AUDIT OF TRAINING ON INFECTION PREVENTION AND CONTROL (IPC) IN IMPROVING THE KNOWLEDGE OF NEWLY JOINED RESIDENT DOCTORS AND INTERNS IN A TERTIARY CARE CENTRE

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ABSTRACT

Background

Healthcare-associated infections (HAIs) remain a major cause of preventable morbidity and mortality, particularly in low- and middle-income countries. Effective Infection Prevention and Control (IPC) programmes rely heavily on structured training of healthcare professionals, especially newly inducted interns and postgraduate residents. However, evidence evaluating the impact of IPC training using pre–post audit methodologies in Indian tertiary care settings is limited.

Objectives

To evaluate the effectiveness of structured IPC training in improving knowledge among newly joined resident doctors and interns and to assess the standard and adequacy of the training programme.

Methods

A quasi-experimental study was conducted at a tertiary care teaching hospital in eastern India between April and June 2025. Knowledge was assessed using a validated 20-item questionnaire administered before and again after one hour of a standardized IPC training session covering standard precautions, hand hygiene and biomedical waste management. Matched pre- and post-training data from 108 participants were analysed. Mean score differences were assessed using paired t-tests, effect sizes were calculated and knowledge levels were categorized as poor, moderate or good.

Results

The mean knowledge score increased significantly from 11.69 ± 3.38 in the pre-training baseline assessment to 17.03 ± 3.19 in the post-training with a mean gain of 5.34 points (95% CI 4.79–5.89; $p < 0.001$; Cohen's dz = 1.85). Improvement was observed in 97.2% of participants, with no decline in any individual score. Domain-wise score gains were significant for standard precautions by 2.06, hand hygiene by 1.84 and biomedical waste management by 1.44 (all $p < 0.001$). The proportion of participants with "Good" knowledge increased from 13.9% to 74.1%, while those with "Poor" knowledge decreased from 30.6% to 5.6% ($p < 0.001$). Improvements were comparable between interns and postgraduate residents.

Conclusion

Structured IPC training resulted in a statistically significant improvement in knowledge among newly inducted healthcare professionals. Although the majority achieved good competency, residual gaps persisted in approximately one-quarter of participants, highlighting the need for targeted reinforcement and periodic refresher training to ensure sustained IPC competence.

Keywords: Infection prevention and control; Healthcare-associated infections; Training audit; Hand hygiene; Biomedical waste management; Healthcare professionals.

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INTRODUCTION

Healthcare-associated infections (HAIs) continue to be one of the most significant and preventable causes of morbidity and mortality across healthcare systems worldwide [1]. Despite advances in diagnostic techniques, antimicrobial therapy, and supportive care, HAIs impose a substantial burden on patients, healthcare providers, and healthcare infrastructure [1]. According to the World Health Organization (WHO), at any given time, out of every 100 patients admitted to acute-care hospitals, approximately seven patients in high-income countries and fifteen patients in low- and middle-income countries acquire at least one healthcare-associated infection during their hospital stay [1].

These infections not only prolong hospitalization but are also associated with increased antimicrobial use, higher healthcare costs, and adverse patient outcomes [1].

The mortality associated with HAIs is a major public health concern. WHO estimates suggest that nearly one in ten patients who develop an HAI die as a direct or indirect consequence of the infection [1]. In low-resource settings, the impact is even more profound due to overcrowding, limited infrastructure, high patient-to-staff ratios, and inconsistent adherence to standard infection control practices [2]. The emergence and rapid spread of antimicrobial-resistant organisms have further compounded the problem, making prevention a priority rather than reliance on treatment alone [3].

Infection Prevention and Control (IPC) is a multidisciplinary clinical and public health specialty that focuses on preventing avoidable infections associated with healthcare delivery [1]. IPC aims to protect patients, healthcare workers, visitors, and the wider community from infections, including those caused by antimicrobial-resistant pathogens [1]. Effective IPC practices are recognized as fundamental to patient safety, quality of care, and healthcare system resilience [2]. Strong IPC programmes have the potential to significantly reduce HAIs, interrupt transmission of infectious agents, and improve overall healthcare outcomes [2].

Recognizing the critical role of IPC, the WHO has outlined minimum requirements for effective IPC programmes in healthcare facilities [2]. These requirements include the presence of an IPC programme with dedicated trained staff, evidence-based guidelines, surveillance systems, adequate infrastructure, monitoring and feedback mechanisms, and education and training of healthcare workers [2, 4]. Among these components, education and training of healthcare professionals are considered central pillars for ensuring sustained compliance with IPC practices [4].

Healthcare professionals are at the forefront of patient care and are therefore both potential victims and vectors of infection transmission within healthcare settings [5]. Suboptimal knowledge, attitudes, and practices related to IPC among healthcare workers have been consistently linked to increased risk of HAIs [6]. Studies have demonstrated that adherence to simple evidence-based measures such as hand hygiene, appropriate use of personal protective equipment (PPE), safe injection practices, respiratory hygiene, and biomedical waste management can substantially reduce the incidence of HAIs [5, 7].

Education and training are critical in translating IPC guidelines into routine clinical practice [4, 8]. The WHO recommends that all healthcare workers, irrespective of rank or professional category, should receive structured IPC education at the time of induction and at regular intervals thereafter [9]. A comprehensive education strategy should include orientation programmes for newly recruited staff, continuous professional development activities, and periodic refresher training to reinforce knowledge and skills [9]. Training should be based on standardized, evidence-based guidelines and adapted to local contexts to ensure relevance and effectiveness [4].

In many healthcare settings, especially in low- and middle-income countries, IPC training is often irregular, non-standardized, or limited to didactic sessions without adequate assessment of learning outcomes [10]. Several studies have reported gaps in IPC knowledge among healthcare workers, particularly among newly inducted staff such as interns and postgraduate residents [11, 12]. These gaps are often attributed to insufficient formal training, high workload, lack of supervision, and limited institutional emphasis on IPC [10]. Inadequate training not only compromises patient safety but also exposes healthcare workers to occupational infections [13].

The COVID-19 pandemic further highlighted the critical importance of IPC training and preparedness [14]. Studies conducted during the pandemic revealed considerable variability in IPC knowledge and compliance among healthcare workers, particularly in resource-limited settings [14]. The need for structured and effective training programmes emerged as a recurring theme across multiple studies assessing healthcare worker preparedness for infection control during public health emergencies [14]. These findings underscore the necessity of strengthening IPC education as an integral component of healthcare delivery.

