e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(10); 682-687

Original Research Article

Infection Control Practices and Outcomes: Analyse Infection Control Measures and their Impact on HAI Rates

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Received: 01-07-2026 / Revised: 15-08-2026 / Accepted: 21-09-2026
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Conflict of interest: Nil

Abstract

Background: Healthcare-associated infections (HAIs) are an important cause of morbidity, mortality, longer hospital stays and healthcare costs globally. To lower the rate of HAIs and the morbidity and mortality associated with them, effective Infection Prevention and Control (IPC) practices are necessary, especially in low-resource health care settings.

Methods: A cross-sectional observational study in which 100 patients who were hospitalized in Patna Medical College and Hospital (PMCH), Patna, Bihar, from January to June, 2025 were included. Data were collected with a structured questionnaire and an observation checklist that was designed according to the guidelines of IPC from the World Health Organization (WHO). Patient demographic data and patient compliance with infection control measures and clinical outcomes, including the occurrence of HAI, were collected. Data was analysed using SPSS version 26 and the p-values were < 0.05.

Results: The prevalence of HAIs was 24%, Surgical Site Infections (SSIs) made up 33.3% of all HAIs, followed by Catheter-associated Urinary Tract Infections (CAUTIs) (25.0%), Ventilator-associated Pneumonia (VAP) (16.7%), Central line-associated Bloodstream Infections (CLABSIs) (12.5%) and other infections (12.5%). The hand hygiene, Personal Protective Equipment (PPE), use and environmental cleaning compliance rates were over 80%. The higher the compliance rate for the infection prevention measures was, the lower the HAI rate was, and this was significantly associated ($\chi^2 = 18.74$; $p = 0.001$). The overall recovery rate was 82% and mortality was 6%.

Conclusion: The findings are that strong compliance with IPC was associated to a decrease in HAI and improved outcomes for patients. To maintain patient safety and reduce HAIs, it is crucial to implement continuous surveillance, regular staff training, and enhance hospital infection control programmes in tertiary healthcare environments.

Keywords: Healthcare-associated infections, Infection control, Hand hygiene, Hospital-acquired infection, PMCH, Cross-sectional study.

DOI: 10.25258/ijcpr.18.10.92

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Introduction

HAIs are infections that occur in patients while receiving health care, and that were not present or incubating at the time of admission to the hospital [1]. These infections usually develop 48 hours or more after admission and are a significant patient safety problem across the worldwide.

HAIs are responsible for significant morbidity, mortality, extended hospital stays and healthcare costs [2]. WHO estimates that HAIs affected hundreds of millions of patients every year, particularly in low- and middle-income countries where resource limitations, overcrowding, poor practices in preventing infection and poor surveillance systems make the problem more severe [3]. The problem of HAIs is still prevalent in India, especially in tertiary care hospitals where the critically ill, invasive procedures, and long hospital stays contribute to HAIs. Thus, improving infection prevention has been made a national healthcare priority [4].

SSIs, CAUTIs, CLABSIs, and VAP are the most common types of HAIs [5,6]. Often these

infections are associated to invasive medical devices and surgical procedures. They not only slow recovery by the patient, but also require more intensive care, more antimicrobial treatment and repeated medical interventions. Multidrug resistant organisms (MDROs) are also a challenge to the management of HAIs and underscore the need for effective infection prevention practices [7,8].

IPC is a evidence-based strategies to reduce the spread of infectious agents in health care facilities [9]. The WHO has recommended a comprehensive IPC programme involving the implementation of standard precautions, hand hygiene (the Five Moments for Hand Hygiene), use of PPE environmental cleaning and disinfection, sterilization of medical equipment and proper biomedical waste management [10,11]. An effective IPC programme should also include regular surveillance, training of healthcare workers and compliance monitoring.

With the increasing burden of antimicrobial resistance, adherence to infection control practices has become even more crucial to prevent infection and reduce the unnecessary use of antibiotics and the spread of antimicrobial resistant pathogens. There are substantial differences in compliance, especially in resource constrained environments, despite national IPC guidance. Moreover, there are few published data on the effectiveness of the infection control measures in Bihar. Hence this study is designed with the aim of evaluating infection control measures and the effect on HAI in hospitalised patients under the PMCH Patna. Specific goals include identifying the rates of HAIs, assessing compliance of important infection prevention practices, and assessing the relationship between infection prevention practices and patient outcomes.

