Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 18s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Evaluating the Impact of Radiation Safety Training on Staff Nurse Knowledge: Pre and Post Assessment

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Cite this paper as: Sivaprakash Vijayarajan*, Anita Soundarapandian, Kreethi Suresh kumar, et.al (2025) Evaluating the Impact of Radiation Safety Training on Staff Nurse Knowledge: Pre and Post Assessment. *Journal of Neonatal Surgery*, 14 (18s)18-24.

ABSTRACT

Background: Radiation safety is critical in healthcare, particularly for staff nurses frequently exposed to various imaging modalities. Ensuring their knowledge of radiation protection is vital for both patient care and their safety.

Aims: This study aims to evaluate the effectiveness of a targeted radiation safety training program by comparing the knowledge of staff nurses before and after the training.

Settings and Design: Conducted at Panimalar Medical College Hospital & Research Institute, this pre- and post-assessment study involved 141 staff nurses and 10 operation theatre technicians.

Methods and Material: The training covered essential topics, including proper use of TLD badges, AERB guidelines, and the ALARA principle. A standardized questionnaire was administered before and after the training to assess knowledge improvement. Statistical Analysis Used: A paired t-test was employed to compare pre- and post-training scores, and descriptive statistics were used to analyse the results.

Results: The mean score significantly increased from 2.90 pre-training to 9.15 post-training, indicating a substantial improvement in knowledge. The training effectively enhanced the nurses' understanding of radiation safety, with statistically significant results ($p < 0.0001$).

Conclusion: The radiation safety training program was highly effective in improving the knowledge of staff nurses, leading to better preparedness in handling radiological procedures safely. This improvement underscores the importance of regular, targeted training to ensure a safer healthcare environment.

1. INTRODUCTION

Knowledge of radiation safety among staff nurses is essential for enhancing patient care and ensuring healthcare worker safety. Staff nurses frequently assist and transport patients across various departments and investigations, necessitating a thorough understanding of which medical imaging modalities pose radiation hazards. The radiologists and radiology technicians who work in radiology are already trained about radiation hazards and radiation protection. However, staff nurses do not receive any proper training in radiation hazards and radiation protection during their undergraduate or postgraduate courses. Proper training can significantly improve nurses' ability to identify non-ionizing versus ionizing radiation, follow safety protocols during X-ray procedures, and comprehend critical radiation safety principles [1,2] Considering the radiation safety knowledge among healthcare staff, several researchers conducted surveys at various medical facilities. One study conducted with 101 healthcare professionals to analyze the knowledge, attitudes, and behaviours of radiation workers found they do not have adequate knowledge about radiation safety. [3] To investigate the knowledge of radiation use and safety, eight hospital staff nurses who work in the cardiology labs, first aid clinic, and operation theatre were the subjects of another study. Out of 1500, the response rate is 252 results in nurses having high knowledge in radiation protection but lack in radiation physics, biology, and principles of radion uses. [4] A study conducted in Sri Lanka collected data from 391 nurses working in hospitals, clinics, and other healthcare settings; this study showed a significant lack of awareness about radiation effects and suggested a continuing education program on radiation protection [5]. Most studies had done radiation knowledge surveys among staff nurses, radiation workers, patients, etc. and found a lack of knowledge among them. But no studies had evaluated the effects of learning about radiation protection after training, workshop, or seminar. Our study aims to assess the effectiveness of a targeted radiation safety training program by comparing the knowledge of staff nurses before and after the training. The training covers essential topics such as the correct use of TLD badges, adherence to AERB guidelines, understanding the ALARA principle, and recognizing the importance of minimizing radiation exposure [6]. By addressing these areas, the training program will ensure a safer healthcare environment and maintain radiation safety standards. Staff nurses are integral to the smooth operation of healthcare facilities. Their roles in interventional radiology, diagnostic radiology, and bedside procedures

necessitate a solid foundation in radiation safety to protect themselves and their patients. Despite their crucial roles, there has been a lack of structured radiation safety education tailored specifically for nursing staff, highlighting the need for this study [2] [6]. In addition to improving knowledge, radiation safety training aims to alleviate common fears and misconceptions about radiation exposure among nurses. The long-term goal is to establish a culture of safety and awareness that permeates all levels of patient care, ultimately leading to better health outcomes and reduced occupational hazards for healthcare workers [1] [2].

