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Improving Radiation Safety Literacy Among Healthcare Workers Through Electromedical Technology-Based Training in Padang City

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A R T I C L E I N F O

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A B S T R A C T

This study aimed to improve radiation safety literacy among healthcare workers through electromedical technology-based training as a novel educational approach. The program involved 30 healthcare workers in Padang and was conducted in a one-day session using an educational-participatory method, including lectures, Arduino-based radiation simulation demonstrations, and hands-on practice with protective equipment. Data were collected through pre-test and post-test assessments and skill observations. The results showed a significant increase in knowledge scores from 55 to 85 ($p < 0.05$) and improved practical skills. This training approach effectively enhanced participants' awareness and competence in applying radiation safety principles in healthcare settings.

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INTRODUCTION

The use of radiological equipment in healthcare facilities continues to increase along with the advancement of diagnostic technology (Aprillia, 2025). This condition requires healthcare workers to have adequate understanding of radiation safety principles in order to minimize exposure risks for both staff and patients (Behzadmehr et al., 2021). However, field observations indicate that radiation protection literacy remains relatively low, particularly among non-radiographer healthcare workers who are also involved in the use of radiological equipment. (Wally et al., 2024).

The limited availability of practical and technology-based training is one of the main contributing factors (Romli et al., 2022). Most educational activities still rely on conventional methods without incorporating interactive media, making them less effective in improving practical understanding (Chikeme et al., 2024). Therefore, an innovative approach is needed through electromedical technology-based training that can provide direct hands-on learning experiences (Nuha Febry Anisa et al., 2025).

This community service activity focuses on improving radiation safety literacy through the use of an Arduino-based simulation device designed to visualize radiation exposure in a simple and interactive manner (Aprillia et al., 2024). This approach represents the main contribution of the program, as it provides not only theoretical education but also practical experience that is easily understood by participants (Christwardana et al., 2022).

The contribution of this activity lies in the implementation of simple yet practical technology-based learning media that can be sustainably utilized in healthcare facilities (Aprillia, 2024). In addition, this activity offers novelty through the integration of electromedical technology with community service programs, particularly in the aspect of radiation safety, which is still rarely developed in the form of direct simulation (Brzozek & Karipidis, 2023).

Thus, this activity aims not only to improve knowledge but also to build awareness and enhance the skills of healthcare workers in properly applying radiation protection principles in daily healthcare practice.

IMPLEMENTATION AND METHODS

Implementation of the Activity

This community service activity was conducted at Siti Rahmah Hospital in Padang City in January 2026. The program was carried out over one day with structured sessions, including lectures, demonstrations, hands-on practice, and evaluation. A total of 30 participants were involved, consisting of healthcare workers such as nurses, medical staff, and supporting personnel engaged in the use of radiological equipment. The diverse backgrounds of participants indicated the need to improve understanding of radiation safety, particularly among those without formal training in radiology.

The activity began with an introduction to basic radiation safety concepts, followed by a demonstration of a radiation simulation device, and hands-on practice using radiation protective equipment. The program concluded with an evaluation to measure improvements in participants' knowledge and skills.

Method of Activity

The community service method applied in this activity was an educative-participatory approach that combined both theoretical and direct practical learning. This method was chosen to enhance participant engagement and to facilitate a better understanding of radiation safety concepts.

The methods used in this activity included:

1. **Lecture Method**
   Delivery of materials related to basic principles of radiation safety, biological effects of radiation, and the importance of using personal protective equipment in healthcare practice.
2. **Demonstration Method**
   Demonstrations were conducted using an Arduino-based radiation simulation device designed to provide a simple and interactive visual representation of radiation exposure levels.