Objectives

- To evaluate infection control practices and influence on the rates of HAI among hospitalized patients.
- To measure the rate of HAIs.
- To assess adherence to infection prevention.
- To determine the factors that contribute to HAI.

Materials and Methods

Study Design: The design of this study was a cross-sectional observational study in a hospital setting to assess the infection control practices and associated to the prevalence of HAIs in hospitalised patients. A cross-sectional approach was considered appropriate as it enabled the evaluation of IPC measures and clinical outcomes during the hospital stay, without the investigators from intervening.

Study Area: This study was carried out in PMCH, Patna, Bihar, tertiary care teaching hospital, which provides specialized medical and surgical care to large number of patients from Bihar and adjoining states. Patients admitted to selected medical, surgical, intensive care and specialty wards were included in the study.

Study Duration: The study was conducted six months from January 2025 to June 2025. In this period, eligible patients were sequentially enrolled and clinical and infection control information was gathered during the patients' hospital stay.

Sample Size: In total, 100 hospitalized patients were included in the study who met the inclusion criteria. Patients were considered for enrollment if they had been in hospital for over 48 hours, as the typical time for HAI to occur is after 48 hours.

Inclusion Criteria

- The number of patients who were admitted for over 48 hours
- Age ≥18 years
- Inpatients in medical/surgical ward, in-patient units and orthopedic wards.
- The patient(s) who have given informed consent

Exclusion Criteria

- Infection present at admission
- Hospital stay less than 48 hours
- Patients discharged against medical advice
- Incomplete medical records

Sampling Technique: The recruitment of participants was a convenience sample. Patients who met the inclusion criteria and were admitted to the selected wards during the study period were recruited until the required sample size of 100 patients was archived. The technique was selected because of the availability of participants and the fact that it was an observational study.

Data Collection: Data were collected by direct observation and patient interviews (where appropriate) and on a structured data collection form by reviewing medical records. Demographic and clinical data comprised age, gender, hospital ward, comorbidities and hospital stay.

Assessment of infection control variables covered hand hygiene measures, use of PPE, catheter care practices, dressing of the surgical wounds, sterilization of medical equipment, disposal practices of biomedical waste, environmental cleaning and disinfection and implementation of the isolation precaution. The clinical outcomes variables were the presence of HAI, type of HAI (SSI, CA-UTI, CLABSI, VAP), length of hospital stay, intensive care unit (ICU) admission, hospital discharge status, and in-hospital mortality.

Statistical Analysis: Data collected were analysed using SPSS version 26.0. Demographic characteristics and infection control practices were summarized using descriptive statistics. Data for continuous variables were reported as mean ± SD and for categorical variables as frequencies and percentages. The association between categorical variables was tested using Chi-square test and between continuous variable was tested using independent t-test. Logistic regression analysis was used to determine factors independently associated with occurrence of HAIs. A p-value < 0.05 was regarded as statistically significant.

Ethical Considerations: The study was conducted following approval from the Institutional Ethics Committee of Patna Medical College and Hospital. All participants (or their legal guardian) provided written informed consent prior to participation. All patient data was kept confidential and private, and collected information was only utilized for research, according to ethical standards.

Results

To assess the infection control practice and the effect on the HAI rate 100 patients were hospitalized and included in study from PMCH, Patna.

Baseline Characteristics: The average age of the study subjects was 48.6 ± 16.4 years, the majority of which were 41-60 years old (36%). The male population comprised 58% and the female population comprised 42% of the study population. The majority of patients was admitted to medical ward (34%), surgical ward (28%), ICU (22%) and orthopedic ward (16%). The most prevalent comorbidities were diabetes mellitus and hypertension (32% and 38%, respectively). In total, 22% of the patients had to be admitted to the ICU during their hospitalizations. The average duration of hospitalization was 8.9 ± 3.7 days.