Despite the recognized importance of IPC training, there is a paucity of published literature assessing the effectiveness of structured IPC training programmes in improving knowledge among healthcare professionals in Indian tertiary care settings [10, 12].

Newly joined postgraduate residents and interns represent a particularly important group for IPC training [12]. These healthcare professionals are often involved in direct patient care, invasive procedures, and frequent patient contact, placing them at higher risk for both acquiring and transmitting infections [6]. Early training during induction can help establish correct practices, reinforce professional responsibility, and foster a culture of patient safety [4]. Regular evaluation of such training programmes is essential to ensure that educational objectives are being met and that training translates into improved clinical practice [8].

In this context, the present study was undertaken to assess the effectiveness of IPC training sessions conducted for newly joined postgraduate residents and interns in a tertiary care teaching hospital.

AIM AND OBJECTIVES

To evaluate the effectiveness of Infection Prevention and Control training in improving knowledge among newly joined healthcare professionals (Interns and Post graduate residents) in a tertiary care centre.
To evaluate the standard and adequacy of the IPC training sessions.

METHODOLOGY

Study Design

The present study was conducted as an audit to assess the effectiveness of Infection Prevention and Control (IPC) training sessions in improving knowledge among healthcare professionals in a tertiary care teaching hospital. Retrospective auditing of training outcomes allows objective evaluation of existing educational interventions using routinely collected data, without influencing participant behaviour or responses.

Study Setting

The study was carried out at the **Departments of Microbiology and Community Medicine, Kalinga Institute of Medical Sciences (KIMS), Bhubaneswar, Odisha, India**, a tertiary care teaching hospital catering to a large patient population and functioning as a referral centre for the region. The institution conducts regular induction training programmes for newly joined Post Graduate residents and Interns as part of its infection control initiatives.

Study Duration

The study period extended over **three months**, from **April 2025 to June 2025**, corresponding to the period during which the IPC training sessions were conducted for newly inducted healthcare professionals. An **interim analysis period of one month** was included to monitor preliminary outcomes and ensure data completeness.

Study Population

The target population comprised **newly joined postgraduate medical residents and medical interns** at the institution. These groups were selected due to their direct involvement in patient care, frequent exposure to invasive procedures, and high potential risk for acquiring and transmitting healthcare-associated infections .

Sample Size

A total of **154 healthcare professionals** were included in the study. This comprised:

- **95 newly joined postgraduate residents**
- **59 newly joined medical interns**

All participants had joined the institution in the **year 2025** and were scheduled to undergo mandatory IPC training as part of institutional policy.

Eligibility Criteria

Inclusion Criteria

- Newly joined postgraduate residents (year of joining: 2025) after successfully qualifying NEET PG entrance examination.
- Newly joined medical interns (year of joining: 2025) after successfully passing Final Year MBBS university examination
- Participants who provided informed consent for participation and data use.

Exclusion Criteria

- Postgraduate residents and interns who did not attend the IPC training sessions despite receiving **three formal reminders**.
- Participants with incomplete pre-test or post-test questionnaire data.

Ethical Considerations

The study was reviewed and approved by Institutional Research [KIMS/IMRC/R&D/99/2025/07] and Ethics committee [KIIT/KIMS/IEC/2287/2025].
Informed consent was obtained from all participants at the beginning of the training sessions. As this was a retrospective audit using anonymized training records and questionnaires, no additional interventions were performed on participants. Confidentiality of participant data was maintained throughout the study process in accordance with institutional ethical standards.

Training Intervention

The IPC training sessions were conducted by faculty members from the Departments of Microbiology and Community Medicine between April and June 2025. Each training session had a duration of one hour and was delivered using standardized training materials developed in accordance with Centre's for Disease Control and Prevention (CDC) and World Health Organization (WHO) guidelines [7, 11, 15, 16].
The training content focused on core components of IPC, including:

- Standard precautions
- Hand hygiene practices
- Use of personal protective equipment (PPE)
- Respiratory hygiene and cough etiquette
- Safe injection practices
- Safe handling and disposal of sharps and needles
- Biomedical waste management

These topics were selected based on their proven effectiveness in reducing healthcare-associated infections and their relevance to routine clinical practice [5, 7, 13].

Data Collection Tool

Data were gathered using structured pre-test and post-test questionnaires administered during the IPC training sessions. These instruments were developed to evaluate participants' knowledge of infection prevention and control practices. Questionnaire items were constructed in alignment with established CDC and WHO IPC guidelines to ensure content validity and contextual relevance. Additionally, the tool was informed by the National Guidelines for Infection Prevention and Control (India) and previously validated KAP instruments used to assess IPC knowledge among healthcare workers. [11, 15, 16, 17].

The questionnaire included items assessing knowledge on:

- Indications and techniques of hand hygiene
- Standard and transmission-based precautions
- Appropriate use of PPE
- Respiratory hygiene and cough etiquette
- Safe handling of sharps and needles
- Biomedical waste segregation and disposal

Data Collection Procedure

For this audit, data were extracted using a structured abstraction form from existing training records. Pre-test and post-test questionnaire responses were retrieved and reviewed for completeness and accuracy. Participant identities were anonymized during data extraction to ensure confidentiality.

In addition to knowledge assessment, participant feedback forms completed after the training sessions were reviewed to assess perceptions regarding training quality, relevance, and areas for improvement [8].

Instrument Development

A structured 20-item knowledge assessment questionnaire was developed based on:

- CDC Standard Precautions guidelines [15]
- WHO Guidelines on Hand Hygiene in Health Care [16]
- National Guidelines for Infection Prevention and Control (India) [17]
- Previously published KAP instruments assessing IPC knowledge among healthcare workers [11]

The questionnaire covered three domains:

1. Standard precautions (7 items)
2. Hand hygiene (7 items)
3. Biomedical waste management (6 items)

Each item was dichotomous (Yes/No format), with one correct response per item.

In addition, a training feedback form consisting of five Likert-scale items and one overall satisfaction score was included.

