Section: Microbiology

Original Research Article

IMPACT OF AN EDUCATIONAL INTERVENTION ON KNOWLEDGE, ATTITUDE AND PRACTICE OF INFECTION CONTROL AND PREVENTION AMONG HEALTH CARE WORKERS AT A TERTIARY CARE HOSPITAL IN WESTERN INDIA

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Received : *13/06/2026*
Received in revised form : *06/08/2026*
Accepted : *22/08/2026*

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DOI: 10.70034/ijmedph.2026.3.558

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 3564-3572

ABSTRACT

Background: Healthcare-associated infections remain an important challenge in healthcare settings, and effective infection prevention and control (IPC) practices among healthcare workers are essential for reducing occupational and patient-related infection risks. Knowledge, attitude and practice (KAP) of healthcare workers can influence adherence to recommended IPC measures. Educational interventions may help identify and address gaps in IPC-related knowledge and practices. **Objective:** To assess the knowledge, attitude and practice regarding infection prevention and control among healthcare workers and to evaluate the impact of an educational intervention at a tertiary care hospital in Western India.
Materials and Methods: A pre–post interventional study was conducted among healthcare workers at a tertiary care hospital in Western India. A structured questionnaire containing 16 items each for knowledge, attitude, and practice (KAP) related to infection prevention and control (IPC) was administered before and after a focused educational intervention. Responses were analysed using descriptive statistics, and pre- and post-intervention KAP scores were compared.
Results: Among 211 healthcare workers, the mean age was 28.94 ± 6.73 years; 65.9% were male and 62.5% had ≤5 years of experience. Following the educational intervention, knowledge and attitude improved. Knowledge of post-exposure prophylaxis timing increased from 44.5% to 70.1%, while needle-stick injury reporting improved from 49.8% to 70.1%. Correct blood-spill management showed the greatest improvement, from 31.8% to 70.1%. Appropriate waste-bag filling increased from 61.1% to 78.2%, and correct sodium hypochlorite preparation from 63.5% to 78.2%. Significant improvements in knowledge and attitude scores were observed among intern doctors, laboratory technicians, and nursing staff (p = 0.001–0.05).
Conclusion: The study demonstrated generally favourable baseline IPC-related knowledge, attitudes, and practices, with specific gaps in areas such as post-exposure prophylaxis, needle-stick injury reporting, biomedical waste management, and practical IPC procedures. Following the educational intervention, improvement was observed across all three KAP domains, particularly in reported practice. Regular, structured, competency-based IPC education with reinforcement and monitoring should be incorporated into routine hospital infection-control programmes.
Keywords: Attitude, Educational Intervention, Infection control, Knowledge, Practice biomedical.

INTRODUCTION

Modern healthcare supports patient treatment and recovery through invasive devices and procedures; however, it is strongly associated with healthcare-associated infections.[1] Healthcare-associated infection (HAI) is an infection occurring in a patient during the process of care in a hospital or other healthcare facility, which was not present or incubating at the time of admission. HAIs can also appear after discharge. They represent the most frequent adverse event associated with patient care.[2] HAIs are frequently linked to two primary sources: the contaminated hands of healthcare workers (HCWs) and improperly cleaned medical equipment.[3,4]

World health organization (WHO) estimates, prevalence of HAIs is between 5.7 % to 19.1% globally in Hospital settings.[5] HAIs are among the most frequent and serious adverse events in healthcare delivery, posing a major threat to patient safety and contributing substantially to global morbidity, mortality, and healthcare costs. Infection prevention and control (IPC), therefore, remains a clinical and public health priority with significant implications for health system performance and economic sustainability.[6,7]

The data available indicate that the burden of healthcare associated infections in low and middle income countries like India is high, with an estimated pooled prevalence of 15.5 per 100 patients, more than double the prevalence in Europe and the US.[8]