Table 1: Baseline Characteristics of the Study Participants (n = 100)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–40	30	30.0
41–60	36	36.0
>60	34	34.0
Gender		
Male	58	58.0
Female	42	42.0
Ward		
Medical	34	34.0
Surgical	28	28.0
ICU	22	22.0
Orthopedic	16	16.0
Diabetes mellitus	32	32.0
Hypertension	38	38.0
ICU admission	22	22.0
Mean hospital stay (days)	**8.9 ± 3.7**	—

Compliance with Infection Control Practices: The level of compliance with infection prevention and control practices was relatively good, with high levels of compliance for biomedical waste disposal (90%) and environmental cleaning (88%). Compliance with hand hygiene was assessed for 82% of patient care episodes with appropriate use of PPE recorded for 86%. Adherence to the catheter care, sterile dressing and isolation precautions was from 78% to 84%, which represents room for further progress in compliance with IPC guidelines.

Table 2: Compliance with Infection Control Practices

Infection Control Practice	Compliant n (%)	Non-compliant n (%)
Hand hygiene	82 (82.0)	18 (18.0)
PPE use	86 (86.0)	14 (14.0)
Catheter care	80 (80.0)	20 (20.0)
Sterile dressing	84 (84.0)	16 (16.0)
Environmental cleaning	88 (88.0)	12 (12.0)
Biomedical waste disposal	90 (90.0)	10 (10.0)
Isolation practices	78 (78.0)	22 (22.0)

Prevalence of Healthcare-Associated Infections: Of the 100 patients studied, 24 (24%) had a HAI while hospitalized. The most prevalent HAIs were SSI (33.3% of HAIs), CAUTI (25.0%), VAP (16.7%), CLABSI (12.5%), and other hospital-acquired infections (12.5%).

Table 3: Distribution of Healthcare-Associated Infections

Type of HAI	Frequency (n)	Percentage of HAIs (%)
Surgical Site Infection (SSI)	8	33.3
Catheter-Associated UTI (CAUTI)	6	25.0
Central Line-Associated Bloodstream Infection (CLABSI)	3	12.5
Ventilator-Associated Pneumonia (VAP)	4	16.7
Others	3	12.5
Overall, HAI prevalence	**24**	**24.0**

Association between Infection Control Compliance and Healthcare-Associated Infections: There was significantly less HAI occurrence in locations where there is high compliance to infection control measures versus moderate or poor compliance. Only 8.0% of patients with the higher compliance group developed HAI, while 26.7% and 56.0% of patients with moderate- and poor-compliance groups, respectively, developed HAI. There was a statistically significant association between infection control compliance and the occurrence of HAIs ($\chi^2 = 18.74$, $p = 0.001$).

Table 4: Association between Infection Control Compliance and HAI Occurrence

Compliance Level	HAI Present n (%)	HAI Absent n (%)	Total	χ^2	P-value
High (n=50)	4 (8.0)	46 (92.0)	50		
Moderate (n=30)	8 (26.7)	22 (73.3)	30		
Poor (n=20)	12 (60.0)	8 (40.0)	20	**18.74**	**0.001***

***Statistically significant ($p < 0.05$).**

Clinical Outcomes: In clinical outcomes, 82% of the patients had a successful recovery, and 12% of them were hospitalized for a long time. 10% of patients required transfer to the ICU during the study period and overall mortality was 6%. The average length of hospital stay was significantly longer among patients with HAIs than among patients without HAIs (13.2 ± 4.1 days vs. 7.6 ± 2.8 days, respectively), highlighting the important contribution of HAIs to patient recovery and health care utilization.

Table 5: Clinical Outcomes of the Study Participants

Clinical Outcome	Frequency (n)	Percentage (%)
Recovery	82	82.0
Prolonged hospitalization	12	12.0
ICU transfer	10	10.0
Mortality	6	6.0
Average hospital stay (overall)	**8.9 ± 3.7 days**	—
Average stay with HAI	**13.2 ± 4.1 days**	—
Average stay without HAI	**7.6 ± 2.8 days**	—

In general, the results suggest a significant relationship between increased level of adherence to infection prevention and control measures, and the occurrence of HAI and clinical outcome. Infection control measures were found to be associated with reduced number of HAIs, reduced hospital length of stay, and better patient recovery rate highlighting the importance of implementing standard infection control measures in order to increase and improve patient safety in tertiary care hospitals.

