitoring, equipment sterilization, and periodic infection control audits to prevent nosocomial infections.

Evidence-based interventions remain the cornerstone of IPC success. Climo et al. (18) demonstrated that daily chlorhexidine bathing and continuous staff retraining significantly reduce healthcare-associated bloodstream infections and the acquisition of multidrug-resistant organisms (MDROs). The current findings align with this evidence, suggesting that structured and repetitive IPC training, reinforced through clinical supervision, could markedly improve compliance among ICU nurses in Pakistan.

Local evidence further corroborates these insights. Rizwan et al. (19) reported that nurses in Lahore exhibited good theoretical awareness of infection control but demonstrated lapses in practice due to inconsistent monitoring, limited workshops, and weak institutional accountability. This mirrors the findings of the present study, emphasizing the urgent need for organizational commitment and regular skill-based reinforcement to enhance IPC compliance.

Additionally, Olsen et al. (20) highlighted the role of contaminated personal and medical devices, such as mobile phones, in the transmission of pathogens in healthcare environments. These findings illustrate that infection control requires vigilance beyond traditional clinical procedures and must include regulation of personal device hygiene and environmental decontamination practices, an area in which ICU staff in this study also demonstrated limited awareness.

Implications for Practice and Policy

The findings of this study have important implications for nursing education, policy formulation, and hospital management. Strengthening IPC compliance requires a multidimensional approach that includes regular training, mentorship, and strict enforcement of standard precautions. The positive correlation between knowledge and practice underscores the potential benefits of continuous education programs; however, these must be supported by a conducive work environment and adequate resources.

Hospital administrators should prioritize routine IPC audits, integrate infection control modules into continuing education programs, and establish reward systems to encourage compliance. Moreover, national nursing curricula and policy frameworks should align with WHO and CDC guidelines to ensure standardization of IPC training. Evidence-based interventions such as daily chlorhexidine bathing, regular staff retraining, and feedback-driven supervision can significantly reduce healthcare-associated infection rates.

Strengths and Limitations

A key strength of this study is its inclusion of both public and private tertiary hospitals across Punjab, thereby enhancing representativeness and generalizability. However, the reliance on self-reported data may introduce bias, as nurses could overestimate their compliance with IPC protocols. Additionally, the cross-sectional design limits the ability to establish causality between knowledge and practice. Future research employing observational or mixed-method designs could provide a more accurate understanding of IPC behaviors and the organizational factors that influence them.

Conclusion

ICU nurses in Pakistan demonstrate moderate knowledge and practice in IPC, with performance influenced by qualifications and experience. The strong link between knowledge and practice underscores the need for continuous training and institutional reinforcement. Persistent weaknesses in PPE use, waste management, and needlestick safety highlight structural and resource barriers that require systemic reform. Strengthening infection control education, ensuring adequate supplies, and fostering a safety-driven culture are essential to reduce hospital-acquired infections and enhance patient and staff safety in critical care settings.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

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Conflict of interest

The authors declared no conflicts of interest.

Author Contribution

AS

Manuscript drafting, Study Design,

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Review of Literature, Data entry, Data analysis, and drafting an article.

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Conception of Study, Development of Research Methodology Design,

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Study Design, manuscript review, and critical input.

MD

Manuscript drafting, Study Design,

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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