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Effectiveness of Structured Teaching Programme on Infection Control Practices and Assessment of Knowledge Retaining Ability Among Nurses in Intensive Care Units: A Multicenter Longitudinal Interventional Study

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Abstract:

- ***Introduction:***
  Hospital-acquired infections are a significant global public health problem, leading to an increase in morbidity and mortality. Studies have shown that nurses' knowledge and practices related to infection control are often inadequate. There is a need for targeted education and training of nurses to improve their knowledge and adherence to guidelines.

- ***Objectives:***
  Our study aimed to assess the effectiveness of the Structured Teaching Programme (STP) and evaluate nurses' knowledge retention ability.

- ***Methods:***
  This Quantitative, Longitudinal study was conducted between April and May 2022 among the intensive care unit (ICU) nurses at three tertiary care multi-speciality hospitals in Coimbatore, South India. A total of 227 nurses were included by convenience sampling. Data was collected using a standardised, self-administered questionnaire on infection control practices. Pre-test followed by an STP on infection control practices, and two post-tests (Immediately following the STP and one month after the STP) were conducted later using the same questionnaire.

- ***Results:***
  The study showed that the baseline knowledge among nurses was low (mean 21.02), and it significantly improved immediately after STP (mean 31.9). After a month, the knowledge was reduced (mean = 29.7); however, compared to the baseline knowledge, it was still higher and statistically significant ($p < 0.001$).

- ***Discussion:***
  The study provides valuable insights into the effectiveness of training programs on improving knowledge.

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➢ ***Conclusions:***

This study recommends that healthcare institutions provide regular training and retraining to healthcare workers on infection control practices based on recent guidelines.

Keywords: *Hospital-Acquired Infection, Infection Control, Intensive Care Units, Knowledge Assessment, Structured Teaching Programme.*

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I. INTRODUCTION

Hospital-acquired infections (HAIs) are a significant global public health problem, posing a risk to patient safety, prolonging hospital stay, causing increased healthcare costs, and eventually leading to mortality in some cases. The World Health Organisation (WHO) estimates that HAIs affect millions of patients worldwide, leading to significant morbidity, mortality, and financial burdens on healthcare systems [(1)].

Approximately 15% of all hospitalised patients experience at least one HAI during their stay in a healthcare facility. HAI occurs after 48 hours of hospitalisation, and it delays the patient's recovery, increases healthcare costs, morbidity and mortality. Despite efforts to reduce HAIs, they remain a significant burden, with an estimated 8.9 million cases in Europe between 2016 and 2017. The most common types of HAIs are bloodstream infections, Urinary tract infections, pneumonia, and Surgical site infections [(2)].

Infection prevention is a process of placing a barrier between the susceptible host and the microorganisms. Nurses play a critical role in the prevention of HAIs, and their knowledge and adherence to infection control practices are essential for reducing the incidence of these infections. They are responsible for delivering direct patient care and implementing infection control practices [(3)].

However, studies have shown that nurses' knowledge and practices related to infection control are often inadequate, leading to increased risks of HAIs [(4,5)]. Education and training are the cornerstones for improving infection control practices [(6-8)]. There are a limited number of studies conducted to assess the knowledge retention among nurses.

➢ *Aims and Objectives / Research Questions / Hypotheses*

This study aimed to improve knowledge and practices of infection control and knowledge retention among nurses using a structured Teaching Programme (STP) that provides targeted education and training. In the study setting, what is the baseline knowledge regarding infection control practices, and to what extent do the ICU nurses retain the knowledge gained from the STP? The study hypothesised that there would be a significant difference in the knowledge and retention after the implementation of STP among critical care nurses.

II. METHODS

This study followed the STROBE reporting guidelines. A quantitative, longitudinal design was adopted to evaluate the effectiveness of an STP on infection control practices.

The study was conducted among nurses working in ICUs across three tertiary care multi-speciality hospitals in Coimbatore, Tamil Nadu, from April 2022 to May 2022. A total of 227 critical care nurses were included in the study through a voluntary opt-in method of sampling. Nurses select themselves to participate based on their own volition. Nurses who were willing and consented were included in the study. Nurses who were not willing or did not consent were excluded from the study.

