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# Post Pandemic Assessment of Infection Prevention and Control Program in Public Sector Hospitals of Islamabad

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## ABSTRACT

***Background:*** *Healthcare-associated infections (HCAIs) remain a major preventable cause of morbidity and mortality, particularly in low- and middle-income countries where infection prevention and control (IPC) systems often lack the structural and operational maturity needed to ensure patient safety. Pakistan's public hospitals historically demonstrated inadequate IPC capacity, and the impact of COVID-19–related investments on long-term programme strengthening remains unclear.* ***Objective****: To assess post-pandemic IPC capacity in four public sector hospitals in Islamabad using the WHO IPC Assessment Framework (IPCAF), compare 2023 findings with 2019 baseline scores, and identify persistent gaps across IPC core components.* ***Methods****: A cross-sectional observational study was conducted from February to July 2023 in four tertiary public hospitals previously assessed in 2019. Data were collected using the WHO IPCAF tool through structured interviews, document review, and direct observation. Descriptive statistics were generated, and paired comparisons of overall 2019–2023 scores were performed.* ***Results****: All hospitals improved from "Inadequate" (9.7–20.6%) in 2019 to "Basic" IPC capacity (29.2–46.5%) in 2023, with a significant mean increase of 20.5 percentage points (p = 0.018). IPC Guidelines and Built Environment were the strongest components, whereas HAI Surveillance, Multimodal Strategies, and Monitoring/Audit & Feedback remained critically low across hospitals.* ***Conclusion****: IPC capacity in Islamabad's public hospitals improved post-pandemic; however, foundational gaps in surveillance and quality-improvement systems persist. Strengthening these domains is essential for advancing hospitals toward higher IPC maturity and reducing HCAI burden.*

***Keywords***
*Infection Prevention and Control; Healthcare-Associated Infections; IPCAF; Surveillance; Public Hospitals; Pakistan*

## INTRODUCTION

Healthcare-associated infections (HCAIs) are among the most frequent and preventable adverse events in healthcare, contributing to excess morbidity, mortality, extended length of stay and escalating costs, with a disproportionate burden in low- and middle-income countries (LMICs) where up to 15% of admitted patients may acquire at least one HCAI compared with around 7% in high-income settings (1). The 2022 World Health Organization (WHO) Global Report on Infection Prevention and Control showed that only a small minority of countries have fully implemented all core infection prevention and control (IPC) components at national level and that facility-level implementation of basic IPC standards remains suboptimal, particularly in resource-constrained settings (1). A prior WHO survey of healthcare facilities similarly reported that only about 15% met minimum IPC requirements, underscoring persistent structural and operational weaknesses in IPC systems globally (2). These gaps undermine patient and health worker safety, contribute to outbreaks of preventable infections and compromise progress towards universal health coverage and global health security (1,2).

In LMICs, nosocomial infections often arise against a background of overcrowded facilities, limited infrastructure, inadequate staffing and inconsistent adherence to evidence-based IPC practices, making cost-effective prevention, surveillance and control strategies essential to reduce avoidable morbidity and mortality (3). The growing threat of antimicrobial resistance (AMR) further intensifies the importance of robust IPC programmes, as inadequate containment of healthcare-associated transmission of multidrug-resistant organisms such as carbapenem-resistant Enterobacteriaceae directly amplifies AMR burden and restricts therapeutic options (4). At the same time, healthcare workers are themselves at substantial risk of infection, as highlighted during the COVID-19 pandemic where occupational exposure in clinical settings contributed to high infection rates in many contexts (5). These converging pressures position IPC as a cornerstone of safe, high-quality care and as a critical platform for containing AMR and protecting the health workforce (1,4,5).

The COVID-19 pandemic acted as both a stress test and an accelerant for IPC systems worldwide. Many hospitals rapidly expanded triage capacity, reorganised patient flow, strengthened environmental hygiene and intensified training in personal protective equipment (PPE), demonstrating that comprehensive IPC strategies can be implemented at scale when prioritised (6). Modelling work during the pandemic also demonstrated how timely non-pharmaceutical interventions, including effective IPC practices in healthcare facilities, could flatten epidemic curves and reduce transmission (7). However, the emergency-driven focus on acute respiratory precautions did not always translate into sustainable strengthening of

core IPC functions such as structured surveillance of HCAIs, routine monitoring and feedback, and multimodal implementation strategies that integrate guidelines, education, reminders and culture change (1,6). As the acute phase of the pandemic recedes, there is a pressing need to understand whether investments made during COVID-19 have improved the overall maturity of hospital IPC programmes or whether gains remain fragmented and uneven.