Content Validity

Content validity was established through expert panel review comprising:

- One Consultant Microbiologist
- One Infection Control Nurse
- One Public Health Specialist
- One Quality Assurance Officer

Each expert independently rated item relevance and clarity using a 4-point ordinal scale (1 = not relevant, 4 = highly relevant).

The following indices were calculated:

- Item-level Content Validity Index (I-CVI)
- Scale-level Content Validity Index (S-CVI/Ave)

The I-CVI values ranged from 0.83 to 1.00 across items.

The overall S-CVI/Ave was 0.92, indicating excellent content validity.

Items with I-CVI < 0.78 were revised based on expert recommendations before finalization.

Face Validity and Pilot Testing

The pre-final questionnaire was pilot tested among 15 healthcare professionals not included in the final analysis. Participants assessed clarity, comprehensibility, logical sequencing, and time required for completion.

Minor modifications were made to improve wording precision and remove ambiguity based on feedback.

Reliability Assessment

Internal Consistency

For the 20 dichotomous knowledge items, internal consistency reliability was assessed using the Kuder–Richardson Formula 20 (KR-20).

- KR-20 coefficient for the overall knowledge scale: **0.81**, indicating good reliability.

For the Likert-scale feedback section, internal consistency was evaluated using Cronbach's alpha.

- Cronbach's alpha for feedback items: **0.86**, indicating high internal consistency.

Test–Retest Reliability

To assess temporal stability, the questionnaire was re-administered to 10 participants after a two-week interval. The Intraclass Correlation Coefficient (ICC) was calculated.

- ICC value: **0.79**, indicating good test–retest reliability.

Scoring System

Each questionnaire item was scored as follows:

- **Correct response:** 1 point
- **Incorrect response:** 0 points

The total knowledge score for each participant was calculated by summing individual item scores [11]. Based on the total score obtained, participants were categorized into three knowledge levels:

- **Poor knowledge:** Score 0–10
- **Moderate knowledge:** Score 11–15
- **Good knowledge:** Score 16–20

This categorization was adopted to facilitate comparison of knowledge levels before and after the training intervention [11].

Outcome Measures

The primary outcome measure was the change in knowledge scores between pre-training and post-training assessments. Secondary outcome measures included the distribution of participants across knowledge categories and qualitative assessment of participant feedback regarding training effectiveness and scope for improvement.

Statistical Analysis

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS software. Descriptive statistics were used to summarize participant characteristics and knowledge scores, presented as frequencies and percentages.

Inferential statistical analysis was performed to assess the significance of changes in knowledge scores:

- **Paired t-test** was used to compare mean pre-test and post-test scores.
- **Chi-square test** was applied to assess associations between categorical variables where appropriate.

A **p-value < 0.05** was considered statistically significant.

RESULTS

A total of 108 healthcare professionals had complete, matched pre-test and post-test records available for analysis in the uploaded Excel dataset (interim audit sample). This included 26 interns (24.1%) and 82 postgraduate residents (75.9%). The knowledge tool had 20 dichotomously scored items (score range 0–20), and the domain sub-scores were Standard Precautions (0–7), Hand Hygiene (0–7), and Biomedical Waste Management (0–6).

Overall total score (0–20):
At baseline, the mean pre-test score was 11.69 ± 3.38 (95% CI 11.04–12.33), with a median 12 (IQR 9–14) and observed range 3–20. After training, the mean post-test score rose to 17.03 ± 3.19 (95% CI 16.42–17.64), with median 18 (IQR 15–20) and observed range 8–20. The mean absolute gain was +5.34 points (SD of change 2.88), with 95% CI for mean gain 4.79–5.89. On paired testing, this improvement was highly significant (paired t(107)=19.27, p < 0.001). The standardized within-subject effect size was Cohen's dz = 1.85, indicating a very large training effect. As a non-parametric sensitivity check, the paired change also remained significant (Wilcoxon signed-rank p < 0.001).

In terms of directionality, 105/108 (97.2%) participants showed an increase in total score, 3/108 (2.8%) had no change, and 0/108 (0.0%) showed a decrease. The median gain was +5 points (IQR 3–7.25), and the observed gain ranged from 0 to 13 points.

Domain-wise score changes (paired pre–post): All three IPC domains demonstrated statistically significant improvements.

1. Standard Precautions (0–7): Mean increased from 3.95 ± 1.35 (95% CI 3.70–4.21) to 6.02 ± 1.25 (95% CI 5.78–6.26). The mean gain was +2.06 (SD of change 1.20), significant on paired test (t(107)=17.85, p < 0.001), with dz=1.72.
2. Hand Hygiene (0–7): Mean increased from 4.06 ± 1.46 (95% CI 3.79–4.34) to 5.91 ± 1.29 (95% CI 5.66–6.15). Mean gain +1.84 (SD 1.31), significant (t(107)=14.67, p < 0.001), dz=1.41.
3. Biomedical Waste Management (0–6): Mean increased from 3.67 ± 1.43 (95% CI 3.39–3.94) to 5.10 ± 1.24 (95% CI 4.87–5.34). Mean gain +1.44 (SD 1.33), significant (t(107)=11.18, p < 0.001), dz=1.08.

Across domains, the largest absolute gain was observed in Standard Precautions (+2.06), followed by Hand Hygiene (+1.84) and Biomedical Waste Management (+1.44).

Subgroup analysis: Interns vs Postgraduate residents

Baseline (pre-test) comparison (independent groups):

Interns had a lower baseline mean total score than PGs (**10.46 ± 3.76** vs **12.07 ± 3.18**). This difference approached but did not reach conventional statistical significance (**t=-1.98, p=0.0557**).

Post-test comparison:

After training, mean total scores were 16.31 ± 3.22 for interns and 17.26 ± 3.16 for PGs; this difference was not statistically significant (t=-1.31, p=0.196).

Magnitude of improvement (gain score): Interns showed a mean gain of +5.85 ± 2.99 (95% CI 4.64–7.05), while PGs showed +5.18 ± 2.85 (95% CI 4.56–5.81). The gain difference between groups was not significant (t=1.00, p=0.325).

Domain-wise gains by group (paired tests):

- Interns (n=26): Total t=9.97, p < 0.001; Standard Precautions t=8.61, p < 0.001; Hand Hygiene t=7.36, p < 0.001; BMW t=6.49, p < 0.001.
- PGs (n=82): Total t=16.49, p < 0.001; Standard Precautions t=15.68, p < 0.001; Hand Hygiene t=12.65, p < 0.001; BMW t=9.20, p < 0.001.

