Original Article

Individual Protection Adopted by ICU Nurses against Radiation and its Related Factors

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Abstract

Introduction: not following safety tips during mobile radiography can bring about risks for nurses in ICU wards.

Objective: the study aimed to determine the status of personal protection against radiation and its associated factors in nurses working in ICU wards of health care-educational centers affiliated with Guilan University of Medical Sciences in Rasht, Iran.

Materials and Methods: in this cross-sectional analytical study, the knowledge and performance of 142 nurses in ICU wards were examined in terms of personal protection against radiation as well as the protective equipment and facilities available through census. The data collection instruments included a research-made questionnaire and checklist. The questionnaire consisted of two sections: the first dealt with personal-occupational information, while the second section included 11 four-option questions related to knowledge about protection against radiation. For data analysis, descriptive and inferential statistical indices (mean, standard deviation, Mann-Whitney, Kruskal-Wallis, and logistic regression) were used.

Results: the findings indicated that 64.1% of samples were women, 62.7% were married, and 90.1% had bachelor's degree. Considering employment status, 52.1% were permanent employed, while 86.6% were in turn taking nurses. A total of 41.5% of samples had a working background of less than 5 years, and 97.9% of them had not participated in any course for protection against radiation. The results also indicated that most samples (62.7%) had poor knowledge about personal protection against radiation, and only 37.3% of samples had medium knowledge, and finally none of them had favorable level of knowledge. None of the ICU wards were equipped with necessary and sufficient equipment, among which only lead divider was sufficiently available in all wards. Regarding the protective performance of samples, the results showed that 100% of samples had a poor performance. There was a significant relationship between the knowledge of protection against radiation and gender (P=0.01), being married (P=0.041), and education (P=0.016). A significant relationship was also observed between the protective performance of samples and gender (P=0.011), training method (P=0.006), and age (P=0.005).

Conclusion: Considering the poor knowledge of the studied samples and inadequacy of equipment regarding protection against radiation, and in response to poor performance, training nurses and equipping the ICU wards seem to be essential.

Keywords: **Radiation Protection, Hospital Nursing Staff, Intensive Care Units**

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Introduction

In several countries, occupational hazard is one of the most important problems in the field of health [1]. It is estimated that 2.02 million work-related deaths occur around the word annually. The International Labour Organization (ILO) estimates that about 4% of world's Gross domestic product (GDP) (around 2.8 trillion dollar) is spent directly or indirectly in treating work-related injuries and diseases [2]. According to a report, the injuries and diseases of the health professionals amount to more than 418 billion annually [3]. Therefore, paying attention to occupational hazards for nurses is of great importance. One of the most important occupational threats is the ionizing radiation risk (subgroup of physical occupational hazard), particularly the x-ray risk [5, 4].

The use of ionizing radiation in medicine is inevitable for diagnosis, treatment, and research [6]. Various diseases and the need to identify them with the help of ionizing radiation have increased the number of diagnostic imaging tests. More than 80% of the patients go through radiography in the process of diagnosis and therapy. Moreover, 30% to 50% of the medical decisions, especially the critical ones, are based on radiological findings [7]. On the other hand, it is also proven that ionizing rays are harmful to humans [6]. According to recent estimates, i all the methods of reducing radiation are followed, more than 100 deaths as a result of cancer can be prevented each year [8]. Leukemia, thyroid, lung, skin, bone, and breast cancers are caused due to ionizing radiation [9].

Rays also cause serious genetic complications in the long run, which have a negative impact on future generations. The genetic mutation is more in workers exposed to radiation than normal people. Gene displacement caused by diagnostic radiation can cause human somatic mutations, causing cell death, reduced special function, and eventually cancer [10].

One of the most crucial segments of the hospital, which historically use mobile radiography to diagnose and treat diseases, is the Intensive Care Unit (ICU). Among the various methods of imaging with x-ray, mobile x-ray tests have a higher risk of exposure for the nurses, patients, and other employees. This is because mobile radiography is conducted under stressful situations with emergency patients in ICUs. This is followed by the lowest level of collaboration with nurses, radiographers, and radiography equipment, which have poor quality of radiation.

The "As Low as Reasonably Achievable (ALARA)" law, which signifies the lowest level of exposure to radiation [11, 12], has laid down rules in order to minimize short- and long-term radiation effects. According to the law, proper implementation of radiology tests, following the personal protective principles, during mobile x-ray testing, is necessary. This is applicable especially in the section that does not allow displacement or removal of patients and nurses [7]. However, this is frequently neglected. It is argued that the reasons for this negligence are lack of awareness and knowledge on the subject of personal protection against radiation and absence of early diagnostic radiation effects [7, 13, 14]. The Dianatee study in Iran [13] and Szarmach study in Poland [14] showed poor personal protection adopted by the nurses. Based on these two studies and considering the fact that most of the studies on this topic have been done in the radiography section, this study investigated the nurses' personal protection in ICU in Rasht, Iran.

Materials and Methods

In this cross-sectional descriptive study, the researchers investigated the practice of ICU nurses and personal protection facilities and equipment against radiation in the Guilan University Hospitals, Rasht.