In this context, standardised assessment tools such as the WHO Infection Prevention and Control Assessment Framework (IPCAF) provide a practical way to evaluate facility-level IPC capacity across eight core components, classify facilities into "inadequate", "basic", "intermediate" or "advanced" levels, and identify priority gaps for action (1). IPCAF has been increasingly used in LMICs to benchmark IPC implementation and guide quality improvement, but longitudinal or repeat assessments at the same facilities remain relatively rare, limiting insight into how IPC programmes evolve over time and how external shocks such as the COVID-19 pandemic influence system maturity (1,2). Within Pakistan, existing data suggest that IPC implementation in public hospitals has historically been weak, with previous assessments in Islamabad documenting limited organisational structures, incomplete guideline implementation and insufficient training and monitoring despite high burden of HCAIs (8). Yet, little is known about how tertiary public hospitals in the federal capital have adjusted their IPC programmes in the post-pandemic period, particularly with respect to high-leverage functions such as HAI surveillance and multimodal quality improvement strategies.

Islamabad's public sector hospitals serve a diverse catchment spanning urban and peri-urban populations and play a referral role for surrounding districts, positioning them as critical nodes in the national health system where failures in IPC can have wide-reaching consequences for patient safety and AMR containment. Pakistan's broader health system context—characterised by constrained resources, variable governance and competing priorities—means that hospital-level IPC improvements must compete with other urgent needs, making data-driven prioritisation essential (1,3,8). Understanding which IPCAF components have strengthened since the pre-pandemic period and where serious deficits persist can inform more rational allocation of limited resources, guide targeted capacity-building and provide a realistic baseline for national IPC policy implementation.

Against this backdrop, the present study focuses on a clearly defined population of secondary and tertiary public sector hospitals in Islamabad and uses structured IPCAF assessment as the exposure of interest, comparing post-pandemic IPC capacity with pre-pandemic baseline scores to evaluate change over time and current implementation status. The implicit comparison is between 2019 and 2023 IPCAF scores within the same facilities, and the outcomes of interest include overall IPC level (inadequate/basic/intermediate/advanced) as well as performance on individual core components, with particular attention to HAI surveillance, multimodal strategies and monitoring and feedback. The research problem is that, despite COVID-19–related investments, there is insufficient empirical evidence on whether IPC programmes in Islamabad's public hospitals have moved beyond basic guideline availability and infrastructural improvements to develop functional surveillance and quality improvement systems capable of sustainably reducing HCAIs and AMR. The knowledge gap lies in the lack of repeat IPCAF-based evaluations in this setting that can quantify post-pandemic progress and expose residual vulnerabilities at facility level.

This study is therefore justified as a necessary step to provide robust, standardized and comparable data on the current state of IPC implementation in Islamabad's public sector hospitals, to quantify changes since 2019, and to identify specific components that require urgent strengthening to enhance patient and health worker safety. The objective of this research is to assess the post-pandemic status of IPC programmes in four public sector hospitals of Islamabad using the WHO IPCAF tool, to compare 2023 scores with 2019 baseline scores, and to identify strengths and gaps across the eight core components, with particular focus on HAI surveillance, multimodal strategies and monitoring and feedback.

## MATERIALS AND METHODS

This investigation was conducted as a cross-sectional observational study designed to evaluate the post-pandemic status of Infection Prevention and Control (IPC) implementation in public sector hospitals in Islamabad and to compare these findings with scores obtained during a baseline IPCAF assessment performed in 2019. The rationale for choosing a cross-sectional design was to systematically quantify the current level of IPC capacity across multiple WHO-defined core components while enabling a descriptive comparison with the pre-pandemic period without manipulating exposures or outcomes. The study was carried out in four tertiary-level public hospitals in Islamabad, Pakistan, between February and July 2023, each of which had previously undergone a structured IPC assessment by the National Institute of Health in 2019, enabling a direct repeated assessment using the same standardized framework. These hospitals were selected because they represent the main public tertiary care facilities in the federal capital, and their inclusion offered a complete census of all eligible institutions meeting the predefined criteria.