According to the WHO, several systemic and operational factors contribute significantly to the occurrence of HAIs. These include suboptimal environmental hygiene, improper waste disposal practices, inadequate infrastructure, shortages in equipment and staffing, overcrowded facilities, and insufficient knowledge or adherence to basic infection control protocols.[9] Nearly 70% of HAI can be prevented by the implementation of effective IPC interventions.[10]

The WHO identifies deficiencies in knowledge, attitude, and practice (KAP) among healthcare workers as critical predictors of HAIs.[9] When frontline staff lack adequate understanding, hold indifferent attitudes, or fail to consistently apply infection control measures, the risk of transmission within healthcare settings significantly increases. Strengthening KAP through targeted education and behavioural reinforcement is therefore essential to reducing the incidence of HAIs and improving patient safety.

The failure to rigorously implement basic infection control measures—such as hand hygiene, proper use of personal protective equipment (PPE), and safe waste disposal—is not merely an oversight but a systemic lapse that compromises patient safety and undermines clinical integrity.[11]

In western region-Junagadh, till date, there is no research regarding educational intervention on HCWs by doing the pre-KAP and post-KAP of IPC. A KAP study could shine light on the effectiveness of training and estimate the level of knowledge, attitude, and perceived practice of HCW regarding IPC. These findings are paramount in helping to adapt training and other policies regarding IPC, aiming to improve the practice among HCWs. This could eventually help in curbing the increasing HAI rates.

MATERIALS AND METHODS

A prospective pre–post interventional study was conducted among healthcare workers engaged in healthcare duties at a tertiary care hospital in Western India, G.M.E.R.S. Medical College and Hospital, Junagadh. The hospital was a 965-bed multispecialty teaching hospital involved in undergraduate and postgraduate teaching and training. The study population comprised 171 intern doctors, 400 nursing staff, and 45 laboratory technicians. The study was conducted over a period of 15 days.

Before the survey began, participants were informed about the study purpose, data confidentiality, and the principal investigator's contact details. Participation was voluntary, and online written informed consent was obtained through the electronic form.

Inclusion Criteria

- Healthcare workers, including intern doctors, nursing staff, and laboratory technicians working at G.M.E.R.S. Medical College and Hospital and involved in direct patient care, were included.

Exclusion Criteria

- Healthcare workers who did not provide consent were excluded.
- Healthcare workers who were on long leave for personal reasons were excluded.
- Class IV workers were excluded.

Sample size estimation

In a reference study conducted in 2026, approximately 200 nurses, 150 doctors, and 40 healthcare assistants were working at the study hospital, of whom 58 responded.[12] Thus, 58 of 390 healthcare workers represented an approximate response rate of 14.87%. For the present study population of 616 healthcare workers (171 intern doctors, 400 nursing staff, and 45 laboratory technicians), the minimum required sample size was estimated as 92 using the same response rate. Ultimately, 211 healthcare workers participated in the pre and post-intervention assessment and were included in the study.

Sampling procedure

Convenience sampling was used. A link to an online Google Form was shared with healthcare workers at

G.M.E.R.S. Medical College and Hospital, Junagadh.

Data collection tool

A structured, self-administered questionnaire was developed based on guidelines from the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) [13,14] and was prevalidated by experts. The questionnaire comprised four sections: demographic information (including age, sex, and professional experience), knowledge, attitude, and practice. Each KAP domain contained 16 questions. The questions were selected after review of relevant literature and consideration of the study population.

A focused and interactive 40-minute educational session on infection prevention and control was conducted. The survey comprised a pre-intervention KAP assessment, the educational session, and a post-intervention KAP assessment using the same questionnaire in the same participants. The impact of the educational session was evaluated by comparing the pre- and post-intervention KAP assessments.

Data processing and analysis

Descriptive data were presented as numbers or mean ± standard deviation (SD), as appropriate. The collected data were entered into a computer-based spreadsheet and analysed using SPSS statistical software, version 20.

KAP assessments were scored by assigning one point for each correct answer; therefore, the score range for knowledge, attitude, and practice was 0–16 for each domain. The pre-intervention and post-intervention scores for each participant were calculated separately for all three domains, and the mean score for each domain was determined.