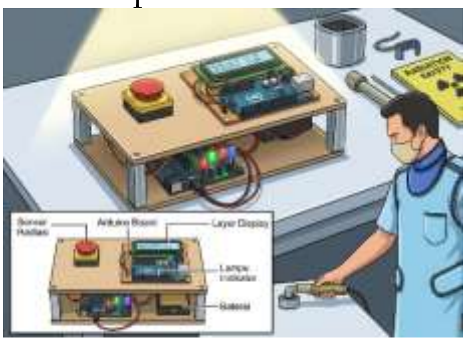

Figure 1. Arduino-Based Radiation Detection Device for Monitoring Radiation Safety

3. **Hands-on Practice Method**
   Participants performed practical exercises in using radiation protective equipment, such as lead aprons and thyroid shields, and learned safe positioning when operating radiological equipment.
4. **Evaluation Method**
   Evaluation was conducted through pre-test and post-test assessments to measure improvements in participants' knowledge, as well as direct observation to assess their skills in using radiation protective equipment.Materi Kegiatan

The materials delivered in this activity included:

a) Basic principles of radiation safety
b) Biological effects of radiation
c) Principles of radiation protection (justification, optimization, and dose limitation)
d) Use of radiation protective equipment
e) Radiation exposure simulation using an Arduino-based device

Conceptual Framework Flow:

Figure 2. Process Flow Diagram

1. **Input:**
   Healthcare workers with low radiation literacy
2. **Process:**
   Electromedical technology-based training (lectures + simulation + hands-on practice)
3. **Output:**
   Improved knowledge and skills
4. **Outcome:**
   Increased radiation safety awareness among healthcare workers

RESULTS AND DISCUSSION

The implementation of the community service activity was carried out through several structured stages, namely lectures, demonstrations, hands-on practice, and evaluation. At the initial stage, participants were given a pre-test to measure their baseline knowledge of radiation safety. Subsequently, participants attended educational sessions covering the basic principles of radiation protection, biological effects of radiation, and the use of personal protective equipment.

Figure 3. Documentation of Radiation Safety Education Activities for Participants

During the demonstration stage, the team introduced an Arduino-based radiation simulation device designed to visualize radiation exposure levels in a simple and interactive manner. Participants were then given the opportunity to engage in hands-on practice, including the use of lead aprons, thyroid shields, and proper positioning at a safe distance from radiation sources.

Figure 4. Demonstration of the Radiation Detection Device

The evaluation results showed an improvement in participants' understanding after the training. In general, there was an increase in scores from pre-test to post-test, indicating the effectiveness of the training methods used. A summary of the evaluation results is presented in Table 1, showing the relationship between participants' pre-test and post-test scores.

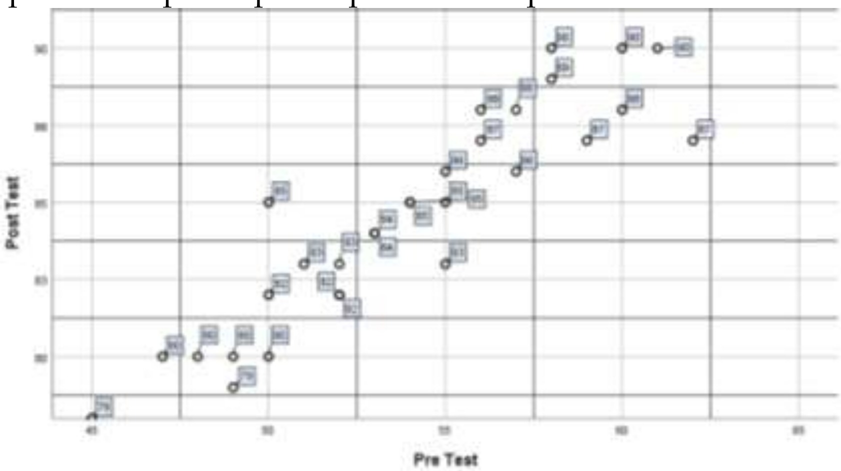

Figure 5. Relationship Between Participants' Pre-Test and Post-Test Scores

The data distribution in Table 1 indicates a positive relationship between pre-test and post-test scores. The upward trend in the distribution pattern suggests that participants with higher initial abilities tended to achieve better final evaluation scores. In addition, there was an overall increase in scores from pre-test to post-test, indicating that the applied learning methods contributed to improving participants' understanding.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre Test	.082	30	.200*	.983	30	.906
Post Test	.104	30	.200*	.959	30	.291