Discussion

Prevalence of Healthcare-Associated Infections: Overall prevalence of HAI in hospitalized patients of PMCH, Patna was 24% in the present study. SSI, CAUTI, VAP, and CLABSI were the most prevalent HAIs. The results are similar to recent Indian studies done in tertiary care hospitals where the prevalence of HAI has been reported as 15-30% with SSIs being the most common infection, given the large number of surgical procedures performed and the long hospital stays after surgery. These findings are consistent with recent Indian studies conducted in tertiary care hospitals to more developed measures of infection prevention, improved surveillance and greater adherence to standard infection control procedures. In the current study, the higher proportion of HAIs may reflect the ongoing importance of HAIs in the healthcare environment in this resource-limited area and the need to enhance infection prevention efforts.

Infection Control Compliance: Assessment of IPC practices showed that the use of biomedical waste management, environmental cleaning, hand hygiene and PPE was in strong compliance [12]. Compliance was, however, relatively low for the care of the catheter and isolation precautions which suggest further areas for improvement. WHO recommends for strict standard precautions including following the "Five Moments for Hand Hygiene" guidelines, ensuring proper use of PPE, proper sterilization of reusable medical devices, and regular disinfection of the environment to reduce the risk of pneumonia [13]. While relatively high compliance was noted in this study, this is a positive effect of the implementation of WHO recommended IPC practices on ensuring patient safety. However, there is a risk of pathogens being transmitted underscoring the importance of regular audits, staff training, and continuous reinforcement of infection control protocols.

Effect of Infection Prevention and Control Measures on Healthcare-Associated Infections: The current study found a significant associated between increased compliance with the infection control procedures and decreased HAI rates. The more IPC measures that were followed, the fewer infections were observed in wards with poor, moderate, or high adherence [14]. This study confirms existing evidence that improved infection prevention programmes have a significant impact on the number of hospital-acquired infections. These systems allow for real-time monitoring of the infection process, helping to detect patterns and trends early, and regular checks on compliance can identify gaps and take necessary adjustments. Also, regular education and training based on competencies enhances the practice of evidence-based practice, including hand hygiene, aseptic practices, catheter care and environmental hygiene among healthcare workers [15]. All of these interventions help to decrease the spread of pathogens in healthcare facilities.

Clinical Outcomes: Patients managed under higher infection control compliance had better clinical results such as higher recovery rates, reduced number of transfers to the ICU, reduced hospital stay, and reduced mortality. In contrast, patients who developed HAIs had longer hospitalizations and higher levels of medical management. These results are similar to those reported earlier that HAIs significantly contribute to health care utilization, treatment cost, and disease morbidity. A successful infection prevention programme not only improves patient survival but also lowers the workload of hospitals by reducing complications, the need for antibiotic use and the length of hospital stays.

Strengths: One of the advantages of this study is that it is conducted in the hospital setting, similar with the clinical practice in tertiary care. A structured assessment, based on WHO infection prevention guidelines, allowed for systematic evaluation of multiple infection control practices. Moreover, the addition of demographic data, IPC compliance indicators, HAI occurrence, and clinical outcomes allowed for a detailed evaluation of the association between each IPC measure and patient outcomes.

Limitations: There are a number of limitations in the study. The limited number of participants (100) may restrict the generalizability of the results. The findings of this study are from a single center at PMCH, Patna and may not be applicable to other healthcare institutions having different patients and infrastructures. The 6-month study period might not have encompassed seasonal changes in the rate of infection. Further, some of the infection control practices were assessed through direct observation, which could have included observer bias. Larger, multicenter studies with follow-up longer than the current study are suggested to confirm these findings.

Conclusion

The prevalence of HAI in the present study overall was 24% with surgical site infections being the most prevalent HAI. This was significantly associated with improved clinical outcomes and reduced HAI rates, especially hand hygiene, PPE, environmental cleaning and sterilization practices. To maintain compliance, regular staff training, and enhanced hospital infection control committees are crucial to lower the rate of HAI and improve patient safety in tertiary care hospitals.

Recommendations: Healthcare facilities should conduct regular hand hygiene audits, mandatory IPC training for healthcare workers and regular infection surveillance. Increasing the use of antibiotic stewardship programmes, ensuring PPE is available and in better condition, improving environmental cleaning, closely monitoring the care of catheters and devices, and reinforcing hospital infection control policies will further help to reduce the number of healthcare-associated infections and enhance patient care.

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