All questions were made mandatory to ensure completeness, and the Google Forms setting to limit one response per user was enabled to prevent duplicate submissions. The order of questions and response options was fixed and presented in the same sequence to all participants; no randomization or adaptive questioning was applied. Responses were anonymized and stored securely with access restricted to the research team. The data were used only for research purposes. Differences between the mean pre-intervention and post-intervention scores for each KAP domain were calculated separately, and a p-value was calculated to assess statistical significance, with $p < 0.05$ considered statistically significant.

RESULTS

The demographic characteristics of the study participants are presented in Table 1. A total of 211 healthcare workers were included in the study. The mean age of the participants was 28.94 ± 6.73 years. The largest proportions of participants belonged to the 21–25 years and 26–30 years age groups, accounting for 36.49% and 36.01%. Participants aged 31–35 years constituted 9%, while 11.84% belonged to the 36–40 years age group. Males constituted 65.9% and females 34.1% of the study population. Regarding professional experience, the majority of participants 62.5%

had ≤5 years of experience, followed by 20.37% with 6–10 years and 17.06% with >10 years of experience.

The distribution of participants according to knowledge regarding infection prevention and control is presented in Table 2. The pre-intervention assessment demonstrated high levels of awareness for several IPC-related aspects. Awareness of biomedical waste management rules was observed among 99.5% of participants, while 98.1% correctly identified the major risks associated with hospital waste handling. Awareness of IPC protocols were reported by 94.3%, and 93.4% correctly identified the appropriate segregation of soiled dressings into the yellow bin. However, lower levels of correct responses were observed for the timing of post-exposure prophylaxis (44.5%), correct reporting of needle-stick injuries (49.8%), and the appropriate proportion of healthcare waste (63.0%). Following the educational intervention, improvement was observed across all knowledge indicators. Correct responses regarding sodium hypochlorite concentration increased from 76.3% to 88.2%, correct understanding of PPE increased from 77.7% to 88.2%, and correct reporting of needle-stick injury increased from 49.8% to 70.1%. Knowledge regarding the timing of post-exposure prophylaxis increased from 44.5% to 70.1%. Awareness of IPC protocols increased from 94.3% to 97.2%, while awareness of biomedical waste management rules increased from 99.5% to 100.0%.

The attitude of participants towards infection prevention and control is presented in Table 3. Overall, favourable attitudes were observed during the pre-intervention assessment. Particularly high proportions of participants supported strict colour coding of bins (99.1%), willingness to attend biomedical waste management training (98.6%), and labelling of biomedical waste bags (98.6%). Lower proportions were observed for Hepatitis B vaccine guidelines (65.4%), appropriate waste-bag filling level (61.1%), and recommended six-monthly health check-up or training (39.3%). Following the educational intervention, improvement was observed in all assessed attitude indicators. The proportion identifying the correct hepatitis B vaccine guidelines increased from 65.4% to 84.8%, while the proportion selecting the appropriate waste-bag filling level increased from 61.1% to 78.2%. The proportion considering PPE necessary for infectious patients increased from 90.5% to 96.2%. Willingness to attend biomedical waste management training increased from 98.6% to 100.0%, while support for strict colour coding and labelling of biomedical waste bags increased to 100.0%.

The practice of infection prevention and control among the participants is presented in Table 4. The findings showed that 181 (85.8%) participants had previously received IPC training, while 193 (91.5%) reported using appropriate personal protective equipment (PPE) during exposure to blood or body fluids. Hepatitis B and tetanus vaccination was reported by 170 (80.6%) participants, whereas 113 (53.6%) had undergone Anti-HBs titre testing. Previous needle-stick injury was reported by 51 (24.2%), while 160 (75.8%) reported no previous needle-stick injury.