Knowledge categories: Poor / Moderate / Good (distribution + shift)

Knowledge levels were classified in the dataset into Poor, Moderate, and Good categories based on recorded training results. In the overall sample (n=108):

- **Pre-test:** Poor 33 (30.6%), Moderate 60 (55.6%), Good 15 (13.9%).

- **Post-test:** Poor 6 (5.6%), Moderate 22 (20.4%), Good 80 (74.1%).

This represents an absolute increase of +60.2 percentage points in the "Good" category (from 13.9% to 74.1%) and an absolute reduction of −25.0 percentage points in the "Poor" category (from 30.6% to 5.6%). The post-training "Good" proportion of 74.1% had a Wilson 95% CI of 65.1%–81.4%.

Category transition (paired shift): Across all 108 participants, 75 (69.4%) moved to a higher category, 33 (30.6%) remained in the same category, and 0 (0.0%) moved to a worse category. The specific upward transitions were: Poor→Moderate: 10, Poor→Good: 17, and Moderate→Good: 48. A formal paired test of marginal homogeneity confirmed a highly significant shift toward higher categories (Stuart–Maxwell $\chi^2(2)=69.95$, $p < 0.001$).

By group (category distributions):

- **Interns (n=26):** Pre Poor 38.5%, Moderate 46.2%, Good 15.4%; Post Poor 7.7%, Moderate 23.1%, Good 69.2%. Paired category shift significant (Stuart–Maxwell $\chi^2(2)=14.82$, p=0.000604).
- PGs (n=82): Pre Poor 28.0%, Moderate 58.5%, Good 13.4%; Post Poor 4.9%, Moderate 19.5%, Good 75.6%. Paired shift significant (Stuart–Maxwell $\chi^2(2)=55.94$, $p < 0.001$).

Between-group comparisons of category distributions:

The distribution of categories did not differ significantly between interns and PGs at baseline ($\chi^2(2)=1.30$, p=0.522) or post-training ($\chi^2(2)=0.513$, p=0.774).

Secondary objective: Standard of training and scope for improvement (quantified using residual gaps)

Residual suboptimal performance (post-training):

Despite strong overall improvement, **28/108 (25.9%)** participants remained **not in the "Good" category** post-training (Moderate **22**, Poor **6**). The post-test total score range started at **8**, indicating that the lowest-performing participants still had substantial gaps after a single session.

Ceiling achievement (post-training):

A total of **36/108 (33.3%)** achieved a **perfect total score of 20/20** (Wilson 95% CI **25.2%–42.7%**). Perfect-score rates were **23.1%** in interns (**6/26**) and **36.6%** in PGs (**30/82**). Domain-level perfect scores post-training were: Standard Precautions **50.0% (54/108)**, Hand Hygiene **43.5% (47/108)**, and BMW **54.6% (59/108)**.

Item-level performance (20-item questionnaire; percent correct):

Averaged across the 20 items, the overall mean percent-correct increased from **58.4% pre** to **85.1% post**, a gain of **+26.7 percentage points**. By group, mean percent-correct increased from **52.3% to 81.5%** in interns (**+29.2 points**) and from **60.4% to 86.3%** in PGs (**+25.9 points**).

Post-training, the **lowest-performing items** still had correctness rates in the **~77.8%–80.6%** range overall, indicating persistent, item-specific knowledge gaps even after training. In interns, the lowest post-training item correctness was **69.2%** for the weakest items, showing a wider residual gap in that subgroup compared to PGs.

Relationship between baseline knowledge and improvement (scope targeting): There was a significant inverse association between baseline score and gain, indicating that participants with lower baseline knowledge improved more (consistent with a training impact plus ceiling effects). Overall, Pearson $r = -0.491$ ($p < 0.001$) and Spearman $\rho = -0.480$ ($p < 0.001$) between TOTAL_Pre and gain. This pattern held in both interns ($r=-0.564$, p=0.0027) and PGs ($r=-0.453$, $p < 0.001$). Numerically, this supports targeted reinforcement for lower baseline performers as a measurable scope for improvement.

Internal consistency of the knowledge tool (audit of measurement quality):

Cronbach's alpha for the 20-item set was **0.62** at pre-test and **0.79** at post-test. By group, alpha was **0.68→0.75** in interns and **0.58→0.80** in PGs. This indicates moderate baseline internal consistency and stronger post-training consistency, consistent with reduced random responding and more uniform understanding after training.

Effectiveness (primary): Mean total score increased from 11.69 to 17.03 with mean gain +5.34; $t(107)=19.27$, $p < 0.001$, dz=1.85; 97.2% improved, 0% worsened.

Knowledge category improvement: "Good" category increased from 13.9% to 74.1%; paired category shift $\chi^2(2)=69.95$, $p < 0.001$; 69.4% improved category; 0% worsened.

Scope for improvement (secondary): Post-training, **25.9%** were still not "Good" (Moderate/Poor), perfect total score achieved by **33.3%**, and weakest items remained at ~**77.8%–80.6%** correct overall (lower in interns, down to **69.2%** for weakest items), supporting the need for reinforcement and/or targeted remediation based on baseline performance.

DISCUSSION

This retrospective audit demonstrates a large and statistically robust improvement in Infection Prevention and Control (IPC) knowledge after a standardized one-hour training session among newly inducted healthcare professionals. In the interim analytic dataset with 108 paired records, the total knowledge score (0–20) increased from a mean pre-test 11.69 ± 3.38 (median 12, IQR 9–14) to a mean post-test 17.03 ± 3.19 (median 18, IQR 15–20). The mean gain was +5.34 points (95% CI 4.79–5.89), which was highly significant (paired $t(107)=19.27$, $p < 0.001$) with a very large within-subject effect size (Cohen's $dz=1.85$). The improvement was not driven by a small subset: 97.2% (105/108) improved their score, 2.8% (3/108) remained unchanged, and 0% declined. This directly fulfils the primary objective by quantifying the effectiveness of training with a magnitude of change that is not only statistically significant but also programmatically meaningful.