The primary outcome of the study was to determine the effectiveness of the STP in enhancing the knowledge of infection control practices by analysing the scores from pre-tests and post-tests statistically. Secondary outcomes included assessing the baseline knowledge of infection control practices and evaluating the retention of knowledge one month after the STP.

A structured questionnaire was prepared for the study covering all the aspects of infection control practices. The questionnaire included demographic details and 35 questions covering hand hygiene, equipment disinfection, patient care related to infection control, procedural infection control measures, antibiotic usage, and biomedical waste handling. The data collection instrument was a standardised, self-administered questionnaire confirmed by subject experts, with reliability confirmed by Cronbach's alpha ($r = 0.95$), showing excellent internal consistency.

A two-hour teaching program on awareness, knowledge and importance of practising an evidence-based approach for the prevention of HAIs. STP was conducted by Infection control nurses and nurse educators, employing various teaching methods such as lectures, discussions, and demonstrations to enhance understanding of infection control measures.

The study was conducted with approval from the Institutional Review Board (IRB) and secured informed consent from all participants, ensuring ethical standards and confidentiality. A pre-test was administered to 227 nurses using a standardised questionnaire to assess baseline

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knowledge of infection control practices. Following the pre-test, a 2-hour teaching program on awareness, knowledge and importance of practising an evidence-based approach for the prevention of HAIs. STP was conducted by Infection control nurses and nurse educators, employing various teaching methods such as lectures, discussions, and demonstrations to enhance understanding of infection control measures. Immediately after the STP, the first post-test was administered using the same questionnaire to evaluate the immediate impact of the training. Assess knowledge retention, a second post-test was conducted one month later. Data collection was conducted by the Infection control nurses and nurse educators.

All ethical guidelines were strictly followed to ensure unbiased reporting, such as samples being included through voluntary participation in the study, common teaching materials and instruction shared to all researchers, and missing data were cleaned before analysis.

Basic descriptive data were presented as frequency (percentage) or mean (SD). The chi-square test measured the association between categorical variables (percentage of correct responses) at different time points. The total score comparisons over time were analysed using T-tests and ANOVA, with a p-value of less than 0.05 and a 95%confidence interval (CI) was considered statistically significant. Data analysis was performed using Statistical Package for the Social Sciences (SPSS, version 16, New York, USA), STATA (version 10, Texas, USA), and Epi Info (version 3.5.1, USA).

Ethical clearance was obtained from the Institutional Review Board of the study setting in Coimbatore, India (XXX). Permission to collect data was obtained from the Director and Head of the Department of ICU at the target hospitals. Written voluntary informed consent to implement the intervention was obtained from participants. No participant-identifying information was collected. No participants were forced to participate in the study. All ethical principles were followed throughout the study period.

III. RESULTS/ FINDINGS

The study was done on 227 participants from three different tertiary health care centers in a district. Nearly three-fourths (73.6%) of the study population were females, and 95.1% were in the age group of 20 to 30 years. Only about 10% of them were currently married. The majority, i.e., 199(87.7%), graduated from private institutes. 82.8% were staff assigned directly for patient care, and 5.3% were in their training period. Before the training, 182(79.8%) believed that they had adequate knowledge of infection control practices. One hundred and seventy-five (76.7%) had attended a teaching program on infection control before the study.

The section on knowledge about hand hygiene, including hand washing and the use of hand rub, included five components. Initially, a relatively low proportion of participants were aware of the correct steps for hand hygiene, but the STP significantly improved this knowledge, with a retention rate of 61.7% after one month. A substantial increase in knowledge about hand hygiene techniques needed in patient care was seen post-training, which remained consistent in the retention test. Less than 50% of participants correctly found the 5 moments of hand hygiene and the necessity of using hand rub, even when hands appeared visibly clean. The mean scores for hand hygiene knowledge improved significantly from 3.2 at baseline to 3.9 post-intervention. While a higher baseline knowledge on the duration of hand rub application was noted, it further increased following the STP.

