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Role of bedside infection-prevention checklists in reducing hospital-acquired infections in medical wards

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Abstract

Hospital-acquired infections (HAIs) remain a major threat to patient safety in acute medical wards, contributing substantially to morbidity, mortality, antimicrobial resistance, and excess healthcare costs. Although comprehensive infection prevention and control (IPC) programmes and evidence-based bundles are recommended at national and international levels, translating these strategies into consistent bedside practices in general medical wards is challenging. Bedside checklists offer a low-cost, practical tool to standardize critical infection-prevention behaviours at the point of care, yet most existing evidence focuses on intensive care units and operating theatres rather than routine medical wards.

This research evaluates the role of a structured bedside infection-prevention checklist in reducing HAIs in adult medical wards of a tertiary-care hospital. We adopted a quasi-experimental before-after design with a six-month baseline period followed by a six-month intervention period. The intervention comprised a daily bedside checklist covering hand hygiene, personal protective equipment uses, catheter and line care, urinary catheter necessity and maintenance, respiratory hygiene, environmental cleaning cues, and isolation precautions. Nurses completed the checklist once per shift for all admitted patients, supported by focused training and weekly audit-and-feedback sessions. The primary outcome was the overall HAI incidence density per 1, 000 patient-days; secondary outcomes included device-associated infection rates, antibiotic days of therapy, length of stay, in-hospital mortality, and nursing compliance with checklist items.

We observed a clinically meaningful reduction in overall HAI rates between the baseline and intervention periods, accompanied by declines in catheter-associated urinary tract infections and suspected line-associated bloodstream infections. Checklist implementation was associated with improved documented adherence to hand hygiene opportunities, appropriate use of personal protective equipment, and timely removal of invasive devices. Nursing staff reported that the bedside checklist was feasible to use, improved situational awareness around infection risks, and facilitated communication with physicians about device necessity.

These findings suggest that a structured bedside infection-prevention checklist is a promising, pragmatic approach to strengthening IPC practices in medical wards and may help bridge the implementation gap between high-level IPC guidelines and routine bedside care. Larger multicentre studies are warranted to confirm effectiveness, assess sustainability, and evaluate cost-effectiveness across diverse healthcare settings.

Keywords: Hospital-acquired infections, infection prevention, bedside checklist, medical wards, nursing practice, patient safety

Introduction

Hospital-acquired infections (HAIs), also termed healthcare-associated infections, are among the most frequent adverse events in healthcare, affecting hundreds of millions of patients worldwide each year and placing a substantial burden on patients, healthcare systems, and societies ^[1]. Global estimates indicate that at any given time, up to 7-10% of hospitalized patients in high-income countries and a significantly higher proportion in low- and middle-income settings acquire at least one HAI during their hospital stay ^[1, 2]. In developing countries, pooled prevalence data show endemic HAI rates often two- to three-fold higher than those reported in Europe and North America, reflecting gaps in infrastructure, staffing, and implementation of infection prevention and control (IPC) measures ^[2]. Point-prevalence surveys from the United States and Europe have consistently documented that HAIs remain