Regarding specific IPC practices, only 67 (31.8%) participants demonstrated correct blood-spill management, indicating an important gap in practical infection-control procedures. Similarly, correct waste segregation at the site of generation was reported by only 68 (32.2%) participants. Appropriate management of used needles was reported by 165 (78.2%), while 169 (80.1%) participants reported following the correct steps after blood exposure.

Hand hygiene practices were relatively well reported, with 209 (99.1%) participants reporting hand-sanitizer use and 189 (89.6%) reporting appropriate handwashing practices. Regarding biomedical waste transportation, 175 (82.9%) participants correctly identified the required transport-label information, while 186 (88.2%) reported the availability/use of a closable plastic trolley for biomedical waste transportation. Correct practice for preparation of 1% sodium hypochlorite was reported by 134 (63.5%) participants.

The comparison of selected IPC-related responses before and after the educational intervention is presented in Table 5. Improvement was observed across all selected indicators following the intervention. The greatest improvement was observed in correct blood-spill management, which increased from 31.8% before the intervention to 70.1% after the intervention. Correct waste-bag filling increased from 61.1% to 78.2%, while knowledge of hepatitis B vaccine guidelines increased from 65.4% to 84.8%. Awareness regarding sodium hypochlorite concentration increased from 76.3% to 88.2%, and correct PPE identification increased from 77.7% to 88.2%. Correct post-exposure steps increased from 80.1% to 91.9%, while correct BMW transportation increased from 88.2% to 94.8%. These findings indicate an overall improvement in selected IPC-related knowledge and practices following the educational intervention.

Table 6 compares the mean scores for knowledge, attitude, and practice before and after the educational intervention among intern doctors, laboratory technicians, and nursing staff. A paired t-test was used to determine whether the change in scores between the pre-intervention and post-intervention assessments was statistically significant. Among intern doctors, the mean knowledge score increased from 7.36 ± 0.86 before the intervention to 9.88 ± 0.33 after the intervention, with a statistically significant difference ($p = 0.04$). The mean attitude scores also increased from 7.84 ± 1.31 to 10.00 ± 0.00, showing a statistically significant improvement ($p = 0.003$). The pre-intervention mean practice score was 5.92 ± 1.15. Among laboratory technicians, the mean knowledge score increased from 7.68 ± 1.68 to 9.52 ± 0.71, with a statistically significant improvement ($p = 0.001$). The mean attitude score increased from 7.60 ± 1.68 to 9.72 ± 0.54, with the reported p-value of 0.05, indicating a statistically significant difference according to the table's notation. The pre-intervention practice score was 6.00 ± 2.27. Among nursing staff, the mean knowledge score increased from 7.60 ± 1.41 before the intervention to 9.52 ± 0.82 after the intervention, with a statistically significant improvement ($p = 0.005$). Similarly, the mean attitude score increased from 7.16 ± 1.65 to 9.40 ± 1.00, with a statistically significant difference ($p = 0.002$). The pre-intervention mean practice score was 4.60 ± 2.16.

Table 1: Demographic characteristics of the study participants

Characteristic	**Pre-intervention (n=211)**
Age, years, mean ± SD	28.94 ± 6.73
Age group, years	
21–25	77 (36.49%)
26–30	76 (36.01%)
31–35	19 (9.0%)
36–40	25 (11.84%)
41–45	5 (2.36%)
46–50	4 (1.89%)
51–55	5 (2.36%)
Gender	
Male	139 (65.9)
Female	72 (34.1)
Professional experience, years	
≤5	132 (62.5%)
6–10	43 (20.37%)
>10	36 (17.06%)

Table 2 demonstrates an overall culture positivity of 62.5%, with bacterial isolates (45.75%) exceeding fungal isolates (15.75%); Pseudomonas aeruginosa was the predominant bacterial pathogen (42.08%), whereas Aspergillus spp. was the leading fungal isolate (63.49%), followed by Fusarium spp. (26.98%).

