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Healthcare Worker-Mediated Cross-Transmission: A Systematic Analysis and Intervention Following a Carbapenem-Resistant Acinetobacter baumannii Outbreak in a Cardiac Tertiary Care Center

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Abstract

INTRODUCTION:

Carbapenem-resistant *Acinetobacter baumannii* (CRAB) presents a critical threat in intensive care settings, with outbreaks leading to significant morbidity and mortality. In November 2025, a cardiac tertiary care center in Karachi, Pakistan experienced a CRAB outbreak involving seven patients across the intensive care unit (ICU) and coronary care unit (CCU), manifesting as central line-associated bloodstream infections (CLABSIs) and hospital-acquired pneumonia (HAP).

METHODS

Following an Infection Control Committee meeting on 27th November 2025, a targeted, one-month intensive Infection Prevention and Control (IPC) surveillance program was initiated from 1st -31st December 2025. A senior infection control nurse was deployed exclusively during evening shifts to observe, document, and provide immediate spot teaching sessions on IPC breaches across all clinical areas, including ICU, CCU, operation rooms (OR), and dialysis units. Surveillance focused on hand hygiene, personal protective equipment (PPE) use, transmission-based precautions, environmental cleaning, and reprocessing of medical devices.

RESULTS

IPC surveillance documented 309 instances of spot teaching across 64, 85, 73, and 87 healthcare workers in four successive weeks. Persistent, systemic non-compliance was identified, including incorrect PPE use especially in OR and during isolation precautions, improper sharps and waste disposal, delayed isolation initiation, and critical lapses in the reprocessing of equipment such as bougie catheters and oxygen bottles. Significant environmental issues, including rusted equipment and alarming hygiene failures, were also recorded. The outbreak was successfully controlled, with no new CRAB cases reported during and after the surveillance period.

CONCLUSION

The strategic reinforcement of IPC surveillance during evening shifts, coupled with real-time corrective feedback, was instrumental in identifying and addressing latent systemic failures and behavioral non-compliance that contributed to the outbreak. This study underscores the necessity of continuous, proactive IPC monitoring beyond routine hours and highlights the role of immediate, on-the-spot education in effecting behavioral change and sustaining a culture of safety.

1. INTRODUCTION

Healthcare-associated infections (HAIs) caused by multidrug-resistant organisms (MDROs) represent a formidable challenge to global public health, burdening healthcare systems with increased morbidity, mortality, and economic costs.[1,2] Among these, carbapenem-resistant *Acinetobacter baumannii* (CRAB) stands out for its remarkable capacity for environmental persistence, propensity for nosocomial transmission, and association with severe infections in critically ill patients, particularly those in intensive care units (ICU) and undergoing invasive procedures.[3,4] Outbreaks of CRAB are notoriously difficult to contain due to its resistance to most first-line antibiotics and its ability to colonize both patients and the hospital environment.[4]

Outbreak management in tertiary care hospitals requires a multifaceted approach rooted in robust infection prevention and control (IPC) principles. Core strategies include active surveillance, strict adherence to hand hygiene and contact precautions, effective environmental decontamination, and antimicrobial stewardship.[5] However, the consistent application of these measures is often impeded by human factors, workflow pressures, and variability in compliance across different shifts and departments.[6,7] Notably, lapses in IPC protocols may be more prevalent during evening and night shifts, periods often characterized by reduced supervisory presence and higher staff-to-patient ratios.[8,9]

The pervasive threat of CRAB is amplified by a complex interplay between microbial virulence, environmental contamination, and entrenched human factors within hospital workflows. While the pathogen's ability to survive for extended periods on dry surfaces, from bed rails to ventilators, creates a persistent reservoir, it is the breach in fundamental IPC practices by healthcare workers that most often bridges this environmental reservoir to susceptible patients.[10] This human element transforms a latent risk into an active outbreak. The challenges are systemic and behavioral, where cognitive overload in high-acuity settings leads to missed hand hygiene moments; habitual shortcuts become normalized, especially during periods of high workload or fatigue; and a pervasive ‘know-do’ gap exists where theoretical knowledge of protocols fails to translate into consistent practice. This gap is frequently widened by systemic failures, such as poorly accessible alcohol-based hand rub dispensers, shortages of appropriately sized personal protective equipment (PPE), or confusing waste segregation guidelines. Furthermore, the social and hierarchical culture within clinical units can emphatically enable or inhibit compliance. Therefore, understanding and interrupting CRAB transmission requires moving beyond a purely microbiological or environmental focus to address these intricate human and organizational determinants.