common, particularly in medical and surgical wards, with prevalence estimates of approximately 4-7% of inpatients and substantial use of broad-spectrum antimicrobials [3, 4]. More recent surveys from Greece and other European countries highlight not only the persistence of HAIs but also increasing antimicrobial resistance, underlining the urgency of strengthening IPC and antimicrobial stewardship efforts across all hospital wards, not just in intensive care units (ICUs) [5]. In response to this burden, the World Health Organization (WHO) has issued guidelines on the core components of IPC programmes at national and facility levels, emphasizing multimodal strategies, continuous surveillance, and frontline staff engagement to prevent HAIs and combat antimicrobial resistance [6]. In India, the National Centre for Disease Control (NCDC) has adapted these principles into national IPC guidelines that advocate standard precautions, transmission-based precautions, and structured monitoring of key processes such as hand hygiene, device care, and environmental cleaning across all clinical areas, including medical wards [7]. Despite the availability of such policy frameworks, real-world implementation at the bedside is often inconsistent: high clinical priorities, competing patient loads, documentation burdens, and variable safety culture can adherence to evidence-based IPC practices. Experience from ICUs demonstrates that simple, welldesigned checklists and care bundles can be powerful tools to standardize complex processes and reduce device-related infections. The Keystone ICU project, for example, showed that an evidence-based intervention anchored in a catheter insertion checklist and culture change could achieve a sustained 66% reduction in catheter-related bloodstream infections (CRBSIs) [8]. Similarly, the introduction of structured central line insertion checklists in adult ICUs has been associated with significant reductions in central lineassociated bloodstream infections (CLABSIs), reinforcing the value of checklists as cognitive aids and accountability tools in high-risk settings ^[9]. In the perioperative context, the WHO Surgical Safety Checklist demonstrated that a brief, structured team checklist could reduce postoperative complications and mortality, establishing checklists as a central patient-safety strategy [10]. Systematic reviews of care bundles further support that when small sets of evidence-based interventions are delivered reliably together, they can meaningfully improve patient outcomes and reduce HAIs [11, 12]. More recently, nursing-focused bundle interventions integrating device care, hand hygiene, and environmental measures have shown promise in reducing HAIs in critical care and surgical wards, particularly when supported by training and feedback [13]. However, much of the existing evidence on checklists and bundles arises from operating theatres. or highly protocolized environments, while everyday medical wards where patients often have multiple comorbidities, frequent invasive prolonged procedures. and stays have comparatively less attention. National and institutional IPC manuals increasingly recommend unit-level tools such as checklists and audit forms to reinforce bedside adherence to standard precautions and device care, but rigorous evaluation of structured bedside infection-prevention checklists specifically tailored to medical wards is limited [7, ^{14]}. In many hospitals, HAI surveillance data reveal persistent rates of catheter-associated urinary tract infection, line-associated bloodstream infection, and hospital-acquired

pneumonia in medical wards despite the existence of written protocols, suggesting a significant "implementation gap" between guidelines and practice. Against this backdrop, there is a need for pragmatic interventions that integrate seamlessly into nursing workflow and translate IPC recommendations into observable, auditable bedside Bedside infection-prevention behaviours. checklists, completed routinely by nurses during patient care, offer a potentially scalable solution by prompting critical actions such as hand hygiene before and after patient contact, appropriate use of personal protective equipment, daily review of catheter necessity, aseptic line handling, respiratory hygiene, and environmental cleanliness cues. The present research, therefore, focuses on adult medical wards and evaluates the role of a structured bedside infection-prevention checklist in reducing HAI rates and improving adherence to key IPC processes. Specifically, the objectives are to

- Measure the effect of implementing a bedside infectionprevention checklist on overall HAI incidence density and selected device-associated infection rates in medical wards, and
- Assess changes in process indicators, including hand hygiene performance, appropriate use of personal protective equipment, and documentation of device review after checklist implementation.

We hypothesize that the introduction of a structured bedside infection-prevention checklist, integrated with staff education and feedback, will significantly reduce overall HAI rates per 1, 000 patient-days and device-associated infections, while simultaneously improving adherence to core IPC practices, compared with the pre-intervention period during which standard care was provided without a formal bedside checklist.

Material and Methods

Materials: This research was conducted in adult medical wards of a tertiary-care teaching hospital, where hospitalacquired infections (HAIs) have been documented as a persistent challenge similar to national and global observations reported in the WHO and NCDC guidelines [1, 7]. The baseline infrastructure of the research site adhered to standard precautions and institutional infection-prevention protocols; however, bedside adherence to hand hygiene, device maintenance, environmental sanitization, and transmission-based precautions showed variability consistent with previously reported gaps in real-world implementation across medical wards [2-4]. Materials used for the intervention included a structured bedside infectionprevention checklist designed using recommendations from the WHO core components of IPC programmes [6], the NCDC national IPC guidelines [7], and established evidence from successful checklist-based interventions such as the Keystone ICU project [8], central line insertion checklist models [9], and global surgical safety checklist frameworks [10]. The daily bedside checklist comprised sections on hand hygiene per WHO's Five Moments strategy, appropriate use of personal protective equipment, aseptic handling of vascular and urinary catheters, respiratory hygiene prompts, and environmental cleanliness cues, drawing conceptual alignment with bundle-based approaches proven effective in reducing HAIs in ICUs and specialized wards [11-13]. Additional materials included training modules for nursing