Domain-wise analysis confirms that the training effect was broad and not restricted to a single content area. The largest absolute improvement was observed in Standard Precautions, which increased from 3.95 ± 1.35 to 6.02 ± 1.25 (mean gain +2.06, $t(107)=17.85$, $p < 0.001$, $dz=1.72$). Hand Hygiene increased from 4.06 ± 1.46 to 5.91 ± 1.29 (gain +1.84, $t(107)=14.67$, $p < 0.001$, $dz=1.41$), and Biomedical Waste Management improved from 3.67 ± 1.43 to 5.10 ± 1.24 (gain +1.44, $t(107)=11.18$, $p < 0.001$, $dz=1.08$). These gains indicate that a short structured intervention can substantially raise knowledge across core IPC domains typically responsible for healthcare-associated infection risk reduction.

The categorical knowledge classification further supports the training's impact. Pre-training, only 13.9% (15/108) were in the "Good" category; post-training, 74.1% (80/108) achieved "Good", representing an absolute increase of +60.2 percentage points. Simultaneously, "Poor" knowledge reduced from 30.6% (33/108) to 5.6% (6/108), an absolute reduction of −25.0 percentage points. Importantly, paired category transitions showed 0% deterioration. A total of 69.4% (75/108) moved to a higher category and 30.6% (33/108) remained in the same category; the overall shift toward higher categories was highly significant (Stuart–Maxwell $\chi^2(2)=69.95$, $p < 0.001$). These results align tightly with the primary objective because they show the training changed not only mean scores but also the practical distribution of competence levels.

Subgroup analyses suggest the training benefited both interns and postgraduate residents in a comparable way. Interns entered with a numerically lower baseline score (10.46 ± 3.76) than PGs (12.07 ± 3.18), with a borderline baseline difference ($p=0.0557$). After training, the post-test means converged (16.31 ± 3.22 interns vs 17.26 ± 3.16 PGs; $p=0.196$). Interns had a mean gain of +5.85 ± 2.99 (95% CI 4.64–7.05), while PGs gained +5.18 ± 2.85 (95% CI 4.56–5.81), and the gain difference was not significant ($p=0.325$). Category shifts remained significant within both groups (interns: $\chi^2(2)=14.82$, $p=0.000604$; PGs: $\chi^2(2)=55.94$, $p < 0.001$) and groupwise category distributions were not significantly different pre-training ($p=0.522$) or post-training ($p=0.774$). This suggests the session was broadly effective across trainee strata and did not preferentially benefit only one group.

The **secondary objective**—assessing training standard and identifying scope for improvement—can be addressed quantitatively through residual gaps and performance dispersion after training. Despite strong gains, **25.9% (28/108)** remained outside "Good" (Moderate **20.4%**, Poor **5.6%**) after the session. Post-test total scores ranged from **8 to 20**, demonstrating that a minority still had substantial gaps even after intervention. At the upper end, **33.3% (36/108)** achieved **20/20**, indicating that the content was learnable and that ceiling performance was attainable for many. However, ceiling attainment was not universal, and the persistence of a moderate/poor tail indicates that a single one-hour exposure is not sufficient for all learners.

Item-level outcomes provide additional evidence for targeted improvement. Averaged across 20 items, mean percent-correct increased from **58.4% pre** to **85.1% post** (+**26.7** percentage points). Yet, the weakest post-training items still remained around **77.8%–80.6%** correct overall, and in interns the weakest items fell as low as **69.2%** correct. This residual item-specific weakness points to content areas requiring reinforcement (e.g., more emphasis, clearer framing, or demonstration-based teaching for those items), even though overall performance improved.

A further quantitative insight into training optimization comes from the association between baseline score and gain. There was a consistent inverse relationship between baseline knowledge and improvement (Pearson $r=-0.491$, $p < 0.001$; Spearman $\rho=-0.480$, $p < 0.001$), meaning participants with lower initial scores tended to improve more, but also that participants starting closer to the maximum had less room for improvement (ceiling effect). The pattern held in both interns ($r=-0.564$, $p=0.0027$) and PGs ($r=-0.453$, $p < 0.001$). Practically, this supports a stratified training approach: learners with low baseline scores may benefit from additional targeted reinforcement or follow-up assessment to ensure they reach the "Good" category.

Finally, the reliability of the questionnaire improved post-training. Cronbach's alpha increased from **0.62 pre** to **0.79 post** overall, suggesting that post-training responses were more internally consistent and likely reflected more coherent understanding. This also strengthens confidence in the observed post-training score distribution.

Taken together, these numeric findings show the training program was effective by multiple metrics (mean gain, proportion improving, category shift, domain gains) while also providing clear evidence to refine training (persisting non-Good proportion, weakest item performance, and baseline-linked tailoring). This directly satisfies both the primary and secondary objectives using measurable endpoints.

CONCLUSION

In this interim audit sample of 108 paired assessments, IPC knowledge improved substantially after training. The mean total score increased from 11.69 ± 3.38 to 17.03 ± 3.19 with a mean gain of +5.34 (95% CI 4.79–5.89), $p < 0.001$, and 97.2% of participants improved. The proportion with "Good" knowledge increased from 13.9% to 74.1%, and "Poor" knowledge decreased from 30.6% to 5.6%, with 0% deterioration in category. Improvements were significant across all domains (Standard Precautions +2.06, Hand Hygiene +1.84, Biomedical Waste +1.44, all $p < 0.001$). However, 25.9% remained below "Good" post-training and certain items remained ≤~80% correct overall (down to 69.2% among interns for weakest items), indicating clear scope for strengthening training delivery and reinforcement.

RECOMMENDATIONS

1. **Introduce a structured reinforcement pathway** for the post-training non-Good group (**28/108; 25.9%**), with a short follow-up micro-session and reassessment to reduce the residual Moderate/Poor proportion toward <10%.
2. **Target low-performing items** identified by post-training correctness remaining around **77.8%–80.6%** overall (and **≤69.2%** among interns), using item-focused clarification, practical demonstrations, and scenario-based questions.
3. **Stratify support using baseline score**, because gain correlates inversely with baseline (**r=−0.491 overall**). Learners with low baseline scores should receive additional support to ensure consistent attainment of "Good" competency.
4. **Aim to increase ceiling attainment**, improving the proportion achieving **20/20** beyond the current **33.3%**, through interactive teaching (skills stations, demonstrations, and brief competency checks).
5. **Maintain domain emphasis** on Standard Precautions (largest gain **+2.06**) while strengthening BMW and Hand Hygiene reinforcement given persistent item-level gaps.
6. **Institutionalize periodic refresher assessment**, because a single session leaves **~1 in 4** participants below "Good". A planned re-test (e.g., 4–8 weeks) can quantify retention and guide continuous improvement.