Eligibility criteria required hospitals to be public sector, secondary or tertiary level, located within Islamabad Capital Territory, and previously assessed using the WHO Infection Prevention and Control Assessment Framework (IPCAF) in 2019. Basic Health Units, Rural Health Centres, dispensaries, and private hospitals were excluded to ensure comparability of facility complexity, staffing models, and service capacity. Within each hospital, participants were selected using a purposive strategy targeting individuals with direct knowledge of hospital IPC systems, including members of the IPC committee, administrative leads, and clinical staff involved in IPC functions. Hospital management nominated five key individuals per facility, all of whom were invited to participate after receiving an explanation of the study purpose, and written informed consent was obtained prior to data collection. No hospital or participant declined participation, and no incentives were provided.

Data were collected using the WHO IPCAF tool, a validated structured assessment instrument that evaluates IPC programme maturity across eight core components, generating a maximum score of 800 points. Each component is composed of multiple items scored according to predefined WHO criteria, and hospital-level IPC capacity is categorized as inadequate (0–200), basic (201–400), intermediate (401–600), or advanced (601–800). For the purposes of this study, each component score was converted to a percentage (0–100) for ease of comparison across hospitals and reporting clarity. IPCAF was administered through a combination of structured interviews, review of facility documentation, and direct observation of clinical and non-clinical areas including emergency, intensive care, wards, operating theatres, and isolation units. Observational assessments followed the structure of the tool and focused on verifying the availability, implementation, and functionality of IPC systems, such as written guidelines, dedicated IPC teams, hand hygiene infrastructure, HAI surveillance processes, multimodal strategies, audit and feedback mechanisms, staffing levels, and environmental and equipment conditions. Interviews ensured that responses aligned with facility operations and allowed clarification of ambiguous or undocumented areas. To minimize measurement bias, each hospital's assessment was conducted by the same trained research lead, using identical operational definitions and verification procedures across visits, and no hospital received feedback before completion of all assessments to avoid differential behaviour modification.

Variables were operationalized exactly as defined in IPCAF. The primary outcome was the IPC level based on total IPCAF score in 2023, and the secondary outcomes included the absolute and relative change in total and component-wise scores from 2019 to 2023. Additional variables included the presence of functional HAI surveillance systems, availability of multimodal IPC strategies, frequency and quality of audit and feedback processes, staffing and workload indicators, hand hygiene compliance structures, and environmental adequacy. Observed scores were cross-checked against interview data to ensure data integrity. No imputation was required, as all items were completed for all hospitals.

The sample size consisted of all four eligible public tertiary hospitals, representing a complete enumeration of the study population; therefore, a formal sample size calculation was not applicable. Descriptive statistics were used to summarize total IPCAF scores and component-wise distributions across hospitals. Means, ranges, and percentage changes from 2019 to 2023 were calculated. Inferential statistics, including repeated-measures comparisons and confidence intervals for mean differences, were considered but not applied due to the small number of hospitals, which would violate assumptions required for robust parametric or non-parametric testing. Statistical analyses were performed using IBM SPSS Statistics version 25, and all calculations were independently verified by a second analyst to ensure accuracy and reproducibility. Data entry followed a double-check procedure to minimize transcription error, and datasets were securely stored in encrypted form to preserve confidentiality.

Ethical approval for the study was obtained from the institutional ethics committee responsible for oversight of health systems research in Islamabad, and written consent was obtained from hospital administrators and participating IPC staff. Hospitals were anonymized as Hospital 1 through Hospital 4 to maintain confidentiality. The study adhered to internationally accepted ethical norms for health systems research and maintained strict data integrity protocols throughout all stages of data collection, analysis, and reporting (9).