In this context, surveillance strategies that are dynamic, proactive, and contextual, become critical. Conventional IPC audits, often scheduled during daytime administrative hours, may fail to capture the true landscape of compliance, particularly during evening and night shifts where supervisory oversight diminishes and workflow pressures differ.[8,11] Hence, reactive investigations after an outbreak are often less beneficial and represent a failure of compliance. Instead, a paradigm shift towards proactive, real-time surveillance is needed to identify and correct latent failures before they coalesce into transmission events. This involves deploying IPC expertise directly into the clinical environment during all shifts to

observe practice in real-time, provide immediate feedback, and gather authentic data on barriers to compliance. The ‘spot teaching’ or immediate correction model is particularly potent, as it delivers just-in-time education at the exact moment and location of the error, thereby maximizing relevance and impact.[12,13] This strategy aims to reshape both individual behavior and unit culture through consistent, non-punitive reinforcement. By focusing on high-risk periods and employing direct observational feedback, healthcare institutions can shift from a cycle of post-outbreak investigation to a model of continuous pre-emptive risk mitigation, building a more resilient defense against outbreaks.

In November 2025, Tabba Heart Institute, a cardiac tertiary care center, identified a cluster of CRAB infections. Seven patients were affected, who developed central line-associated bloodstream infections (CLABSIs) and hospital-acquired pneumonia (HAP), raising immediate concern for a potential outbreak driven by healthcare worker-mediated cross-transmission. An initial investigation, discussed in an Infection Control Committee (ICC) meeting on 27th November 2025, excluded contaminated pharmaceuticals or a single environmental source, pointing instead towards breaches in fundamental IPC practices as the potential driver of outbreak. In response, a one-month intensive IPC surveillance initiative was launched from 1st -31st December 2025, with a novel focus on deploying a senior infection control nurse (ICN) exclusively during the evening shift to conduct real-time observations and interventions. This study details the findings of that surveillance, the interventions undertaken, and the outcomes achieved, providing a practical framework for mitigating similar outbreaks.

2. METHODS

2.1. STUDY DESIGN AND SETTING

This was a prospective, observational quality improvement study conducted at Tabba Heart Institute, Karachi, Pakistan, over one month, from 1st -31st December 2025. The intervention was triggered by the investigation of a CRAB outbreak that occurred in November 2025. The institute is a dedicated cardiac care facility with a 12-bed ICU, a 12-bed coronary care unit (CCU), 3 operating rooms (ORs), a catheterization lab, and step-down and general wards.

2.2. OUTBREAK INVESTIGATION AND INFECTION CONTROL COMMITTEE MEETING

The initial outbreak involved seven patients with CRAB isolates (n = 3 CLABSI and n = 4 HAP). A comprehensive outbreak investigation was undertaken from 21st -25th November 2025. This included environmental cultures from ICU, CCU, OR, and other critical areas; cultures of high-use medications; hand cultures from 10 ICU and OR staff members; and cultures of water and central line sleeve kits. All investigations returned negative results. The findings were presented at an ICC meeting on 27th November 2025, chaired by the Medical Director and attended by heads of clinical departments, nursing, pharmacy, and quality assurance. The consensus concluded that the outbreak was primarily due to

healthcare worker-mediated cross-transmission linked to lapses in IPC practices, necessitating immediate reinforcement.

2.3. INTERVENTION: ENHANCED EVENING SHIFT IPC SURVEILLANCE

Based on the ICC recommendations, the IPC department implemented an intensive surveillance program. The key operational change was the assignment of a senior ICN to work the evening shift through 1st -31st December 2025. This shift was strategically chosen based on the hypothesis that IPC compliance decreases outside of routine administrative and morning rounds.