On the disinfection of equipment, a significant improvement in knowledge was seen across all components. Awareness about the need for sterilising medical equipment between patient uses was low (less than 40%) in the pre-intervention period but improved to over 80% post-intervention. Initially, less than one-third of participants knew that instruments shared between patients needed to be disinfected before each use; this knowledge increased significantly after the STP.

For infection control measures during procedures, over 95% of participants already had good knowledge of the correct positioning of urine bags, with no notable change post-intervention. Similarly, about 85% of participants knew the 'no-touch' technique for urinary catheter insertion at baseline, which did not improve significantly after the training. However, knowledge about the relationship between urinary tract infections and catheter types increased significantly from less than a quarter to over three-quarters post-intervention. Knowledge on preventing ventilator-associated pneumonia was initially low but showed significant improvement after the training.

There was a significant improvement in nurses' knowledge of antibiotic usage. Awareness that Inj. Meropenem doesn't cover Methicillin Resistant Staphylococcus Aureus (MRSA), increased from 28.2% to 86.3%, with 74.9% retaining this knowledge ($p < 0.01$). Understanding that prophylactic antibiotics aren't needed for mechanically ventilated patients with catheters rose from 20.2% to 89.0%, sustaining at 80.2% ($p < 0.01$). Knowledge of correct Vancomycin administration (slow Intravenous (IV) over 60 minutes) increased from 65.6% to 91.2%, with 84.1% retention ($p < 0.01$). Lastly, awareness of post-exposure prophylaxis for Human Immune Deficiency (HIV) within 24 hours improved from 46.3% to 89.9%, holding at 83.7% ($p < 0.01$).

The knowledge of the need for segregation of biomedical waste disposal was low (64.84%), and there was a significant improvement (92.06%) after training. (Figure S1)

Knowledge on isolation was found to be very low (52.9%) and significantly improved (84.1%) after STP. (Figure S2)

The responses were converted into scores, and the mean scores of each time were compared with the other. The

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comparison of knowledge of infection control practices among critical care nurses across three time periods—pretest, immediate post-test, and post-test after one month—reveals significant improvements at each stage. From the pretest mean of 21.02 to 28.32 immediately after the intervention, and further increasing to 31.96 one month later, all comparisons show highly statistically significant results ($p = 0.000$). The immediate post-test vs. pretest comparison (MD = 7.295, t = -20.334) demonstrates a notable improvement in knowledge right after the intervention, while the pretest vs. post-test after one month (MD = 10.938, t = -39.738) indicates continued and sustained learning. The further increase between the immediate post-test and post-test after one month (MD = 3.643, t = -11.388) suggests that knowledge retention and understanding deepened over time. (Table 1)

IV. DISCUSSION

Our study aimed at assessing the level of knowledge among nurses on infection control practices. We also evaluated the improvement and retention of knowledge following an STP.

The demographic profile shows most of them were female (73.6%), young (95.1%), single (89.9%), and assigned nurses (82.8%). And 76.7% had attended a teaching program on infection control before the study. However, staff in the ICU have high turnover or attrition rates.

Our study found that less than 50% of the study population possessed correct knowledge about the 5 moments of hand hygiene and the necessity of cleaning hands even when they appear visibly clean, which is consistent with previous studies that have reported poor hand hygiene practices among healthcare workers [9,10]. This highlights the need for ongoing education and training programs on hand hygiene practices among nursing staff to ensure they are aware of the latest guidelines and recommendations related to hand hygiene. The STP resulted in a significant improvement in the knowledge related to hand hygiene among nursing staff.

The retention of knowledge after STP was also relatively higher (61.7%), which suggests that the training program was effective in improving the long-term retention of knowledge and practices related to hand hygiene. This is an important finding as hand hygiene is a critical component of infection control practices and plays a crucial role in preventing the transmission of HAIs and antimicrobial resistance [11,12].