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 6. Results of Data Normality Test

The results of the normality test indicated that both pre-test and post-test data were normally distributed. Based on the Kolmogorov–Smirnov test, the significance values for the pre-test and post-test were 0.200 (> 0.05), respectively. Consistent results were also shown by the Shapiro–Wilk test, with significance values of 0.906 for the pre-test and 0.291 for the post-test. Since all significance values were greater than 0.05, the data met the assumption of normality, allowing the use of parametric statistical analysis such as the paired sample t-test.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre Test - Post Test	-30.600	1.668	.341	-31.298	-29.902	-89.720	29	.000

Figure 7. Results of the Paired Sample t-Test

The results of the paired sample t-test showed a significant difference between pre-test and post-test scores. The mean difference was −30.600 with a t-value of −89.720 and degrees of freedom (df) = 29. The significance value obtained was 0.000 ($p < 0.05$), indicating that the difference between the two measurements was statistically significant. The 95% confidence interval ranged from −31.298 to −29.902, further confirming an improvement in learning outcomes after the intervention. These findings indicate that the applied learning method had a significant effect on increasing participants' scores from pre-test to post-test.

Discussion

The results of the study indicate that the training activities conducted were able to improve participants' understanding of radiation safety. The increase in scores from pre-test to post-test suggests that the learning approach, which combined lectures, demonstrations, and hands-on practice, contributed positively to enhancing participants' knowledge. The experiential learning approach enabled participants not only to receive theoretical information but also to understand the application of radiation safety concepts through simulation and direct practice.

The use of an Arduino-based radiation simulation device in the demonstration activities also contributed to improving the effectiveness of the learning process. The simple and interactive visualization of radiation exposure levels helped participants understand radiation protection concepts more concretely. Learning methods that utilize simulation media are known to enhance participant engagement and strengthen conceptual understanding of the material, especially for abstract topics such as radiation exposure.

The statistical test results further support these findings. The normality test indicated that the data met the assumption of normal distribution, allowing parametric analysis to be applied. Furthermore, the results of the paired sample t-test showed a significant difference between pre-test and post-test scores, indicating that the training intervention had a significant effect on improving participants' knowledge. These findings confirm that the training method used was effective in enhancing participants' understanding of basic radiation safety principles.

In addition to the improvement in knowledge, observations during the activity also showed an increase in participants' skills in using radiation protective equipment and their understanding of safe positioning relative to radiation sources. This indicates that a learning approach integrating cognitive aspects and practical skills can provide a more comprehensive impact in enhancing radiation safety awareness and competence. Therefore, a training model based on demonstration and hands-on practice, supported by simulation media, has strong potential to be an effective strategy for radiation safety education programs in both educational settings and healthcare facilities.

CONCLUSIONS AND RECOMMENDATIONS

The radiation safety training conducted through lectures, demonstrations, and hands-on practice proved effective in improving participants' understanding. The evaluation results showed an increase in scores from pre-test to post-test, indicating an improvement in knowledge after the training. Statistical test results also demonstrated that the data were normally distributed and that there was a significant difference between pre-test and post-test scores. This indicates that the training method applied, including the use of an Arduino-based radiation simulation device, was able to enhance participants' understanding of radiation safety principles as well as the proper use of radiation protective equipment.

Recommendations

Based on the study results, it is recommended that radiation safety training programs using demonstration and hands-on practice approaches be continuously developed and implemented. The use of interactive simulation media can serve as an effective alternative learning method to enhance participants' conceptual understanding and practical skills. Furthermore, future studies are suggested to involve a larger number of participants and conduct long-term evaluations to assess the sustainability of improvements in knowledge and skills in applying radiation safety in workplace or educational settings.

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