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Table 1. Composition of the analysed sample (paired records)

Participant group	N	Percent
Postgraduate residents	82	75.9%
Interns	26	24.1%
Total	**108**	**100%**

Table 2. Pre- and post-training IPC knowledge scores (overall paired analysis, N=108)

Measure	Pre (mean ±SD)	Pre (median [IQR])	Pre (range)	Post (mean ±SD)	Post (median [IQR])	Post (range)	Mean gain (95%	Paired t-test p

							CI)	
Standard precautions score (0–7)	3.95 ± 1.35	4 [4, 14]	1–7	6.02 ± 1.25	6 [14, 16]	2–7	2.06 (1.84 – 2.29)	< 0.001
Hand hygiene score (0–7)	4.06 ± 1.46	4 [4, 14]	1–7	5.91 ± 1.29	6 [14, 16]	2–7	1.84 (1.60 – 2.09)	< 0.001
Biomedical waste management score (0–6)	3.67 ± 1.43	4 [4, 9]	1–6	5.10 ± 1.24	6 [9, 15]	0–6	1.44 (1.18 – 1.69)	< 0.001
Total knowledge score (0–20)	**11.69 ± 3.38**	12 [5, 7]	**3–20**	**17.03 ± 3.19**	18 [13, 23]	**8–20**	**5.34 (4.80 – 5.89)**	< 0.001

Table 3. Knowledge category distribution before and after training (overall and by group)

Group	Pre: Poor	Pre: Moderate	Pre: Good	Post: Poor	Post: Moderate	Post: Good
Overall (N=108)	33 (30.6%)	60 (55.6%)	15 (13.9%)	6 (5.6%)	22 (20.4%)	80 (74.1%)
Interns (n=26)	10 (38.5%)	12 (46.2%)	4 (15.4%)	2 (7.7%)	6 (23.1%)	18 (69.2%)
Postgraduate residents (n=82)	23 (28.0%)	48 (58.5%)	11 (13.4%)	4 (4.9%)	16 (19.5%)	62 (75.6%)

Between-group comparison (Chi-square): **Pre** p=0.522; **Post** p=0.774.

Table 4. Pre- to post-training transition of knowledge categories (paired, N=108)

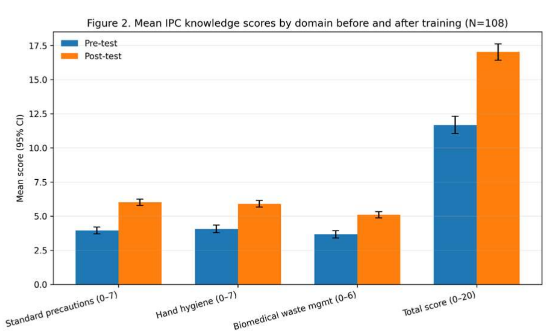
	Post: Poor	**Post: Moderate**	**Post: Good**
Pre: Poor (n=33)	6 (18.2%)	10 (30.3%)	17 (51.5%)
Pre: Moderate (n=60)	0 (0.0%)	12 (20.0%)	48 (80.0%)
Pre: Good (n=15)	0 (0.0%)	0 (0.0%)	15 (100.0%)

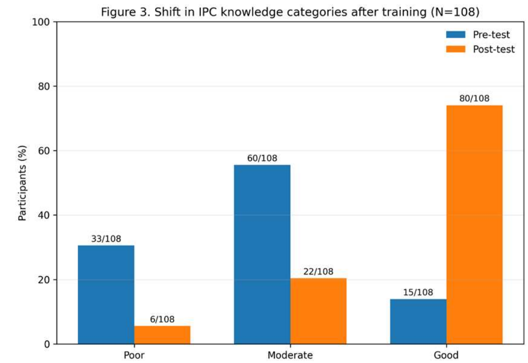
Paired shift test (Stuart–Maxwell): Overall χ^2=116.90, df=2, p<0.001. (Interns: χ^2=28.00, p < 0.001; PGs: χ^2=89.69, p<0.001.)

Table 5. Interns vs postgraduate residents: pre, post, and gain scores

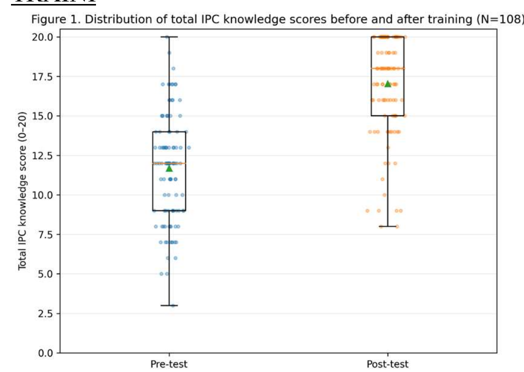
Measure	**Interns Pre mean ± SD**	**PGs Pre mean ± SD**	**p (Pre)**	**Interns Post mean ± SD**	**PGs Post mean ± SD**	**p (Post)**	**Interns Gain mean ± SD**	**PGs Gain mean ± SD**	**p (Gain)**
Standard precautions score (0–7)	3.31 ± 1.57	4.16 ± 1.21	0.0158	5.58 ± 1.33	6.16 ± 1.19	0.0539	2.27 ± 1.34	2.00 ± 1.15	0.3635

Hand hygiene score (0–7)	3.62 ± 1.39	4.21 ± 1.45	0.0678	5.62 ± 1.33	6.00 ± 1.28	0.2016	2.00 ± 1.39	1.79 ± 1.28	0.5027
Biomedical waste management score (0–6)	3.54 ± 1.42	3.71 ± 1.44	0.6016	5.12 ± 1.14	5.10 ± 1.27	0.9466	1.58 ± 1.24	1.39 ± 1.37	0.5172
Total knowledge score (0–20)	**10.46 ± 3.75**	**12.07 ± 3.18**	**0.0557**	**16.31 ± 3.22**	**17.26 ± 3.16**	**0.1962**	**5.85 ± 2.99**	**5.18 ± 2.85**	