The surveillance followed a structured protocol, beginning with daily, unannounced rounds conducted by the ICN in all clinical and support areas. These areas included the Emergency Room, Step-Down Unit, Private Wing, High Dependency Unit, CCU, ICU, General Wards, Operation Theaters, Cardiac Catheterization Lab and Central Sterile Supply Department. During these rounds, observations were documented against five core IPC domains using an observational checklist. The domains were (i) hand hygiene, focusing on compliance with the World Health Organization (WHO)'s 'Five Moments for Hand Hygiene'; (ii) PPE, assessing the correct use of gloves, gowns, masks, and eye protection; (iii) transmission-based precautions, evaluating the timely initiation and maintenance of isolation protocols; (iv) environmental hygiene and waste management, checking cleanliness and proper waste segregation; and (v) reprocessing of medical devices, verifying compliance with cleaning, disinfection, and sterilization protocols for reusable items.

Upon identifying a breach, the ICN provided immediate, on-the-spot education to the involved healthcare worker (Spot Teaching). This intervention involved explaining the correct protocol, its rationale, and the associated infection risk. The staff member's name, department, and the topic of teaching were then logged in a dedicated register. For significant or recurrent breaches, an escalation process was followed, with issues reported simultaneously to the respective team leaders, unit managers, and department heads. Finally, a comprehensive weekly report compiling all observations, corrective actions, and preventive measures was generated to ensure systematic feedback and accountability.

2.4. DATA COLLECTION AND ANALYSIS

Data was collected daily using a standardized surveillance form. Qualitative data consisted of detailed descriptions of non-compliant events, the units involved, and the staff addressed. Quantitative data included the number of spot teaching sessions conducted per week and the vaccination status audit of OR staff. Data from the surveillance forms, spot teaching registers, and summary reports were synthesized to identify patterns, recurrent themes, and systemic weaknesses. The primary outcome measure was the containment of the CRAB outbreak, defined as no new clinically or microbiologically confirmed CRAB cases in ICU/CCU patients with onset in the three-month post-intervention surveillance period.

3. RESULTS

3.1. SPOT TEACHING INTERVENTIONS

The senior ICN conducted 309 spot teaching sessions over the four-week period, engaging a wide range of healthcare workers, including nurses, technicians, physicians, housekeeping staff, and security personnel. The week-wise review showed an increasing trend in engagements: 64 in the first week, 85 in the second, 73 in the third, and 87 in the fourth week (Table 1). This trend suggests either an increase in surveillance vigilance or a persistent high level of non-compliance requiring continuous intervention.

Table 1
Weekly Distribution of Spot Teaching Sessions Conducted During Enhanced Evening Shift IPC Surveillance (December 2025)

Week	Number of Healthcare Workers Receiving Spot Teaching	Cumulative Total
1st Week	64	64
2nd Week	85	149
3rd Week	73	222
4th Week	87	309

3.2 CATEGORIZATION OF MAJOR IPC BREACHES

To systematically interpret the breadth and recurrence of observed non-compliant practices, IPC breaches identified during enhanced surveillance were thematically grouped into major categories. This categorization was undertaken to highlight dominant patterns of risk, distinguish behavioral from system-level deficiencies, and facilitate targeted corrective interventions. The resulting framework reflects recurrent operational vulnerabilities across clinical and support areas and provides a structured basis for prioritizing institutional IPC strengthening efforts. The five major breach categories identified are described below.

3.2.1. NON-COMPLIANCE WITH PERSONAL PROTECTIVE EQUIPMENT AND ISOLATION PRECAUTIONS

This was the most frequently observed IPC lapse (Fig. 1). Staff were found not wearing gowns, masks, or gloves when managing patients on contact or droplet precautions. For instance, on 2nd December 2025, staff and a patient attendant mobilized a contact precaution patient without donning gowns or masks (Table 2). In the OR, anesthesiologists were observed performing intubations and intravenous cannulations without gowns while wearing jewelry such as rings and chains, a direct breach of aseptic principles. Furthermore, delays in implementing isolation for suspected influenza and tuberculosis patients, and the absence of appropriate precaution signage on doors, were repeatedly noted, increasing the risk of cross-transmission.

3.2.2. INADEQUATE MANAGEMENT OF BIOMEDICAL WASTE AND SHARPS

Improper waste segregation and disposal posed a significant hazard (Fig. 1). Sharps were found on floors, in green general waste bins, and even inside linen hampers. Overfilled sharps containers and infectious waste red bags were common. Dialysis circuits, which are infectious waste, were incorrectly disposed of in general waste bins. These practices contravene standard biomedical waste management protocols and expose staff and patients to bloodborne pathogens.