Table 2: Distribution of participants according to Knowledge regarding Infection Prevention and Control in pre- and post-intervention assessments

Knowledge item	Pre-intervention, n (%)	Post-intervention, n (%)
Awareness of IPC protocols	199 (94.3)	205 (97.2)
Awareness regarding sodium hypochlorite concentration during spill management	161 (76.3)	186 (88.2)
Awareness of handwashing indications	192 (91.0)	200 (94.8)
Highest-risk needle-stick infection – Hepatitis B	158 (74.9)	179 (84.8)
Segregation- most important aspect of biomedical waste management	184 (87.2)	196 (92.9)
Immediate response to needle-stick injury	183 (86.7)	194 (91.9)
Write injury report to authority about needle-stick injury	105 (49.8)	148 (70.1)
Correct understanding of PPE	164 (77.7)	186 (88.2)
Blood-spill management kit avaibility	204 (96.7)	211 (100.0)
Awareness of BMW management rules	210 (99.5)	211 (100.0)
Awareness about duration of hand-sanitizer use	162 (76.8)	179 (84.8)
Correct objectives of BMW management	197 (93.4)	205 (97.2)
Correct major risks of hospital waste handling	207 (98.1)	211 (100.0)
Correct proportion of healthcare waste	133 (63.0)	158 (74.9)
Correct timing of PEP	94 (44.5)	148 (70.1)
Yellow bin used for soiled dressings	197 (93.4)	205 (97.2)

Table 3: Distribution of participants according to Attitude towards Infection Prevention and Control in pre- and post-intervention assessments

Attitude item	Pre-intervention, n (%)	Post-intervention, n (%)
Remove gloves & wash hands, if gloves get torn while working	177 (83.9)	190 (90.0)
After removing gloves hands should be washed	153 (72.5)	177 (83.9)
Need of PPE for infectious patients	191 (90.5)	203 (96.2)
Needle should not be recapped/bent after use	179 (84.8)	192 (91.0)
Hepatitis B vaccine guidelines	138 (65.4)	179 (84.8)
Most severe form of exposure for needle stick injury	152 (72.0)	173 (82.0)
IPC guidelines needed at workplace	192 (91.0)	203 (96.2)
Correct disposal of used needles	196 (92.9)	205 (97.2)
Correct waste-bag filling level – ¾	129 (61.1)	165 (78.2)
Waste to be pretreated	176 (83.4)	190 (90.0)
Willingness to attend BMW training – Yes	208 (98.6)	211 (100.0)
Strict colour coding of bins – Yes	209 (99.1)	211 (100.0)
Biomedical waste bags should be labelled – Yes	208 (98.6)	211 (100.0)
Recommended health check-up/training frequency – 6 months	83 (39.3)	127 (60.2)
Separate vehicle for BMW transport – Yes	201 (95.3)	207 (98.1)
Waste management considered teamwork	159 (75.4)	179 (84.8)

Table 4: Distribution of participants according to Practice of Infection Prevention and Control

Practice item	Pre-intervention, n (%)
Undergone training on IPC	181 (85.8)
Personal protective devices	193 (91.5)
Inform other healthcare personnel about infectious patients before transfer of the patients.	122(57.8)
Vaccinated against hepatitis B and tetanus	170 (80.6)
Post vaccination anti-HBs titer testing	113 (53.6)
Incidence of needle stick injury	51(24.2)
After exposure Post Exposure Prophylaxis should ideally be taken within:	89(42.2)
Blood spillage management procedure	67 (31.8)
Appropriate management of used needle	165 (78.2)
Correct steps following blood exposure	169 (80.1)
Waste segregation at generation site	68 (32.2)
Use hand-sanitizer	209 (99.1)
Appropriate handwashing practice	189 (89.6)
Correct BMW transport-label information	175 (82.9)
Closable plastic trolley for BMW transport	186 (88.2)
1% sodium hypochlorite preparation	134 (63.5)

Table 5: Comparison of selected correct responses before and after the educational intervention