The knowledge of the need for sterilising medical equipment in between patient care was very poor (less than 40%) and significantly improved to more than 80% after STP. Similarly, the knowledge on disinfection of certain instruments shared among patients also improved significantly after the intervention. The importance of disinfection and sterilisation in healthcare settings cannot be emphasised enough.

The risk of transmission of infectious agents from contaminated medical equipment can lead to hospital-acquired infections and pose a serious threat to patient safety. Therefore, healthcare providers must be well-informed about the proper disinfection and sterilisation techniques.

Previous studies have also highlighted the importance of staff education and training in infection control practices for reducing the incidence of hospital-acquired infections. A study demonstrated that implementing an educational program for nursing staff on infection prevention and control resulted in a significant reduction in the incidence of hospital-acquired infections.

The comparison scores revealed that the baseline knowledge on infection control practices among nurses was low (mean 21.02, SD), like Sadaf S et al. (2018) study, which also had a low score in the pre-test [13]. Researchers have linked nurses' lack of knowledge to worsening patient outcomes [14-15].

A noteworthy discovery is that knowledge scores significantly improved immediately after the teaching session (mean = 31.9, SD). The results are consistent with the findings of previous studies conducted in various settings, which showed that structured educational interventions can improve the knowledge and practices related to infection control among healthcare workers [16,17]. Surprisingly, after a month, the knowledge reduced (mean -29.7); however, compared to the baseline knowledge, it was higher and statistically significant ($p<0.001$). Nevertheless, many international studies had a similar drop after a one-month interval [18, 19].

The findings of our study indicate that the knowledge related to hand hygiene, disinfection of equipment, and prevention of ventilator-associated pneumonia and practices related to infection control among staff nurses were suboptimal despite their training during nursing education and after the induction course conducted in the hospital [20]. However, an STP on infection control practices improved their knowledge and practices significantly. These findings suggest that further training and reinforcement may be necessary in these areas to improve the knowledge and practices related to infection control.

WHO and many studies recommend simulation training, observation, and feedback to health-care workers to reduce HAI [19-23]. Thus, the infection control team of each hospital should be responsible for the implementation and reinforcement of infection control guidelines, policies, and procedures through repeated training programs so that they are well executed by nursing staff.

The strengths of this study include nurses working in ICUs across three tertiary care multi-speciality hospitals in Coimbatore, and the implementation of STP for nurses and assessing the knowledge retention ability of nurses. This study finding can be implemented in all hospitals as it is cost-effective.

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V. LIMITATIONS

A limitation of our study is that we did a subjective self-assessment, and so the responses may not have accurately reflected the true practices. Due to the basic human tendency, many of the responses could have been to showcase them to be doing things correctly and due to the fear of being punished if wrong. We tried to eliminate this misconception by briefing them that they need not mention their identity, and their anonymity will be maintained throughout the process. The study was conducted only in three tertiary care centers in a single city, and the findings may not be generalizable to a larger population. Randomisation was not done.

This study doesn't assess the attitude of nurses because it requires a qualitative study design. In our study, we checked the knowledge of the nurses alone, but not the level to which it was translated into practice.

➢ *Implications for Practice*

Our study demonstrates that a Structured Teaching Programme (STP) significantly improves ICU nurses' knowledge of infection control practices. HAI can be prevented through raising awareness among nurses and ensuring proper implementation of infection prevention measures. Policy guidance, practical training, education, and behavioural and managerial strategies for nurses are also critical in focusing on HAI prevention.

VI. CONCLUSION

HAI, the knowledge of staff does play an important role, but there are many other confounding factors. Continuing educational programs, in-hospital training and providing updated guidelines are required to improve knowledge regarding infection control practices and HAIs. In our study, Nurses' knowledge regarding infection control practices was found to be inadequate. STP is successful in improving awareness, knowledge, but repetition is needed fewer bring in a behavioural improvement that will finally improve outcomes.

Future research should employ randomisation, nurses' compliance with the bundle and other prevention guidelines.