3.2.3. ENVIRONMENTAL HYGIENE AND EQUIPMENT DEFICIENCIES

Several environmental issues were identified, including the presence of rusted and unclean equipment such as oxygen cylinders, refrigerator bases, leg poles for OR tables, medication trolleys, and dialysis cabinets, which showed significant accumulation of rust and dust that hindered effective cleaning and disinfection. Additionally, lapses in terminal cleaning were observed, whereby items such as oxygen and suction bottles were left behind after patient discharge or transfer from isolation, and precaution posters were not removed in a timely manner.

3.2.4. LAPSES IN REPROCESSING AND STERILIZATION PROTOCOLS

Critical breaches were identified in the chain of responsibility for medical device reprocessing, beginning with clinical areas sending contaminated items to the Central Sterile Supply Department (CSSD) (Table 2). Used dressing sets contained unsheathed sharps, suction bottles were submitted full of secretions, and oxygen bottles arrived with old labels still adhered, practices which exposed CSSD staff to unnecessary risk and compromised the cleaning process. Furthermore, a key finding was the inconsistent handling of bougie catheters across units; while the OR, ICU, and HDU sent them to CSSD for reprocessing, the CCU treated them as single-use, chargeable items, a lack of standardization that poses clear infection prevention and patient safety risks. Additionally, post-cleaning aesthetic issues were noted; oxygen bottles, though disinfected, retained residual adhesive from old labels, making them appear dirty and undermining staff confidence in the sterilization process.

3.2.5. INCOMPLETE HEALTHCARE WORKER VACCINATION RECORDS

An audit of the OR team's vaccination status revealed that while most staff had received Hepatitis B vaccination, records were incomplete. The exact dates of primary series or booster doses were often unknown, and Hepatitis B surface antibody titers had not been checked for the vast majority, leaving their immune status uncertain.

Table 2
Selected Examples of Critical IPC Lapses and Immediate Interventions

Date	Unit	Observation	Immediate Corrective Action
2nd Dec 2025	GWD	Staff mobilized contact precaution patient without gown/mask.	Teaching on mandatory full PPE for contact precautions.
2nd Dec 2025	CCU	Staff did not doff gown after leaving isolation room; sharps in green bin.	Teaching on proper PPE doffing sequence and waste segregation.
4th Dec 2025	OR	Anesthetist wearing jewelry during procedure; no gown for intubation.	Reinforced OR dress code and aseptic technique.
Multiple	All	Urine and drainage bags placed on the floor.	Teaching on care bundle-based approach and infection risk from floor contamination.
11th Dec 2025	ER	All danger boxes (sharps containers) without labels.	Teaching on labeling protocols for hazardous waste.
22nd Dec 2025	CSSD	Receiving sets with sharps inside; bottles with secretions.	Teaching clinical staff on pre-cleaning before sending equipment to CSSD.
29th Dec 2025	CCU	TB-positive patient in CCU with no airborne precaution poster on door.	Poster placed immediately; staff educated on airborne precautions.

3.3 DETAILED ANALYSIS OF HIGH-RISK AREAS AND PRACTICES

The surveillance data allowed for a granular analysis of specific high-risk areas and practices that contributed disproportionately to the risk environment. The Operating Room (OR) complex emerged as a critical hotspot. Beyond isolated PPE breaches, systemic issues were documented: anesthesia machines had soda lime canisters changed at irregular intervals based on variable color-change interpretations rather than a fixed protocol; unsterilized anesthesia tubing and resuscitation bags were noted to be only externally cleaned; and critical hand hygiene stations were poorly accessible, with hand sanitizer placed under crash trolleys. Furthermore, a significant knowledge-practice gap was identified regarding Hepatitis B immunity among OR staff. While most reported vaccination, the absence of documented booster dates or serological confirmation of protective antibody titers left a vulnerable cohort within a high-exposure environment.

The dialysis service, particularly within the CCU, presented a unique and persistent engineering control failure. To accommodate multiple simultaneous dialysis sessions, technicians routinely used long, improvised extension tubing that traversed floor pathways, creating tripping hazards and complicating cleaning protocols. Most alarmingly, this practice led to tubing being connected from isolation rooms to central machines, blatantly breaching containment protocols for patients under airborne or droplet

precautions. This observation underscored a scenario where clinical demand was permitted to override fundamental IPC principles.