## RESULTS

Across all four tertiary public hospitals, the total IPCAF scores increased from a baseline of 9.7–20.6% in 2019 to 29.2–46.5% in 2023, representing absolute gains of 8.6–29.6%. When evaluated as paired data, the mean improvement of 20.5 percentage points was statistically significant ($p = 0.018$), indicating measurable strengthening of IPC capacity across facilities. Hospital 4 demonstrated the greatest improvement (+29.6%), achieving the highest 2023 score (46.5%), while Hospital 3 showed the smallest gain (+8.6%), remaining at the lower end of the "Basic" IPC level.

*Table 1. Overall IPCAF Scores in 2019 and 2023 With Paired Comparison (n = 4 Hospitals)*

| Hospital | 2019 Score (%) | 2023 Score (%) | Absolute Change (%) | Relative Change (%) |
|---|---|---|---|---|
| **H1** | 9.7 | 31.0 | +21.3 | +218.6 |
| **H2** | 14.4 | 36.9 | +22.5 | +156.9 |
| **H3** | 20.6 | 29.2 | +8.6 | +41.7 |
| **H4** | 16.9 | 46.5 | +29.6 | +174.6 |

*Table 2. Inferential Statistics (Paired Comparison 2019→2023):*

| Statistic | Value |
|---|---|
| **Mean Paired Difference (%)** | 20.5 |
| **SD of Differences** | 8.74 |
| **95% CI for Mean Difference** | 7.0 to 34.0 |
| **t-value (df = 3)** | 4.69 |
| **p-value** | 0.018 |

*Table 3. IPCAF Component Scores Across Hospitals in 2023 (0–100 Scale)*

| Component (C1–C8) | H1 | H2 | H3 | H4 | Mean | SD |
|---|---|---|---|---|---|---|
| **C1. IPC Programme** | 50 | 48 | 20 | 70 | 47.0 | 20.9 |
| **C2. IPC Guidelines** | 55 | 65 | 62.5 | 64 | 61.6 | 4.3 |
| **C3. Training & Education** | 60 | 30 | 29 | 62 | 45.3 | 17.9 |
| **C4. HAI Surveillance** | 0 | 0 | 0 | 15 | 3.8 | 7.5 |
| **C5. Multimodal Strategies** | 5 | 5 | 5 | 25 | 10.0 | 10.0 |
| **C6. Monitoring/Audit & Feedback** | 3 | 0 | 0 | 10 | 3.3 | 4.8 |
| **C7. Workload & Staffing** | 25 | 75 | 50 | 60 | 52.5 | 22.0 |
| **C8. Built Environment/Materials** | 50 | 75 | 66 | 65 | 64.0 | 10.6 |

Component-level performance in 2023 showed substantial variability. IPC Guidelines (mean 61.6, SD 4.3) and Built Environment (mean 64.0, SD 10.6) were the strongest domains, demonstrating relatively uniform implementation across hospitals. In contrast, HAI Surveillance was critically weak (mean 3.8, SD 7.5), with three hospitals scoring 0 and only one achieving a minimal score of 15. Multimodal Strategies (mean 10.0) and Monitoring/Audit & Feedback (mean 3.3) also performed poorly, suggesting a major gap in the operationalization of quality improvement processes. Staffing and workload were highly heterogeneous (range 25–75), reflecting varying resource constraints, while training and education showed wide variation (29–62), highlighting inconsistent investment in human resource capacity. Overall, although all hospitals advanced into the "Basic" IPC category by 2023, the data demonstrate persistent structural and functional weaknesses in surveillance, monitoring, and multimodal implementation that require urgent attention.