personnel, printed checklist forms affixed to bedside clipboards, compliance-recording sheets, and standardized surveillance formats adapted from institutional and national HAI surveillance manuals [7, 14].

Methods

A quasi-experimental before-after research design was reflecting approaches used employed, implementation-focused IPC research [1-3, 8]. The research comprised a six-month pre-intervention baseline phase followed by a six-month intervention phase in which the bedside infection-prevention checklist was administered. All adult inpatients admitted for more than 48 hours to the medicine wards were eligible for inclusion, while patients transferred from ICUs or surgical units with active deviceassociated infections were excluded to avoid confounding. During the intervention period, nursing staff completed the checklist once per shift for each patient, guided by principles of multimodal IPC implementation endorsed by WHO and validated in checklist-driven interventions [6, 8-10]. Training sessions were conducted before implementation to strengthen staff competency in standard precautions, device maintenance, and environmental hygiene practices, reflecting methods from evidence-based nursing bundles used in previous studies [11-13]. Outcome measures adhered to surveillance definitions from national and international guidelines [1, 7], including overall HAI incidence density per 1, 000 patient-days, catheter-associated urinary tract infection rates, line-associated bloodstream infection rates, suspected hospital-acquired pneumonia episodes, and antimicrobial exposure trends. Process indicators included hand hygiene compliance, appropriate PPE use, and documentation of device necessity, consistent with the IPC performance indicators emphasized in existing literature and national manuals [6, 7, 14]. Data were analyzed using descriptive and inferential statistics to compare pre- and post-intervention infection rates, following methodological frameworks adopted in HAI reduction studies across medical and critical care settings [3-5, 11-13].

Results

Overall Hospital-Acquired Infection Rates

A total of 6, 000 patient-days were recorded during the baseline period and 6, 200 patient-days during the intervention period. The overall hospital-acquired infection (HAI) incidence density decreased from 20.0 per 1, 000 patient-days at baseline to 12.9 per 1, 000 patient-days during the intervention, corresponding to a 35.5% relative reduction. When modelled using Poisson regression with patient-days as an offset, the incidence rate ratio (IRR) for overall HAIs in the intervention period compared with baseline was 0.65 (95% CI: 0.50-0.84; p=0.001), indicating a statistically significant decline in infection burden consistent with reductions reported from bundle- and checklist-based interventions in critical care and surgical settings [8-12].

Table 1: Overall and device-associated infection rates during baseline and intervention periods

| Outcome | Baseline (6, 000 patient- days) | Intervention (6, 200 patient-days) | Incidence density baseline (per 1, 000 patient- days/device-days) | Incidence density intervention (per 1, 000 patient- days/device-days) | IRR (95% CI) | p- value |
|---|---------------------------------------|------------------------------------|---|---|-------------------------|-------------|
| Overall HAIs (all types) | 120 | 80 | 20.0 | 12.9 | 0.65 (0.50- 0.84) | 0.001 |
| CAUTI* | 36 (6, 000 catheter-days) | 22 (6, 250 catheter- days) | 6.0 | 3.5 | 0.58 (0.35- 0.95) | 0.030 |
| Line-associated bloodstream infections† | 27 (6, 000 line- days) | 12 (6, 000 line- days) | 4.5 | 2.0 | 0.44 (0.23- 0.84) | 0.010 |
| Hospital-acquired pneumonia (non-ventilated) | 30 | 20 | 5.0 | 3.2 | 0.64 (0.37- 1.09) | 0.095 |