The CSSD was identified not as a source of failure, but as a recipient of hazardous practices from clinical areas. The surveillance revealed a failure at the first step, as clinical wards consistently sent contaminated items to the CSSD in an unsafe manner (Table 2). This included dressing sets harboring uncapped sharps posing a severe needle-stick injury risk and suction bottles containing unemptied secretions, which could aerosolize pathogens during handling. This finding reframed the problem from a CSSD processing failure to a critical breakdown in pre-transport protocols at the ward level.

3.4 OUTCOMES OF ESCALATION AND SYSTEMIC INTERVENTIONS

While spot teaching addressed individual behavior, the escalation of systemic issues to unit managers and department heads triggered several concrete administrative actions. Following the reporting of rusted equipment such as OR tables, oxygen cylinders and dialysis cabinets, and dilapidated furniture such as torn OR chairs, formal work orders were issued to the engineering and procurement departments for repair or replacement. Furthermore, the identification of inconsistent bougie catheter reprocessing practices sparked an official interdisciplinary review between the IPC, cardiology, anesthesia, and finance departments to mandate a hospital-wide classification (single-use vs. reusable) and standardize the associated protocol and charging practice.

The intensive surveillance and intervention period from 1st -31st December 2025 was successful in its primary objective. Following the implementation of enhanced evening shift monitoring, immediate spot corrections, and management escalation of systemic issues, no new cases of CRAB infection have been identified in the ICU or CCU post-intervention surveillance period till date (Fig. 2).

4. DISCUSSION

The CRAB outbreak at Tabba Heart Institute and the subsequent intensive surveillance illuminate a common yet critical scenario in hospital epidemiology, namely the gap between established IPC policies and frontline practice. Our investigation's negative environmental and pharmaceutical cultures strongly pointed to human factors and behavioral non-compliance as the outbreak's primary driver, a finding consistent with other outbreak reports where lapses in basic infection control measures fueled MDRO transmission.[4,14] The IPC surveillance in December 2025 served as a diagnostic probe, vividly mapping this gap and demonstrating the efficacy of targeted, real-time intervention.

The decision to focus surveillance on the evening shift proved prescient. The volume and nature of breaches documented, from fundamental PPE errors in isolation rooms to hazardous sharps disposal, suggest that IPC vigilance wanes outside of peak administrative hours. This aligns with studies showing that hand hygiene compliance, for instance, is often lower during nights and weekends.[8,15] The

deployment of a senior ICN during this window provided a supervisory presence that is often missing, enabling immediate correction and reinforcing accountability.

The recurring themes of non-compliance are particularly instructive. The persistent misuse of PPE and delays in initiating isolation underscore a failure in applying transmission-based precautions, which is a cornerstone of MDRO containment. These were compliance rather than knowledge deficits as spot teaching consistently addressed known protocols. This suggests challenges related to workload, entrenched habits, or a culture that tolerates deviations from protocol, particularly during periods of high operational demand. The environmental and equipment findings, particularly rust and residual contaminants, highlight systemic issues in which procurement, maintenance, and housekeeping protocols failed to support the IPC infrastructure.

The most concerning findings involved breaches in the sterile processing chain, notably the egregious safety hazard of sending sharps-laden sets to the CSSD. The inconsistent classification of bougie catheters (reusable vs. single-use) between CCU and other units reveals a critical lack of standardization, which can lead to both infection risks from inadequate reprocessing and unnecessary costs due to premature disposal. Therefore, implementing standardized, hospital-wide protocols for medical device classification and reprocessing is essential to prevent such breaches.