The study consisted of all the nurses working in ICU for adults. A total of 142 participants were included (sampling was census). A self-made questionnaire and checklist were used to collect data. The content validity was confirmed after extensive literature survey and other studies [13].

The questionnaire consisted of two parts. The first part investigated demographic information (age, gender, marital status, education, work experience, employment status, job status, history of participation in training courses, annual testing related to Ray imaging, and the number of mobile photography per shift). However, the second part contained 11 multiple choice questions examining the nurses' knowledge of special care of the principles of radiation protection. Each correct answer received one point and each wrong answer received zero. Zero-4 indicated low knowledge level, 5-8 indicated average level of knowledge, and 9-11 signified good knowledge level. The checklists included two sections: The first section included a review of personal protective equipment against radiation in ICUs. This includes shields shirts, lead skirts, a lead thyroid protective aprons, protective anti-radiation glasses, and lead divider (with six items and two yes/ no options). Score 1 was given if any of these equipment were present and zero for absence. One-2 indicated poor score, 3-4 suggested average score, and 5-6 signified good score. The second part of the check list included the performance of nurses in ICU during mobile shooting with nine items of yes/ no. If any of the parameters in the list was followed by the nurses (including wearing lead gowns, standing behind divider lead, observing a distance of two meters from the radioactive source, standing behind radiology technicians equipped with a lead shield, staying in the section during mobile radiography), score 1 was awarded. Score 0 was given Otherwise. 1-3 indicated poor score, 4-6 indicated average score, and 7-9 meant a good score. Thirteen members of the faculty of nursing and radiology examined it. The CVR and CVI indexes were determined as higher than 70% and 1, respectively. To examine reliability, 20 participants completed parallel test with two weeks interval. With two different formats of questionnaire the mean for the first format was 4.6 ±1.93 and 4.45 ± 1.82 for the second format. The Pearson correlation showed a high correlation (r: 0.983, p = 0.0001). Based on the paired sample T-test, no significant difference between the samples (p = 0.08) was identified. Kuder-Richardson's 20 results showed 94.5% displaying high internal consistency. To investigate the checklist reliability, Interclass Correlation Coefficient (ICC) method was used with 20 samples. The Kappa results showed a reliability of 100% (Kappa = 1).

All the participants were informed of the principles and objectives of the research and data confidentiality, and then the consent form was filled. The participants were free to withdraw from the study if they wished. SPSS Software (version 21) was used to analyze the data using descriptive (mean and standard deviation) and inferential (Mann Whitny, Kruskal–Wallis, Logistic regression) statistics. The level of significance was considered to be 0.95%.

Results

The results showed that 58.5% of the participants were aged between 30 and 40 years, with 64.1% female. A total of 62.7% were married and 90.1% had a bachelor degree. 52.1% were officially employed, and 86.6% were turn-taking nurses. The mean of work experience was 7.2± 5.2. A total of 41.5% of the samples had working experience of less than five years. A total of 97.7% of the participants did not participate in training courses in radiography damages. Furthermore, 59.2% mentioned participation in the training

Table 1: Distribution of studied samples according to their performance status separated by protection items (N = 132)

Observed performance	Unfavorable performance	favorable performance
	N (%)	N (%)
Use of Lead divider	119 (90.2)	13 (9.8)
Not to get out at time of radiation from the ward	59 (44.7)	73 (55.3)
Get away from the care setting for a maximum of 1 minute	199 (14.4)	113 (85.6)

Table 2: The relative chance of knowledge related factors for personal protection against radiation

Variables	Regression coefficient	Standard error	Sig.	Odds ratio	CI 95%	
					Lower	Upper
Men compared to women	1.10	0.43	0.01	3.02	0.30	7.02
Married to single people	0.84	0.41	0.04	2.33	1.03	5.24
Master's Degree relate to Bachelor's Degree	1.99	0.83	0.01	7.33	1.44	37.29
Constant	-0.70	0.34	0.04	0.49		

courses as the most efficient method for gaining useful information. However, 76.1% believed that blood test and periodical check-ups in the hospital are not compulsory. A total of 52.4% of the samples argued that they are exposed to mobile radiography two or three times per shift.

These findings suggested that the majority of the samples (62.7%) had poor knowledge in the field of personal protection against radiation. However, 37.3% of the participants had a moderate knowledge level and none of them had the desired information about protection against rays. The results showed that 100% of the samples had weak protection performance. The results in Table 1 reveal that none of the samples used protective lead shields during the mobile photography. The standard distance (2m) was not observed from the radiation source. The desired performance was showed only by the presence in the section during mobile photography and going away from the care environment during radiation up to one minute. Of all the personal protective equipment against radiation, only the lead divider was sufficient in all the sectors. The mean of individual protection against radiation facilities was equal to 1 in these sectors. The performance was weak in terms of rating.