2. METHODS

Study Design: This study employed a pre-test and post-test design to evaluate the effectiveness of radiation safety training on the knowledge of staff nurses. The study was conducted in a hospital setting, involving a total of 151 staff nurses. The training program was designed focusing on various aspects of radiation safety relevant to the nurses' roles.

Participants: The participants were 141 staff nurses and 10 operation theatre (OT) technicians, all of whom attended the radiation safety training program held on 14th and 21st June 2023 in the hospital lecture hall at Panimalar Medical College Hospital & Research Institute.

Data collection involved the use of a standardized questionnaire administered to participants both before and after a radiation safety training session. Participants who were attended before were excluded from this study. The tool was meticulously developed, ensuring it covered all critical aspects of radiation safety relevant to the participants' roles. Validation of the questionnaire was achieved through expert reviews and pilot testing. The pre- and post-assessment design allowed for a direct comparison of knowledge improvement, ensuring the training's effectiveness could be quantitatively evaluated.

Pre-assessment: Before the training session, a pre-assessment was conducted using a structured questionnaire. The questionnaire covered key areas of radiation safety, including:

- Identification of non-ionizing versus ionizing radiation modalities.
- Safe distances to maintain during X-ray exposures.
- AERB-recommended dose limits for radiation workers.
- Correct usage and storage of Thermo-Luminescent Dosimeter (TLD) badges.
- Understanding of the ALARA principle.
- Knowledge of radiation exposure risks to fetal health during pregnancy.
- Misconceptions regarding the protective role of TLD badges.
- Awareness of radiation levels in different imaging modalities.

Training Program

The training program conducted by AERB certified Level-1 RSO in Panimalar Medical College Hospital & Research Institute. The Training program conducted for 90minutes.

At first a pre assessment questionnaire was designed by RSO and disturbed to participant to fill in 10 minutes of time.

Followed by one hour of lecture including the topics,

- Lectures on the principles of radiation and its safety.
- Discussions on the ALARA principle and its application.
- AERB guidelines and recommended practices.
- Effects of radiation dose to workers, patients and foetus
- Clarifications on misconceptions regarding radiation modalities and protection measures.
- Discussion of knowledge gaps identified in pre assessment

10minutes of Practical demonstration of proper use & storage of TLD badges and lead aprons

After the training session, 10 minutes of post-assessment was conducted using the same questionnaire to measure the improvement in knowledge. The responses were compared to the pre-assessment results to evaluate the effectiveness of the training.

Data Analysis

The data collected from the pre- and post-assessments were analysed using statistical methods to determine the significance of the improvement in knowledge. The following statistical analyses were performed:

- The percentage of correct answers before and after the training was calculated for each question.
- A paired t-test was used to compare the pre- and post-assessment scores to assess the statistical significance of the improvement.
- The impact of the training was also evaluated by calculating the percentage increase in correct responses for each area of radiation safety.

3. RESULTS

Participant Demographics: The study included 151 participants, predominantly female (132 females, 87.4%), with only 19 males (12.6%). This gender distribution reflects the broader demographic trends within the nursing profession.

Educational Qualifications: Participants came from diverse educational backgrounds. The largest group held a Diploma in General Nursing and Midwifery (DGNM) (45.7%), followed by those with a Bachelor of Science in Nursing (B.Sc. Nursing) (40.4%). A smaller percentage had a Master of Science in Nursing (M.Sc. Nursing) (2.6%), while others held

qualifications such as Fellow of Nursing Administration (FNA) (4.6%) or certifications in other healthcare-related fields like Operating Theatre (OT) technology (6.6%).