Although the 309 spot teaching sessions proved instrumental in promptly correcting breaches, their primary value resides in their diagnostic utility rather than serving as a perpetual solution. The recurrent pattern of similar lapses over multiple weeks, including urine bags placed on floors or absent isolation signage, underscores a 'see-one, correct-one' cycle that fails to foster sustained behavioral change. This exemplifies the perennial challenge in healthcare quality improvement, namely transitioning from initial gains to enduring, embedded practices.[11] Spot teaching excels at heightening awareness and delivering just-in-time knowledge, yet it carries the risk of fostering dependency on an external 'IPC police' force.[12,16] Achieving long-term success demands the internalization of these practices into professional habits and unit culture. Complementary strategies are essential, encompassing peer-to-peer accountability frameworks, incorporation of IPC metrics into individual and unit performance evaluations, and empowerment of charge nurses and team leaders to uphold IPC compliance across every shift rather than solely during surveillance rounds. Moreover, the diminishing efficacy of spot teaching for repeat offenders indicates that entrenched behaviors may necessitate formal performance management interventions in tandem with educational efforts.

The vaccination audit identified a significant latent system deficiency manifested as incomplete health records for healthcare staff. Comprehensive immunization of healthcare workers forms a cornerstone of occupational health and safety initiatives, since gaps in immune status documentation increase personal susceptibility to vaccine-preventable infections and elevate transmission risks to patients and peers in high-risk environments.[17]

The surveillance clearly demonstrated that frontline IPC compliance is frequently constrained or facilitated by systemic and administrative decisions. Factors such as rusted equipment, insufficient waste bin supplies resulting in overfilling, and the absence of dialysis extension ports represented deficiencies in maintenance, procurement, and facility planning rather than shortcomings of clinical staff. A fundamental principle of resilient healthcare systems is that they must be designed to make adherence to optimal practices the default and simplest choice. Consequently, outbreak responses must transcend the IPC department to encompass hospital administration, engineering, and finance directorates. Investments in seamless, easy-to-clean equipment, reliable supplies of suitable consumables such as appropriately sized waste bags, and workflows intentionally designed with IPC principles are indispensable elements of patient safety infrastructure, not discretionary expenditures.

The achievements of this intensive one-month initiative should reshape institutional perceptions of IPC surveillance. Far from a mere routine or punitive audit, it ought to be recognized as a continuous, proactive sentinel mechanism for patient safety. The CRAB outbreak served as a sentinel event that unveiled entrenched vulnerabilities. The December surveillance program illustrated that a more frequent, rigorous, and shift-spanning approach can detect and avert risks prior to their escalation into full outbreaks. This approach resonates with the paradigm of preemptive or proactive infection control, which leverages process compliance data not merely for infection enumeration but for prediction and prevention.[18,19] Henceforth, the IPC department's remit should be fortified to incorporate routine deep-dive surveillance across high-risk areas during all shifts, complemented by authority to implement rapid-cycle improvements. The resultant data on breach types and frequencies should be disseminated not as evaluative report cards but as strategic dashboards to inform hospital leadership's resource allocation and policy prioritization, thereby elevating IPC from a siloed departmental function to a core organizational imperative.

The study has several important limitations that should be considered when interpreting the findings and their generalizability. First, this was a single-center, prospective quality-improvement investigation conducted over a short one-month intervention period, which limits external validity and does not allow assessment of the long-term sustainability of the observed effects. Second, the observational design did not include a concurrent control group or robust baseline quantitative compliance indicators such as continuous blinded hand hygiene audits or denominator-based compliance rates, making it difficult to establish a direct causal relationship between the intervention and outbreak control and leaving room for potential confounding by parallel administrative and system-level actions. Third, several sources of bias may have influenced the results, including the Hawthorne effect and observer or recording bias, as visible unannounced rounds and real-time documentation may have altered staff behavior and preferentially captured easily observable practices while overlooking less visible non-compliance. Fourth, microbiological and molecular epidemiological analyses were limited, as environmental and pharmaceutical cultures were negative and no molecular typing or whole-genome sequencing was performed, preventing definitive confirmation of transmission pathways and genetic relatedness between isolates. Fifth, the outbreak involved a small number of affected patients, and key patient-centered outcomes such as attributable mortality, length of hospital stay, and cost implications were not

systematically evaluated, restricting conclusions regarding clinical impact and cost-effectiveness. Additional limitations include incomplete occupational health documentation, particularly regarding vaccination status and serological data, variability in the definition and intensity of spot-teaching activities which may have introduced heterogeneity in exposure, the resource-intensive nature of the intervention which may limit scalability in low-resource settings, and the lack of objective assessment of sustained behavioral change after the surveillance period ended. Collectively, these limitations underscore the need for larger, multicenter studies with longer follow-up periods, standardized quantitative infection prevention metrics, incorporation of molecular epidemiology, formal evaluation of clinical and economic outcomes, and the inclusion of appropriate comparison groups to better define effectiveness and reproducibility.