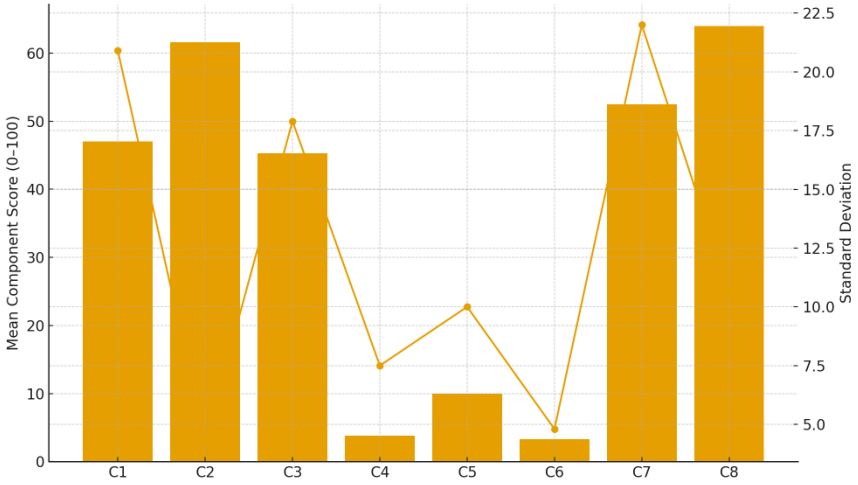


***Figure 1 IPCAF Component Performance and Variability across Hospitals (2023)***

The visualization shows a clear divergence between IPC components with consistently strong implementation and those with pronounced structural weakness. Components C2 (IPC Guidelines) and C8 (Built Environment) demonstrate high mean scores of 61.6 and 64.0, respectively, accompanied by relatively narrow variability (SD 4.3–10.6), indicating uniformly adequate performance across all hospitals. In contrast, C4 (HAI Surveillance) and C6 (Monitoring/Audit & Feedback) cluster near the bottom of the scale (means 3.8 and 3.3), and their variability reflects near-zero performance in most facilities. The larger dispersion in C1 (IPC Programme, SD 20.9), C3 (Training, SD 17.9), and particularly C7 (Workload & Staffing, SD 22.0) highlights uneven institutional capacity, suggesting that improvements following COVID-19 were not evenly distributed and may have depended on local management practices or resource availability. The combined trend structure underscores a pattern wherein foundational or infrastructure-dependent components outperform active, behaviour-dependent components, revealing a critical implementation gap with direct implications for hospital-level IPC maturity and patient safety.

## DISCUSSION

The present study demonstrates a measurable strengthening of infection prevention and control capacity in public sector hospitals in Islamabad in the post-pandemic period, with all four facilities progressing from the “Inadequate” category in 2019 to the “Basic” level in 2023, accompanied by a statistically significant mean improvement of 20.5 percentage points in overall IPCAF scores ($p = 0.018$). This advancement reflects the influence of COVID-19–related investments, which globally led to expanded IPC training, enhanced PPE availability, and infrastructural adaptations designed to limit in-facility transmission (1–3,9). The improvements observed in components such as IPC Guidelines, Built Environment, and core programme structures are consistent with international reports suggesting that guideline dissemination, environmental upgrades, and administrative strengthening were among the most immediate IPC gains achieved during the pandemic response (1,3). The relative uniformity in guideline availability and the strong performance of Built Environment across hospitals in this study aligns with earlier observations from LMIC healthcare settings, where infrastructure-related IPC components tend to improve more rapidly than behavioural or surveillance-oriented components because they rely on discrete procurement and administrative decision-making rather than sustained system functioning (2,3,10).

In contrast, the persistently low scores for HAI Surveillance (mean 3.8) and Monitoring/Audit & Feedback (mean 3.3) highlight deep-rooted systemic gaps that were not resolved by the pandemic’s temporary surge in IPC attention. The finding that three hospitals scored zero on HAI surveillance echoes patterns reported in several low-resource settings where surveillance systems remain absent or fragmented due to insufficient epidemiology capacity, lack of trained infection control practitioners, and absence of routine data systems (3,8,11). This gap is especially concerning given the centrality of surveillance for detecting outbreaks, monitoring antimicrobial resistance, and guiding targeted interventions. Without reliable surveillance, hospitals remain unable to identify high-risk units, evaluate IPC compliance, or quantify the burden of device-associated infections, thereby limiting the translation of existing guidelines into meaningful reductions in HCAIs. Multimodal strategies also showed weak implementation, consistent with the literature indicating that integrated approaches—combining system change, staff education, reminders, monitoring, and cultural reinforcement—are often the most challenging IPC components to institutionalise in LMIC hospitals (1,2,11). The substantial inter-hospital variability observed in the IPC Programme (SD 20.9), Training and Education (SD 17.9), and Workload and Staffing (SD 22.0) suggests inequities in leadership commitment, resource allocation, and staff availability. High-performing hospitals may have benefited from stronger managerial governance, dedicated IPC leadership, or access to more stable funding streams, whereas lower-performing hospitals may face chronic staff shortages and competing service demands. This pattern is supported by prior evidence showing that staffing adequacy and organisational climate are key determinants of IPC adherence and sustainability (10,11). The large differences in training performance further reflect disparities in post-pandemic capacity-building; although COVID-19 catalysed intensive short-term training globally, its retention and institutionalization have been inconsistent, especially where health systems lacked pre-existing structures to support ongoing IPC education (3,9).