<u>QUESTIONNAIRE FORMAT FOR "AUDIT OF TRAINING IN INFECTION PREVENTION AND CONTROL PRACTICES ON IMPROVING THE KNOWLEDGE OF HEALTHCARE PROFESSIONALS IN A TERTIARY CARE CENTER"</u> (3, 7, 8, 21)



1. Standard precautions are used for the care of all patients regardless of their diagnosis and perceived infection status.
   A) Yes
   B) No

2. Isolation precaution is one of the components of standard precaution.
   A) Yes
   B) No

3. PPE is important in infection control because it acts as a barrier between infectious materials such as viral and bacterial contaminants and your skin, mouth, nose, or eyes (mucous membranes)
   A) Yes
   B) No

4. Surgical masks can protect the nose and mouth when procedures and activities are likely to generate splashes or sprays of blood and body fluids.
   A) Yes
   B) No

5. Mask must be placed on coughing patients to prevent potential dissemination of infectious
   Respiratory secretions from the patient to others.
   A) Yes
   B) No

6. The purpose of using a gown or apron is to protect clothes from splashes or sprays of blood and body fluids
   A) Yes
   B) No

7. Remove all personal protective equipment (PPE) before leaving the patient's environment.
   A) Yes
   B) No

8. Stationary, telephones kept in wards, and doorknobs cannot be sources of infections.
   A) Yes
   B) No

9. Gloves must be worn every time during handling potentially infectious materials.
   A) Yes
   B) No

10. Gloves must be changed during patient care if you move hands from 'contaminated body site' to 'clean body site'
    A) Yes
    B) No

11. Alcohol based rubs are used after removing gloves.
    A) Yes
    B) No

12. Performing hand hygiene is required before and after patient care.
    A) Yes
    B) No

13. Hands should be washed with soap and water before and after handling potentially infectious materials irrespective of wearing gloves.
    A) Yes
    B) No

14. Washing hands after contact with the patient's environment is one of the elements in standard precaution.
    A) Yes
    B) No

15. If you puncture hand with sharp instruments, you must report to the concerned authorities.
    A) Yes
    B) No

16. Segregation of clinical and non-clinical waste is important for preventing the spread of infection.
    A) Yes
    B) No

17. Ampoules injection that has been used must be disposed of in the clinical waste bin.
    A) Yes
    B) No

18. Puncture-proof containers should be used for disposal of sharps objects.
    A) Yes
    B) No

19. All linen from an infectious patient should be thrown in a red linen bag even when it is free from visible blood or body fluids.
    A) Yes
    B) No

20. Recapping of needles, in general, is appropriate.
    A) Yes
    B) No

<u>TRAINING FEEDBACK FORM</u>

1. The course was relevant to my profession.
   A) Strongly agree
   B) Agree
   C) Undecided
   D) Disagree
   E) Strongly disagree

2. The subject was covered adequately.
   A) Strongly agree
   B) Agree
   C) Undecided
   D) Disagree
   E) Strongly disagree

3. I had the opportunity to ask questions/Clear my doubts.
   A) Strongly agree
   B) Agree
   C) Undecided

D) Disagree
E) Strongly disagree

4. The training would help me improve as a professional on implementation of these policies and procedures.
A) Strongly agree
B) Agree
C) Undecided
D) Disagree
E) Strongly disagree

5. The information was presented in a logical manner for better understanding.
   A) Strongly agree
   B) Agree
   C) Undecided
   D) Disagree
   E) Strongly disagree

6. Your overall satisfaction with the course from 5 to 1 where 5= excellent , 4= very good, 3= good ,2= poor and 1= very poor

7. Any suggestions for improvement -

IMRC APPROVAL

Kalinga Institute of Medical Science(KIMS)
Kalinga Institute of Industrial Technology(KIIT)
Deemed to be University
Research & Development Department
(Established U/S 3 of UGC Act,1956)
Bhubaneswar, Odisha, India

No.: KIMS/IMRC/R&D/99/2025/07

Date: 29.07.2025

To

Dr. Kunalsen Jagatdeo
Assistant Professor
Microbiology
7978567328
Kunalsen.jagatdeo@kims.ac.in

Sir/ Madam,

Sub: Presentation of Project in Research Committee Regarding.

Your Research Protocol" **Audit of Training on Infection Prevention and Control in Improving the Knowledge of Healthcare Professional in a Tertiary Care Center"** was presented before the KIMS Medical Research Committee 25/07/2025.

The project was discussed thoroughly by the committee and concluded unanimously:

Conclusion: Project is approved.

Note: 1. External funding received for, research should be deposited in the A/C- 13462413003025, IFSC Code- PUNB0134610, Bank –PNB, KIIT Branch, Bhubaneswar

2. Any presentation/publication arising out the project should be intimated to the Department of Research and Development.

Ipsa Mohapatra.
(Prof. (Dr) Ipsa Mohapatra)
Member Secretary
Institutional Medical Research Committee
KIMS, KIIT, Bhubaneswar

Member Secretary
Institute Research Committee
School of Medicine
Kalinga Institute of Industrial Technology
(Deemed to be University)
Bhubaneswar-751024

Copy to: - Principal, KIMS of kind information.
Chairman, Ethics Committee, KIMS

KushabhadraCampus(Campus-5) Patia, Bhubaneswar-751024,Odisha,India
EPABX:0674-2305300, Contact Number: 0674-2725708,2725415(Phone/Fax), 2725314(Phone)
E-mail: principal@kims.ac.in , Website: www.kims.ac.in , E-mail: drd@kims.ac.in

IEC APPROVAL

INSTITUTIONAL ETHICS COMMITTEE
KALINGA INSTITUTE OF MEDICAL SCIENCES (KIMS)
KIIT DEEMED-TO-BE-UNIVERSITY, BHUBANESWAR-751024
IEC KIMS has been registered under
CDSCO RegnNo.:- ECR/321/Inst/OR/2013/RR-20
DHR RegnNo.:- EC/NEW/INST/2020/830