Experience: Experience levels varied, with a significant portion of participants (35.1%) having less than one year of professional experience. Other experience categories included 1-2 years (23.8%), 2-3 years (10.6%), and more than 10 years (11.9%). This variation in experience levels highlights the importance of providing standardized training in radiation safety.

Table 1: Pre Assessment Score

S. No	Pre assessment score	Total no: of: participants under each score	
		Pre assessment	Post assessment
1.	0 Mark	22	0
2.	1 Mark	33	0
3.	2 Mark	19	0
4.	3 Mark	18	0
5.	4 Mark	17	1
6.	5 Mark	17	0
7.	6 Mark	18	1
8.	7 Mark	4	7
9.	8 Mark	3	23
10.	9 Mark	0	52
11.	10 Mark	0	67
Mean (Average) Score		2.90	9.15
Median Score		3.0	9.0
Standard Deviation		2.21	1.00

Pre- and Post-Training Knowledge Assessment:

1. **Basic Radiation Knowledge:**
   - **MRI is Non-Ionizing Radiation:** Before training, only 33.1% of nurses identified MRI as non-ionizing, rising to 99.3% in post-training.
   - **ALARA Principle:** Understanding the ALARA principle improved from 38.4% to 88.7%.
   - **TLD Badge Usage:** Knowledge of TLD badge increased from 28.5% to 96.7%.
   - **Mammography is Low Radiation:** Awareness of different modality radiation dose knowledge increases from 19.9% to 96.7%.