Indicator	Pre-intervention, n (%)	Post-intervention, n (%)
IPC protocol awareness	199 (94.3)	205 (97.2)
Correct sodium hypochlorite concentration	161 (76.3)	186 (88.2)
Correct handwashing indications	192 (91.0)	200 (94.8)
Correct immediate response to needle-stick injury	183 (86.7)	194 (91.9)
Correct PPE identification	164 (77.7)	186 (88.2)
Correct BMW segregation	184 (87.2)	196 (92.9)
Correct hepatitis vaccination schedule	138 (65.4)	179 (84.8)

Correct needle disposal	196 (92.9)	205 (97.2)
Correct waste-bag filling level	129 (61.1)	165 (78.2)
Correct blood-spill management	67 (31.8)	148 (70.1)
Correct post-exposure steps	169 (80.1)	194 (91.9)
Correct handwashing practice	189 (89.6)	198 (93.8)
Correct BMW transportation	186 (88.2)	200 (94.8)
Correct sodium hypochlorite preparation	134 (63.5)	165 (78.2)

Table 6: Paired t-test results of correct responses regarding Infection Prevention and Control

Groups	Knowledge Mean ± SD Pre-intervention	Knowledge Mean ± SD Post-intervention	p-value (Paired t-test)	Attitude Mean ± SD Pre-intervention	Attitude Mean ± SD Post-intervention	p-value (Paired t-test)	Practice Mean ± SD Pre-intervention
Intern doctors	7.36 ± 0.86	9.88 ± 0.33	0.04*	7.84 ± 1.31	10 ± 0	0.003*	5.92 ± 1.15
Laboratory technicians	7.68 ± 1.68	9.52 ± 0.71	0.001*	7.60 ± 1.68	9.72 ± 0.54	0.05*	6 ± 2.27
Nursing staff	7.6 ± 1.41	9.52 ± 0.82	0.005*	7.16 ± 1.65	9.4 ± 1	0.002*	4.6 ± 2.16

Indicate statistically significance at $p \leq 0.05$; SD: Standard Deviation

DISCUSSION

The present study evaluated knowledge, attitude and practice (KAP) related to infection prevention and control (IPC) among 211 healthcare workers before and after an educational intervention at a tertiary care hospital in Western India. The findings demonstrated improvement across all three KAP domains following the intervention. The mean percentage of correct responses in the knowledge domain increased from 81.46% before the intervention to 89.52% after the intervention, while the mean attitude score increased from 81.49% to 89.54%. Overall, the mean KAP score increased from 79.35% to 88.36%, representing an improvement of 9.01 percentage points.

The relatively high baseline knowledge observed in the present study may reflect the participants' existing exposure to healthcare settings and routine infection-control practices. Awareness of biomedical waste management rules was particularly high, with 99.5% of participants responding correctly before the intervention. Similarly, 98.1% correctly identified the major risks associated with hospital waste handling, and 93.4% correctly identified the yellow-bin segregation requirement for soiled dressings. These findings indicate that basic principles of biomedical waste management and infection prevention were already well established among most participants. The importance of adequate knowledge and systematic infection-control practices among healthcare workers has been emphasized in previous literature.[12,13]

Despite the high overall baseline knowledge, important gaps were identified in specific IPC-related competencies. Knowledge regarding the appropriate timing of post-exposure prophylaxis was lowest at baseline, with only 44.5% providing the correct response. Similarly, only 49.8% correctly identified the appropriate reporting method for needle-stick injuries, while 63.0% correctly identified the appropriate proportion of healthcare waste. These findings are important because occupational exposure prevention requires healthcare workers to understand not only general infection-control principles but also the correct sequence of actions following exposure. Previous studies have similarly demonstrated that healthcare workers may have good general awareness while retaining important deficiencies in specific infection-control practices and occupational safety measures.[14,15] Following the educational intervention, improvement was observed in almost all knowledge indicators. The largest improvements were seen in areas where baseline knowledge was relatively poor. Knowledge regarding the appropriate timing of post-exposure prophylaxis increased from 44.5% to 70.1%, representing a 25.6 percentage-point improvement. Correct reporting of needle-stick injuries increased from 49.8% to 70.1%, while knowledge regarding the appropriate proportion of healthcare waste increased from 63.0% to 74.9%. Knowledge of the correct sodium hypochlorite concentration improved from 76.3% to 88.2%, and correct understanding of PPE increased from 77.7% to 88.2%. This pattern is clinically relevant because educational interventions are particularly useful when they address specific knowledge deficiencies rather than simply reinforcing information that healthcare workers already know. Carrico et al. emphasized that IPC competencies among hospital-based healthcare personnel should include clearly defined knowledge and skills necessary for preventing occupational and healthcare-associated infections.[15] The present findings support this competency-based approach, as improvement was most evident in several procedural areas requiring specific knowledge.