➢ *Abbreviations*

- HAI - Hospital-Acquired Infection
- HIV – Human Immune Deficiency
- ICU – Intensive care unit
- IV - Intravenous
- MRSA – Methicillin-Resistant Staphylococcus Aureus
- STP – Structured teaching program
- WHO – World Health Organisation

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Table 1 Comparison of Knowledge of Infection Control Practice Among Critical Care Nurses (n=227)

PARAMETERS	M1	SD1	M2	SD2	MD	t Value	P Value
Pre-test Vs Immediate post test	21.02	4.09	28.32	3.03	7.295	-20.334	0.000
Pre-test Vs post-test after one month	21.02	4.09	31.96	3.16	10.938	-39.738	0.000
Immediate post-test vs post-test after one month	28.32	3.03	31.96	3.16	3.643	-11.388	0.000

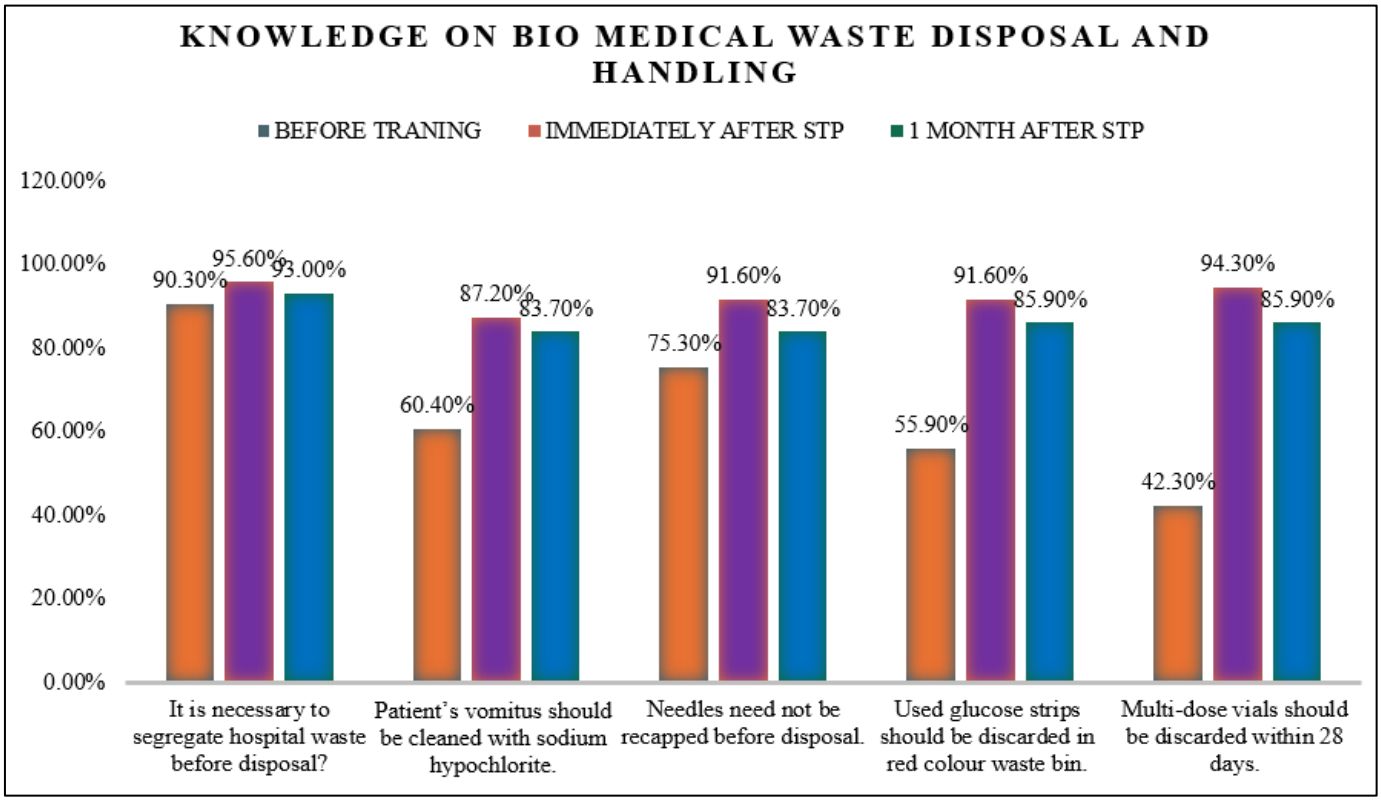

Fig 1 Participants Knowledge of Bio Medical Waste Disposal and Handling (n=227)