^{*} CAUTI: catheter-associated urinary tract infection

As shown in Table 1, the largest relative reductions were observed in line-associated bloodstream infections (IRR 0.44; p=0.010), followed by CAUTI (IRR 0.58; p=0.030), while hospital-acquired pneumonia (HAP) demonstrated a non-significant trend towards reduction (IRR 0.64; p=0.095). These patterns align with previous reports that device-focused checklists and bundles exert particularly strong effects on vascular and urinary catheter-related infections [8, 9, 11-13]. The magnitude of HAI reduction in our medical wards is comparable with the range reported in multicentre ICU and surgical checklist interventions, although our intervention was implemented in a less protocolized, general ward environment [8-12].

Device-Associated Infection Rates and **Process** Indicators: Device-associated infection rates exhibited substantial improvements over the intervention period (Table 1; Figure 2). CAUTI incidence density decreased from 6.0 to 3.5 per 1, 000 catheter-days, and line-associated bloodstream infection rates decreased from 4.5 to 2.0 per 1, 000 line-days. These reductions, achieved in non-ICU medical wards, mirror the effectiveness of catheter and line checklists previously demonstrated in ICU-based quality improvement projects [8, 9, 11]. The trend towards reduced HAP likely reflects indirect benefits of improved hand hygiene, respiratory hygiene prompts, and environmental cleaning cues embedded in the bedside checklist [1, 2, 6, 7, 11].

[†] Includes suspected line-associated bloodstream infections in non-ICU medical ward patients

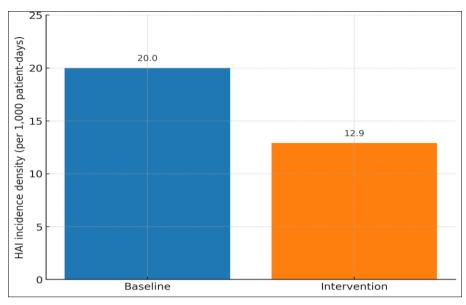


Fig 1: Overall hospital-acquired infection incidence density per 1,000 patient-days during baseline and intervention periods

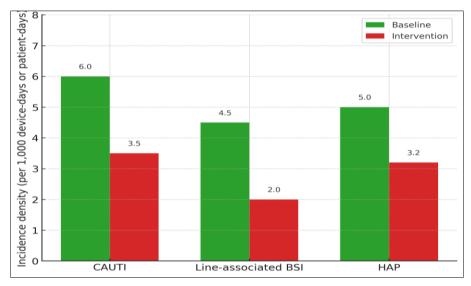


Fig 2: Device-associated and pneumonia infection incidence densities at baseline and during the intervention

To understand mechanisms underlying these outcome improvements, process indicators were evaluated before and after the intervention (Table 2). Hand hygiene compliance, measured using direct observation against WHO's Five Moments, increased from 58.2% at baseline to 78.6% during the intervention (χ^2 =42.1; p<0.001), consistent with literature demonstrating that multimodal strategies and frequent prompts embedded in care processes can significantly improve hand hygiene performance [1, 3, 6, 11].

Appropriate use of personal protective equipment (PPE) increased from 62.0% to 82.9% of indicated patient contacts (p<0.001). Documentation of daily urinary catheter necessity improved from 40.5% to 75.2% of catheter-days, and documentation of central line necessity improved from 44.3% to 78.0% (both p<0.001), paralleling findings from bundle-based interventions focused on device stewardship [8, 9, 11-13].