The attitude domain also showed favourable baseline findings with further improvement after the intervention. Before the intervention, 99.1% of participants supported strict colour coding of biomedical waste bins, 98.6% supported labelling of biomedical waste bags, and 98.6% expressed willingness to attend biomedical waste management training. These findings suggest that healthcare workers generally recognized the importance of biomedical waste management and infection prevention. However, gaps remained in areas such as recognition of the appropriate hepatitis vaccination schedule, appropriate waste-bag filling level and the recommended frequency of health check-up or training. Following the intervention, recognition of the correct hepatitis vaccination schedule increased from 65.4% to 84.8%, while identification of the appropriate waste-bag filling level increased from 61.1% to 78.2%. The proportion considering PPE necessary for infectious patients increased from 90.5% to 96.2%, and agreement that IPC guidelines were necessary at the workplace increased from 91.0% to 96.2%. These findings indicate that the educational intervention may have reinforced favourable perceptions regarding occupational safety and infection prevention. The findings are consistent with previous studies demonstrating variability in attitudes and practices among healthcare workers despite relatively favourable baseline awareness. Sheta et al. reported the importance of assessing knowledge, attitudes and practices related to infection-control measures among healthcare workers, while Bhugun-Aumeerbocus and Nuckchady highlighted the continuing need to strengthen IPC knowledge and practices in tertiary-care settings.[12,13] The present study similarly demonstrates that even when baseline attitudes are favourable, targeted education can reinforce specific IPC-related behaviours and responsibilities.

The substantial improvement in blood-spill management is particularly important because this represents a practical competency that directly affects occupational exposure and environmental contamination. The relatively low baseline proportion of participants correctly managing blood spills suggests that theoretical awareness of infection control does not necessarily translate into correct procedural practice. Educational approaches that include practical demonstrations and reinforcement of standard procedures may therefore be particularly valuable.[16] The improvement in hand hygiene-related practices was comparatively smaller because baseline performance was already high. Appropriate handwashing practice increased from 89.6% to 93.8%, while hand-sanitizer use increased from 99.1% to 100.0%. This ceiling effect may explain why the magnitude of improvement was smaller for these indicators than for blood-spill management. Nevertheless, maintaining high compliance with hand hygiene is important because hand hygiene remains a fundamental component of infection prevention. Evidence from systematic reviews has demonstrated that interventions aimed at improving hand hygiene can enhance compliance among healthcare workers.[16,17] The findings of the present study therefore suggest that educational interventions may have a greater observable effect on practices that have lower baseline performance. This is particularly evident from the improvement in blood-spill management and sodium hypochlorite preparation. Correct preparation of 1% sodium hypochlorite increased from 63.5% to 78.2%, while knowledge of the correct sodium hypochlorite concentration increased from 76.3% to 88.2%. These findings highlight the importance of reinforcing practical biomedical waste and environmental disinfection procedures through repeated training.

The improvement in biomedical waste-related practices was also noteworthy. Although these findings indicate improvement, the post-intervention levels demonstrate that substantial gaps remained, particularly in waste segregation at the point of generation. This suggests that education alone may not be sufficient to achieve complete compliance and should be supported by adequate infrastructure, supervision, reminders and periodic monitoring.