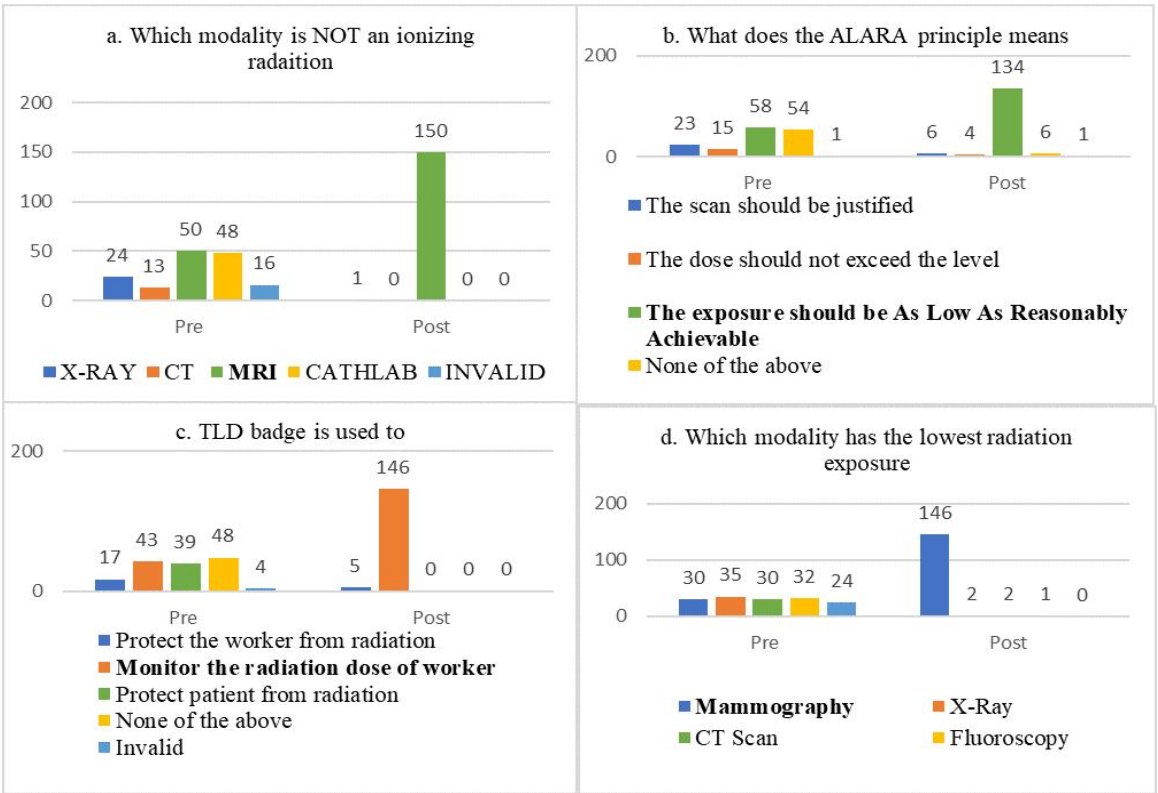

Figure 1: shows dramatic improvement in correct answers post-training.

2. **Radiation Protection and Regulations:**
- **Safe distance during ward Xray:** Safety distance knowledge increases from 40.4% to 97.4%.
- **Radiation Dose Limit for Pregnant Workers:** Knowledge improved from 33.8% to 88.1%.
- **TLD Badge Placement:** Correct responses increased from 24.5% to 90.1%.
- **Radiation Protection:** Safety protection during procedure rose from 39% to 71%
- **Techniques:** Safety techniques knowledge raised from 28.5% to 84.8%.
- **Radiation effects in foetus:** Knowledge increased from 25.2% to 90.1%.

Figure 2: illustrates the significant post-training improvement

Overall, Knowledge Improvement:
- **Pre-Training Scores:** Participants had a mean score of 2.90, indicating limited knowledge.
- **Post-Training Scores:** The mean score increased to 9.15, with a median score of 9.0 and a reduced standard deviation of 1.00, indicating concentrated improvement.
- **Figure 3** demonstrates the clear improvement in knowledge, with no participants scoring below 4 marks in post-training, highlighting the effectiveness of the program in enhancing radiation safety understanding.

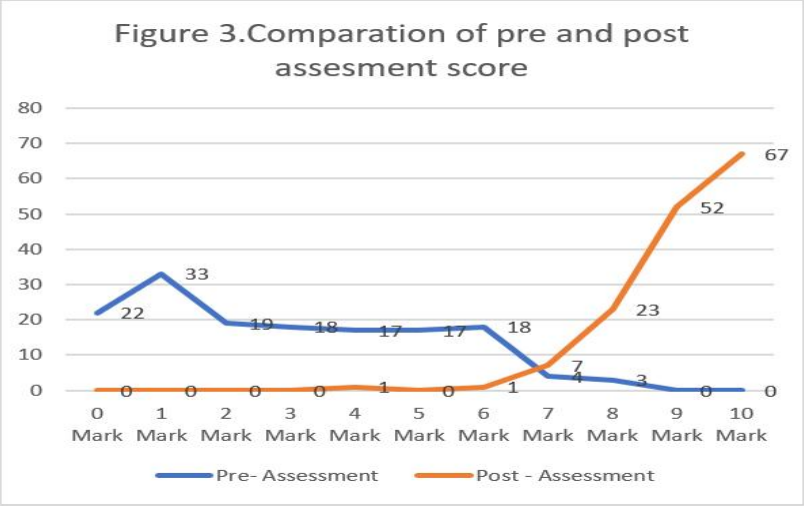

Figure 3: Comparation of pre and post assessment score

Statistical Analysis: The impact of the training on the participants' knowledge was evaluated by comparing the pre- and post-assessment scores using a paired t-test. The results indicate a significant improvement in knowledge following the training.

- **Pre-Assessment Scores:** The mean score before the training was M = 2.90, with a standard deviation (SD) of 2.21 and a standard error of the mean (SEM) of 0.18.
- **Post-Assessment Scores:** After the training, the mean score increased to M = 9.15, with a standard deviation of 1.00 and a SEM of 0.08.

The mean difference between pre- and post-assessment scores was 6.25, with a 95% confidence interval ranging from −6.59 to −5.90. The paired t-test yielded a t-value of 35.68 with a degree of freedom (df) of 150.