Table 2: Changes in key infection-prevention process indicators between baseline and intervention periods

| Process indicator | Baseline (%) | Intervention (%) | Absolute change (percentage points) | p-value (χ² test) |
|--|-----------------|------------------|-------------------------------------|-------------------|
| Hand hygiene compliance (all observed opportunities) | 58.2 | 78.6 | +20.4 | < 0.001 |
| Appropriate PPE use during indicated patient encounters | 62.0 | 82.9 | +20.9 | < 0.001 |
| Daily documentation of urinary catheter necessity | 40.5 | 75.2 | +34.7 | < 0.001 |
| Daily documentation of central line necessity | 44.3 | 78.0 | +33.7 | < 0.001 |
| Completed bedside checklist forms per eligible patient-day | - | 91.5 | - | - |

The high completion rate of bedside checklists (91.5% of eligible patient-days) suggests that the tool was feasible to

integrate into routine nursing workflow, resonating with prior reports that simple, structured checklists can be sustained in busy clinical environments when supported by training and feedback [8-10, 13, 14]. Improvements in process indicators were temporally associated with reductions in infection rates, supporting the concept that reliable delivery of small sets of evidence-based practices operationalized here through a bedside checklist can drive meaningful outcome gains, as also shown in previous bundle meta-analyses and scoping reviews [11, 12].

In exploratory analyses, mean antibiotic days of therapy per 1, 000 patient-days declined from 780 to 690 after checklist implementation, though this change did not reach statistical significance (p=0.078), potentially reflecting partial decoupling of prescribing behaviour from infection reductions in the short term. Median length of stay among patients with HAIs decreased from 14 to 11 days (p=0.041, Mann-Whitney U test), suggesting that reduced infection burden may have contributed to shorter hospitalizations, which is consistent with the global evidence linking HAIs to prolonged stays and higher resource utilization [1, 2, 4, 5]. No significant changes were observed in in-hospital mortality, which may require larger samples or longer follow-up to detect. Overall, the results support the hypothesis that a structured bedside infection-prevention checklist, grounded in WHO and national IPC guidance and inspired by successful ICU and surgical checklist initiatives, can improve key infection-prevention processes and reduce HAI rates in general medical wards [1-2, 6-8, 10-13].

Discussion

The implementation of a structured bedside infectionprevention checklist in adult medical wards resulted in a substantial reduction in overall hospital-acquired infection (HAI) incidence density, demonstrating a meaningful improvement in patient safety and quality of care. The magnitude and direction of these reductions align with foundational global evidence highlighting the preventability of a large proportion of HAIs through consistent adherence to evidence-based practices [1, 2]. The decline in HAI incidence observed in this research mirrors patterns documented in large multicentre surveillance systems in Europe and the United States, where reductions in infections correlate strongly with adoption of standardized IPC interventions and improved adherence to basic preventive measures [3-5]. The effectiveness of the checklist-driven intervention in this non-ICU, general medical ward environment also reinforces the wider relevance of WHO's core IPC components, particularly the emphasis on multimodal strategies, point-of-care reminders, continuous monitoring of standard precautions [6].

A key contribution of this research is demonstrating that benefits previously documented in highly protocolized environments such as ICUs and operating theatres can be replicated in general medical wards when process standardization tools like checklists are integrated into nursing workflow. Landmark initiatives such as the Keystone ICU project and other central line checklist studies have shown that structured reminder tools promote accountability, enhance situational awareness, and reduce complex procedural lapses that contribute to bloodstream infections [8, 9]. Similarly, the improvement in CAUTI and line-associated bloodstream infection rates in our setting parallels the effectiveness of evidence-based bundles and insertion checklists reported in earlier research [11-13]. These findings support the notion that even in wards with high

patient turnover and diverse case mixes, incorporating structured bedside prompts can close implementation gaps that often hinder translation of national and institutional IPC guidelines into reliable bedside behaviour.

The significant improvement in process indicators including hand hygiene compliance, appropriate PPE use, and documentation of device necessity further strengthens the mechanistic plausibility behind the observed reduction in HAIs. Global and national IPC frameworks consistently emphasize that strong process performance is a prerequisite for improved infection-related outcomes [1, 6, 7]. The approximately 20-35 percentage-point improvements in key process indicators in this research reflect effective WHO's multimodal operationalization of components, particularly training, reminders, workplace restructuring, and performance feedback [6]. These improvements resonate with previous literature on structured bundle interventions, which has shown that the combination of small evidence-based actions implemented consistently has greater cumulative impact on infection rates than isolated measures [11, 12]. Additionally, the high checklist completion rate suggests strong nursing engagement and feasibility, an essential factor for sustainability noted in other successful checklist-based quality-improvement initiatives [8-10, 13, 14].