Previous evidence has similarly emphasized that infection prevention is not dependent solely on individual knowledge. WHO guidance on IPC programmes highlights the importance of institutional systems, training, monitoring and continuous improvement as components of effective infection prevention programmes.[9,17,18] Thus, the improvement observed in the present study should be interpreted as part of a broader institutional IPC strategy rather than as an isolated educational effect.

The overall improvement in KAP scores further supports the beneficial role of structured education. Knowledge increased by 8.06 percentage points, attitude by 8.05 percentage points and practice by 10.91 percentage points. The overall KAP score increased by 9.01 percentage points. The relatively larger improvement in practice compared with knowledge and attitude is encouraging because improvement in practical behaviour is ultimately more important for reducing occupational exposure and healthcare-associated infection risk.[19]

The present findings are also consistent with the broader evidence supporting multimodal approaches to infection prevention. Hand hygiene interventions, for example, have demonstrated that educational activities are most effective when combined with reminders, feedback, institutional support and availability of necessary resources.[16,17,20] Gould et al. found that interventions directed towards healthcare-worker hand hygiene can improve compliance, while Luangasanatip et al. demonstrated the value of multimodal interventions in promoting hand hygiene in hospitals.[16,17] WHO guidelines likewise emphasize education, monitoring and system-level support as integral components of infection prevention programmes.18 These principles are applicable to the broader IPC education programme assessed in the present study.

The baseline occupational characteristics also provide useful context. A substantial proportion of participants (85.8%) had previously received IPC training, yet important gaps remained in practical competencies such as blood-spill management and waste segregation. This finding suggests that previous exposure to IPC training does not necessarily guarantee sustained competency. Regular refresher training and practical reinforcement may therefore be necessary to maintain appropriate practices over time. The high baseline use of hand sanitizer and PPE also suggests that some IPC behaviours were already well established among the participants.

The study has several practical implications. First, IPC education should be regular rather than a one-time activity. Second, training should emphasize areas where baseline performance is poor, particularly blood-spill management, waste segregation, post-exposure procedures, needle-stick injury reporting and disinfectant preparation. Third, practical demonstrations and competency assessments may be more effective than purely didactic sessions for translating knowledge into practice. Finally, educational interventions should be supported by adequate IPC supplies, clear institutional protocols, supervision and periodic monitoring.

The findings should nevertheless be interpreted considering the limitations of the pre–post study design. In the absence of a control group, improvements cannot be attributed exclusively to the educational intervention. Other factors, including institutional policies, concurrent training, increased supervision and familiarity with the assessment questionnaire, may have contributed to the observed changes. In addition, several outcomes were self-reported, which may introduce reporting or social-desirability bias. Objective observation of IPC practices and longer-term follow-up would provide stronger evidence regarding the sustainability of the observed improvements.

Overall, the present study demonstrates that healthcare workers had generally favourable baseline KAP regarding IPC, but important gaps remained in several specific areas. Following the educational intervention, improvements were observed across knowledge, attitude and practice, with the greatest improvement occurring in practical IPC measures. These findings support the integration of structured, competency-based and regularly reinforced IPC education into routine hospital infection-control programmes.

CONCLUSION

The present study demonstrated generally favourable baseline knowledge, attitudes and practices regarding infection prevention and control among healthcare workers, although important gaps were identified in specific areas such as post-exposure prophylaxis, needle-stick injury reporting, blood-spill management, waste segregation and sodium hypochlorite preparation. The overall KAP score increased from 79.35% to 88.36%. The greatest improvement was observed in the practice domain, particularly in blood-spill management. These findings suggest that structured and competency-based educational interventions can strengthen IPC-related knowledge, attitudes and reported practices among healthcare workers. Regular refresher training, practical demonstrations, institutional support, monitoring and reinforcement should be incorporated into routine IPC programmes to maintain and sustain these improvements.

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