4. DISCUSSION

The staff nurses are essential for patient care, frequently assisting and transporting patients across various departments and investigations. Thus, it is critical for them to understand which modalities may cause harmful effects. 26 medical students unaware of MRI is non-ionizing radiation out of one hundred medical students [10], a study conducted among 271 allied and general public shows 59 have insufficient knowledge about MRI [11]. In our study from 33% it increases to 99% amount MRI source knowledge. Medical students have good knowledge about ALARA [10], In our study 38.4% aware of ALARA After the training session improved to 88.7%. A study with 176 participants very less of radiology students have good knowledge about TLD [14]**.** Low level of attitude towards TLD knowledge is noticed among staff nurses [15]**.** TLD knowledge among radiology students remain at medium level only and postgraduate students has greater level than undergraduate radiology students [16] in our study only 28.41%) answered rightly about TLD, after training about types and purpose of TLD usage 96.68% answered rightly. Comparing to X-ray, CT scan, and fluoroscopy, the mammography provides minimal radiation exposure, 19.86% answered rightly in pre assessment wheases it improved to 96.68% in post assessment. In another study 51.7% staff nurses and 77.5% respiratory therapists didn't know safe distance during bedside X-ray [24]. In our study 40.6% staff nurses answered correctly in pre assessment while 97.35% in post assessment. AERB-recommended dose limit for pregnant radiation workers, which is 2 mSv/year [4]. Radiation technologist shows average knowledge about the protection of pregnant worker [18]. In our study 51 staff nurses were aware of dose limit in pre training while 133 answered correctly in post-training,[13] [14]. TLD badge should be worn at the level of the chest and inside the lead apron to monitor the whole-body dose. Cross sectional study shows low level knowledge about TLD badges is noted among nurses than technicians and physicians [14] [9]. In our study TLD badge knowledge is improved from 24.5% to 90% of the correct answer after training. [15] [16]. In our study 39% staff nurses aware of that with a proper lead apron and standing away from a radiation source for a shorter time will decrease radiation exposure, in post assessment it improved to 71%. [18]. 28.5% staff nurses aware of ALARA principle, as the distance increases radiation dose decreases in pre assessment. After training session 84.76% of persons answered correctly. Majority of nursing students abbreviates the ALARA but lacks of its knowledge [27]. A study in zambia shows the nurses knowledge about radiation principles is below average [28]. In pre assessment 25.16% staff nurses answered correctly as foetus is most sensitive to radiation during the first trimester [19]. In post assessment 90% answered rightly. In Al-Madinah 262 participants out of 403 said 1st trimester is riskiest time to radiation [20]. Many studies shows that staff nurse, healthcare worker, physicians, even radiology students lack detailed knowledge about radiation safety and protection. So regular safety training should be done for all healthcare workers [21][22][23][24]

5. CONCLUSION

This study provides evidence that a structured radiation safety training program can significantly enhance the knowledge of staff nurses regarding critical aspects of radiation safety. The training led to marked improvements in several key areas

to maximize the impact of such programs, healthcare institutions should consider making them a mandatory component of ongoing professional development. Additionally, adopting a multidisciplinary approach to radiation safety training—incorporating perspectives from radiologists, medical physicists, and radiation safety officers—can further enrich the learning experience and ensure comprehensive understanding among staff. By prioritizing education and continuous improvement in radiation safety, healthcare institutions can foster a safer environment that upholds the highest standards of care.

Limitations: It was only carried out in one institution, which might have limited how broadly the findings might be applied to other medical environments. Furthermore, self-reported data from a questionnaire was used in the study, which may have introduced response biases. Additionally, there was no control group to account for other effects, and the study did not evaluate long-term information retention or behaviour change. Lastly, differences in individuals past radiation safety experiences were not taken into account, which would have affected the ratings before and after the examination. Further studies with a larger sample size, longer follow-up, and a control group may yield more thorough findings.

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