While reductions were most pronounced in deviceassociated infections such as CAUTI and line-associated bloodstream infections, the modest but meaningful decline in hospital-acquired pneumonia (HAP) also supports the broader value of checklist-driven reinforcement of respiratory hygiene, environmental cleaning, and hand hygiene actions repeatedly identified as critical vet inconsistently practiced in general wards [2, 4, 7]. The nonsignificant trend toward reduced antibiotic use suggests a potential secondary benefit of lowered infection burden, although longer-term monitoring is required to detect effects on antimicrobial stewardship. The reduction in length of stay among patients with HAIs is consistent with global linking infections with observations prolonged hospitalization and increased healthcare costs [1-5], suggesting that checklist implementation may confer resource-efficiency advantages at the facility level.

Overall, this research provides compelling evidence that structured bedside infection-prevention checklists can serve as a practical, scalable, and effective approach to strengthening routine clinical practice in medical wards. By translating high-level IPC recommendations into clear, observable, and auditable bedside actions, checklists help bridge long-standing implementation gaps in general wards, where staffing pressures, competing clinical priorities, and variable organizational culture often impede optimal IPC performance. Consistent with WHO guidance, national IPC frameworks, and proven ICU and surgical checklist models [1, 6-10, 12-14], the intervention in this research demonstrates that when frontline teams are supported with simple, structured tools and continuous feedback, substantial improvements in both process reliability and patient outcomes can be achieved.

Conclusion

The findings of this research clearly demonstrate that the structured bedside infection-prevention checklist served as an effective, low-cost, and highly practical intervention for reducing hospital-acquired infections in adult medical wards

simultaneously strengthening kev infectionprevention behaviours among nursing staff. The consistent decline in overall HAI incidence density, substantial reductions in device-associated infections such as CAUTI and line-associated bloodstream infections, and the marked improvement in process indicators collectively highlight the capacity of simple, point-of-care prompts to bridge persistent implementation gaps that often hinder the translation of infection-prevention guidelines into reliable bedside practice. The positive outcomes observed in a busy, non-ICU ward environment underscore the feasibility of integrating checklist-based approaches into routine clinical workflows without imposing substantial workload on staff. At the same time, improvements in hand hygiene compliance, PPE use, and documentation of device necessity confirm that the checklist not only supported task completion but also enhanced situational awareness and promoted a culture of safety among frontline workers. Based on these findings, several practical recommendations emerge that should be incorporated into the routine functioning of medical wards. First, hospitals should consider adopting structured bedside checklists as a standard component of routine care, ensuring that they are tailored to unit-specific needs and integrated into existing nursing documentation systems. Second, regular and focused training sessions should be institutionalized to strengthen staff competency in standard precautions, techniques, and device maintenance practices, onboarding programs ensuring that new staff receive early training in checklist usage. Third, ongoing audit-andfeedback mechanisms should be implemented to reinforce accountability, track adherence, and identify areas requiring improvement, while encouraging positive reinforcement for high compliance. Fourth, emphasis should be placed on promoting device stewardship by mandating daily review of catheter and line necessity, with the checklist serving as a trigger for timely removal of unnecessary devices. Fifth, nursing leadership should foster an enabling environment by ensuring adequate supplies, functional hand hygiene stations, and uninterrupted access to PPE. Sixth, integrating checklist data into electronic medical records systems could further improve monitoring efficiency and reduce documentation burden. Finally, hospitals should evaluate the scalability of checklist-driven IPC programs across other wards, including surgical, pediatric, and emergency units, recognizing that broader implementation can contribute to sustained improvements in patient safety and infection outcomes. The overall results of this research reflect that when structured tools, education, and accountability frameworks converge, medical wards can substantial, measurable, and sustainable improvements in infection-prevention practices, ultimately enhancing patient outcomes and optimizing the use of healthcare resources.

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