5. CONCLUSION

The successful containment of the CRAB outbreak at Tabba Heart Institute was achieved through a targeted multimodal strategy rather than a single intervention, addressing underlying systemic and behavioral gaps in infection prevention and control compliance. Deployment of senior IPC expertise during the high-risk evening shift was a critical component, enabling identification of latent hazards that were not detected during routine daytime surveillance. The spot-teaching approach further facilitated timely corrective feedback and immediate practice improvement.

Declarations

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The project was approved by the Institutional Review Board of the Tabba Heart Institute, Karachi, Pakistan (Ref # THI/IRB/SQ/11-10-2024/111). This quality improvement study did not involve human patients or animals directly; therefore, individual consent to participate was not applicable.

CONSENT FOR PUBLICATION

Not applicable

COMPETING INTERESTS

The authors declare no conflict of interests.

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Author Contribution

MAK - Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Visualization and Writing - original draftMP - Data curation, Formal analysis, Investigation, Software, Validation and Writing - review & editingVB & NS - Data curation and Writing - review & editing

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Data Availability

All data generated during the course of this study has been included in this published article.

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Figures

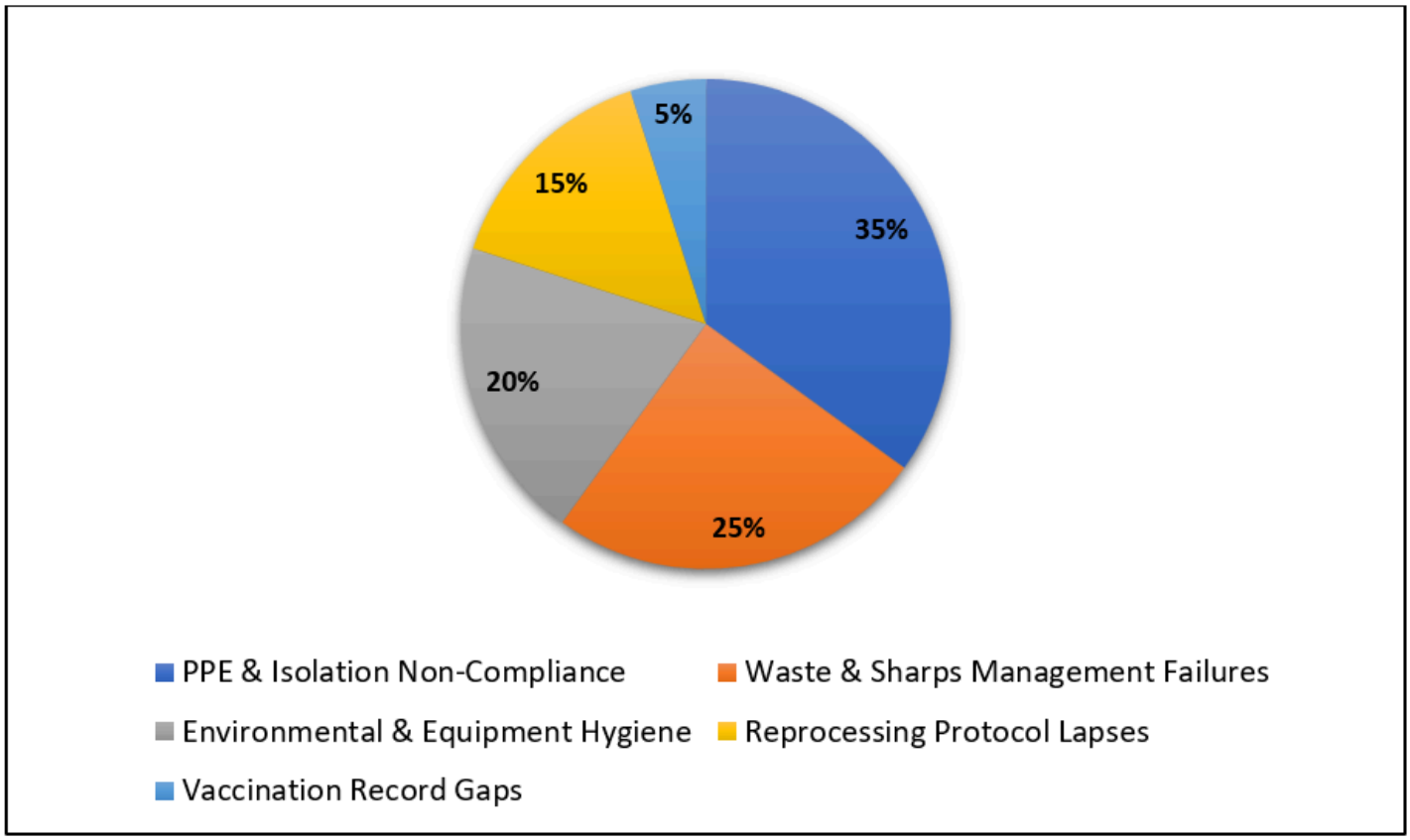


Figure 1

Distribution of Major IPC Breach Categories Identified During Surveillance

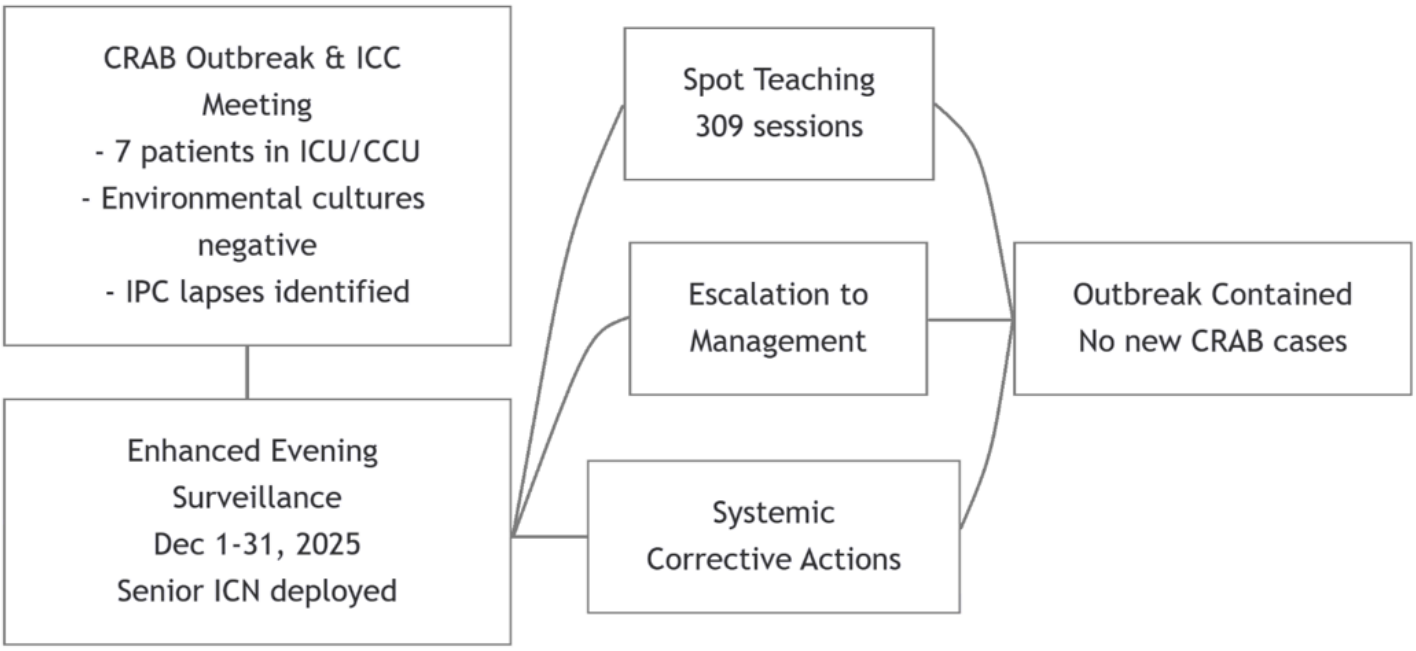


Figure 2

Schematic overview of the multimodal intervention strategy implemented to contain the outbreak