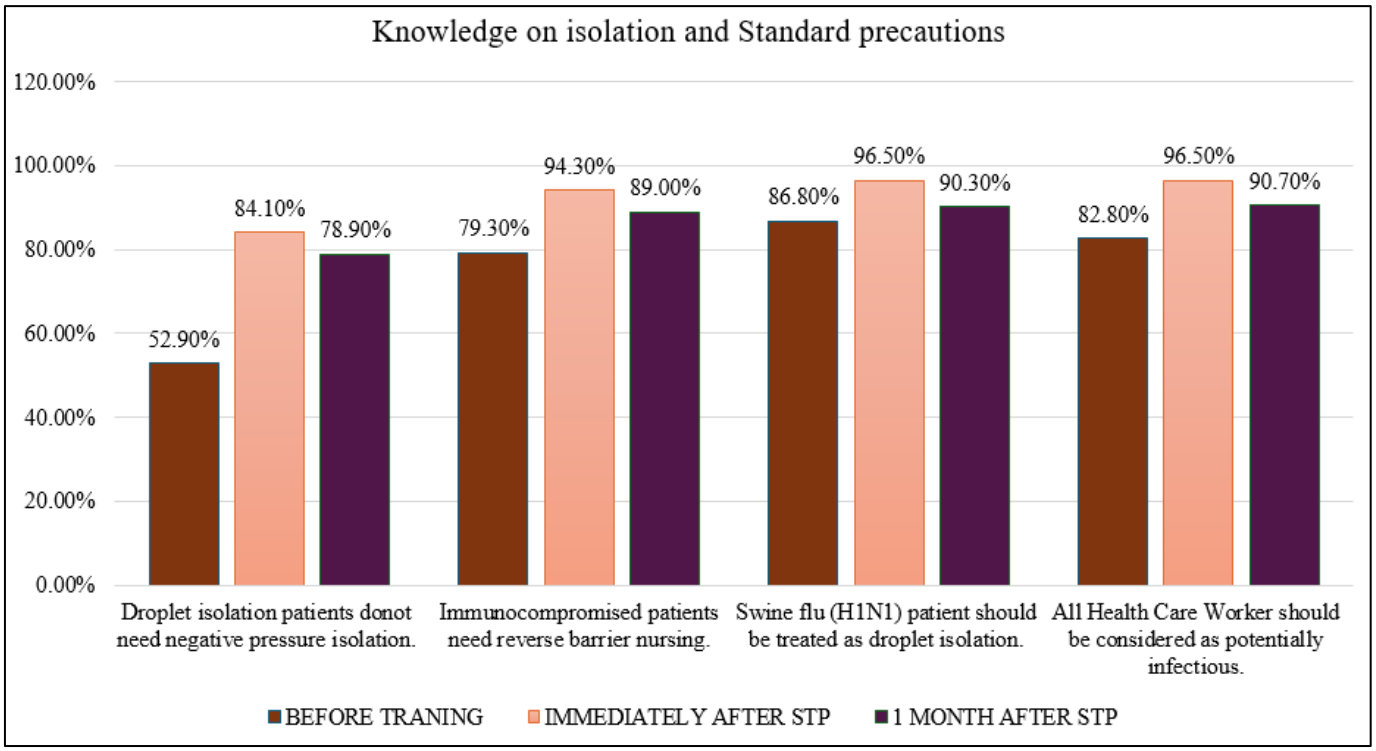

Fig 2 Participants Knowledge on Isolation and Standard Precautions (n=227)