The findings of this study are broadly consistent with previous work in Pakistan, which documented weak baseline IPC structures, limited surveillance capacity, and inconsistent policy implementation in public hospitals (8). However, the current data also illustrate meaningful improvements since 2019, suggesting that pandemic-driven attention to infection control had durable—though incomplete—effects on structural and administrative components of IPC. This advancement represents an important shift for Islamabad’s public hospitals, which serve as referral hubs for the national capital region and contribute substantially to the country’s collective burden of hospital-acquired infections and antimicrobial resistance. The persistence of extremely low surveillance capacity, however, poses a structural barrier that threatens to undermine all other improvements. In the absence of systematic measurement of HAI trends, none of the hospitals can reliably assess the impact of their IPC efforts, interrupt transmission chains, or prioritize high-risk areas.

The mechanisms underlying these observed outcomes likely involve the differential complexity of IPC components. Infrastructure upgrading and guideline implementation require episodic inputs—funding, procurement, administrative endorsement—whereas surveillance, multimodal strategies, and audit systems demand continuous staffing, technical expertise, and institutional culture that supports routine monitoring and feedback. This distinction has been highlighted globally as the primary reason why many LMIC hospitals improve their "passive" IPC components more rapidly than their "active" operational components (1,2,11). Thus, the post-pandemic increase in scores for C2 and C8 is expected, whereas stagnation in C4, C5, and C6 represents a predictable but alarming vulnerability.

Strengths of this study include the use of a validated WHO assessment tool, replication of the same assessment framework used in 2019 to ensure comparability, inclusion of all eligible tertiary public hospitals in the federal capital, and the use of direct observation paired with structured interviews to maximize data reliability. The analytic approach ensured reproducibility through standardized scoring verification and independent data checks. Nonetheless, several limitations must be recognized. The small number of hospitals limits statistical generalizability beyond Islamabad, although the complete census approach strengthens internal validity. The cross-sectional design precludes causal inference about the drivers of improvement, and the reliance on an assessment tool rather than direct measurement of HAI incidence means that the study evaluates capacity rather than clinical outcomes. Furthermore, while IPCAF provides robust structural and procedural benchmarking, it may be sensitive to subjective interpretation if not accompanied by external audit, though the use of a single trained assessor in this study minimized inter-rater variability.

Future research should incorporate prospective surveillance of HAI incidence, explore the organizational determinants of IPC performance variation, and evaluate targeted interventions—particularly surveillance capacity-building and multimodal implementation packages—to determine which strategies most effectively elevate hospitals from "Basic" to "Intermediate" and "Advanced" IPC maturity levels. Integrating digital tools for HAI reporting, strengthening workforce development for infection control practitioners, and embedding routine audit-feedback cycles into hospital governance structures should be prioritized in subsequent studies and policy planning.

## CONCLUSION

The study demonstrates that public sector hospitals in Islamabad have progressed from "Inadequate" to "Basic" IPC capacity since 2019, with statistically significant improvements in overall IPCAF scores driven largely by strengthened guidelines, infrastructure, and organizational structures. However, persistent and severe deficiencies in HAI surveillance, multimodal strategies, and audit-and-feedback systems indicate that core operational functions required to reduce healthcare-associated infections remain underdeveloped. These findings highlight the urgent need for targeted investments in surveillance capacity, workforce development, and continuous quality-improvement mechanisms to translate structural gains into measurable patient safety outcomes. Strengthening these domains is essential for advancing hospitals toward higher IPC maturity and achieving sustainable reductions in infection risk within Pakistan's public healthcare system.

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