Ref. No.: KIIT/ KIMS/ IEC/ 2287 / 2025 Date: 18.08.2025

1. Study Title: - Audit of Training on Infection Prevention and Control in Improving the Knowledge of Healthcare Professionals in a Tertiary Care Center.
2. Subject: **Ethics Committee Approval**
3. Name of the Investigator: - **Dr. Kunalsen Jagatdeo,** Assistant Professor, Microbiology
4. Quorum of the Ethics Committee with Name: -

The following members were present:

1.	Dr. B. N. Panda	: **Chairman**
2.	Dr. N. K. Debata	: **Vice Chairman**
3.	Mr. Jayasankar Mishra, Advocate	: **Member (Legal Expert)**
4.	Mr. Surendra Das	: **Member (Lay Person)**
5.	Mr. Dillip Kumar Dwivedy	: **Member (NGO Representative)**
6.	Dr. Pranati Nanda, Professor, Physiology	: **Member**
7.	Dr. Santosh Kumar Panda, Professor, Paediatrics	: **Member**
8.	Dr. Chaitali Pattanayak, Professor, Pharmacology	: **Member**
9.	Dr. Aparajita Priyadarsini, Profesor, Physiology	: **Member**
10.	Dr. Alpana Mishra, Professor, Community Medicine	: **Member Secretary**

The Institutional Ethics Committee Meeting was held on 08.08.2025.

After hearing the deliberations from the Principal Investigator the Institutional Ethics Committee Members are satisfied, there is no conflict of interests in any manner. Investigating team will keep dignity, rights, safety and well-being of participants maintaining high ethics and the Investigation Team will keep privacy of the individuals and confidentiality of data and documents of Ethics Committee.

The study is **approved** in its presented form.

In the event of leaving the Institute of the Principal Investigator the data as well as residual Biological samples if any, will be handed over to another person (Medical Research person) designated by Principal under intimation to Institutional Ethics Committee.

The approval is valid for 3 Years or the duration of the Project whichever is less.

The Investigator may make a written request for renewal/ extension of the validity, along with the submission of annual status report. Any deviation/ violation/ waiver in the protocol must be informed to the IEC. The IEC must be informed immediately in case of any adverse event/ SAE or any change of study procedure/ site/ Investigator. Also, the Investigator needs to submit the Annual Report to the IEC after completion of the study, and publication status, if any.

The IEC reserves the right to review, to suspend and to cancel the Research Project at any time during the trial.

Dr. Alpana Mishra
Member Secretary, Institutional Ethics Committee
Kalinga Institute of Medical sciences
Bhubaneswar-751024

Kushabhadra Campus (KIIT Campus - 5), Patia, Bhubaneswar-751024
Tel: 0674-2725708/ 2725472 (Ext - 2017), Fax: 0674 - 2725415
Web site: www.kims.ac.in, Email: ethicscommittee.kims@kims.ac.in

Member Secretary
Institutional Ethics Committee
KIMS, Bhubaneswar

CONSENT WAS TAKEN FROM PARTICIPANTS IN THE BELOW

FORMAT BOTH IN ENGLISH AND ODIA

KALINGA INSTITUTE OF MEDICAL SCIENCES
KIIT UNIVERSITY

CONSENT FORM
Serial no

<u>TITLE OF THE RESEARCH</u>**: Audit of training on Infection Prevention and control in improving the knowledge of healthcare professional in a tertiary care center**

NAME OF INVESTIGATOR: Dr Kunalsen Jagatdeo

NAME of the Participant:

AGE:

GENDER:

Medical Qualification:

DATE:

ADDRESS:

PHONE NO:

I have understood the above study very well. My identity will not be disclosed to third party. I am wilfully taking part in this study. I can leave the study whenever I wish. I am giving consent that the data arising from this study can be utilized by doctors if those data is used for scientific purposes.

Signature of Participant Signature of Investigator Signature of Witness

Date- Date- Date-

ସୂଚନା ସମ୍ବଳିତ ସମ୍ମତି ପତ୍ର
<u>କଳିଙ୍ଗ ଇନଷ୍ଟିଚ୍ୟୁଟ ଅଫ ମେଡିକାଲ ସାଇନ୍ସ (କିମ୍ସ), ଭୁବନେଶ୍ୱର, ଓଡିଶା</u>

କ୍ରମିକ ସଂଖ୍ୟା:

<u>TITLE OF THE RESEARCH</u>**: Audit of training on Infection Prevention and control in improving the knowledge of healthcare professional in a tertiary care center**

ଇନଭେଷ୍ଟିଗେଟର ନାମ: **Dr Kunalsen Jagatdeo**

ନାମ:
ବୟସ:
ଲିଙ୍ଗ:
ଚିକିତ୍ସା ଯୋଗ୍ୟତା :
ତାରିଖ:
ଠିକଣା:
ଫୋନ୍ ନମ୍ବର:

ମୁଁ ଉପରୋକ୍ତ ଅଧ୍ୟୟନକୁ ବହୁତ ଭଲ ଭାବରେ ବୁଝିଛି | ମୋର ପରିଚୟ ତୃତୀୟ ପକ୍ଷକୁ ପ୍ରକାଶ କରାଯିବ ନାହିଁ | ମୁଁ ଜାଣିଶୁଣି ଏହି ଅଧ୍ୟୟନରେ ଭାଗ ନେଉଛି | ମୁଁ ଯେତେବେଳେ ଚାହିଁବି ଅଧ୍ୟୟନ ଛାଡି ପାରିବି | ମୁଁ ସମ୍ମତି ଦେଉଛି ଯେ ଯଦି ଏହି ତଥ୍ୟ ବୈଜ୍ଞାନିକ ଉଦ୍ଦେଶ୍ୟରେ ବ୍ୟବହୃତ ହୁଏ ତେବେ ଏହି ଅଧ୍ୟୟନରୁ ଉତ୍ପନ୍ନ ତଥ୍ୟ ଡାକ୍ତରଙ୍କ ଦ୍ୱାରା ବ୍ୟବହାର କରାଯାଇପାରିବ |

ପାର୍ଟିସିପେଣ୍ଟ ଦସ୍ତଖତ:
ତାରିଖ

ଅନୁସନ୍ଧାନକାରୀଙ୍କ ଦସ୍ତଖତ:
ତାରିଖ

ସାକ୍ଷୀ ଦସ୍ତଖତ:
ତାରିଖ