Based on the findings, it was observed that gender (P=0.01), marital status (P: 0.041), and educational background (P = 0.016) were the most important predictive factors associated with the awareness of the nurses. More men, as compared with women (OR=3.02, CI: 0.95 1.30-7.02), had scores above the average. Married individuals (OR=2.33, CI 0.95: 1.04-5.2) and those with a master's degree had higher levels of awareness (table2).
In the case of predicting variables regarding the sample's performance in the field of personal protection against radiation, the results showed that there was a significant relationship between gender

Table 3: Relative chance of performance related factors for personal protection against radiation

Variables	Regression coefficient	Standard error	Sig.	Odds ratio	CI 95%	
					Lower	Upper
Men compared to women	1.33	0.52	0.01	3.79	1.36	10.57
Training method			0.06	.	.	.
Participation in the class than other methods	0.831	0.72	0.05	3.99	0.1	16.60
Studying books and pamphlets in comparison with other methods	1.884	0.81	0.02	6.58	1.33	32.42
Age	-0.124	0.04	0.005	0.88	0.81	0.96
Constant	1.618	1.56	0.30	5.04	.	.

(P = 0.011), method of training (P = 0.006), and age (P = 0.005). This is because women had a more favorable protective function (OR=3.79, CI 0.95: 1.36-10.57). Others variables were shown in table3.

Discussion

Results of the present study showed that the majority of cases had low levels of knowledge regarding personal protection against rays. These findings are in line with the study results of Dianatii et al. These results showed that the nurses in the ICU section have low levels of knowledge, especially when they leave the patient during radiography. It can lead to mechanical ventilation stoppage, hypoxia, and ultimately to death of the patient [13]. The results of this study are also in line with the results of study conducted by Szarmach et al., where they found that among the samples (physicians, radiology technicians, and others), nurses suffered from the lowest level of knowledge [14]. However, the results of this study were against those of Davoodian Talab et al. They found that the average score for knowledge of the participants was in moderate level [15].While Shah in Pakistan showed the mean score of samples knowledge was favorable [16]. It seems that the low level of knowledge of nurses in the ICU section of Guilan hospitals may be due to the fact that they have never participated in a training course.

The results showed that none of the participants at the time of study was equipped with film badge (as a necessary protective tool against rays). Zahery et al.'s study conducted showed that none of the film badges recorded exceeded rays [17]. The results of Heydari's study showed that the ray dosage was lower than the standard level. According to ALARA and due to the fact that the employees in the hospital did not use radiation recording equipment and dressing lead, there was no specific genetic damage mentioned. However, the employees were suggested to use film badge during fluoroscopy and mobile radiography in order to prevent danger [18].

As far as the protective function of the samples was concerned, the study results showed that 100% of the participants had poor performance during radiography in the ICU. Majority of the nurses completely left the section and tended to go to the break room or hallway inside the section. In both the cases, monitoring and taking continuous care of the patients were interrupted. These results are similar to the results of Dianati et al.'s study [13].The results of this study highlighted the cause of such behavior as the lack of knowledge of standard distance (2m) from the ray source. It also showed the low level of awareness of individual protection against radiation of ICU nurses. This can have serious consequences for patients, including reduction or interruption in the care-taking process. Patients depending on the mechanical ventilation system can suffer from sudden obstruction in the paths, followed by complications such as hypoxia, increased length of stay in the intensive care unit, and even death.

Moreover, one of the most common problems of hospitalized patients in ICU is hospital infections. Therefore, it is better to treat ICU like an operation room, and sterilize and control the entry and exit of personnel [19].

Similarly, the results showed that few participants used lead divider during mobile photography and never used protective shields. These results consisted by Dianatee[13] and Tohidnia[7]. According to the results of this study, it seems that deficiency or defect in equipment, such as shields lead, in ICU can be the reason for not using this equipment by nurses. However, the divider lead is one of the protective equipment present in sufficient numbers in all the sections. Low awareness and lack of confidence in using this equipment in photography and difficulty in handling heavy equipment are among reasons for not using lead divider by the nurses. Flor et al. sighted heavy weight in their study as one of the reasons for feeling uncomfortable and not using the protective equipment at the time of angiography [20].

In this study, gender, marital status, and education showed a significant association with knowledge of personal protection against radiation. Although the results of Davoudian talab et al. revealed that there is a direct relationship between education and knowledge of the principles of protection, there was no relationship between gender or marriage and awareness of the principles of radiation protection [15]. According to Chaparian et al., there was no significant relationship between gender or marital status and knowledge of the principles of radiation protection [21]. However, in the present study, married participants had higher knowledge compared to those who are single. This may be related to child-bearing and radiation hazards associated with this field. In this study, no significant relationship was found between the working experience and knowledge of personal protection against radiation. This finding was similar to the results of Davvod talab et al. [15]. In the Szarmach study, one of the factors related to radiation protection knowledge was the participants' working experience. People with working experience between one and five years had higher knowledge of radiation protection [14]. However, Shah et al. showed that participants with 6-20 years of working experience had a higher level of knowledge compared to the other groups [16]. In the present study, there was a significant relationship between the training and protection function. The participants who opted for attending classes to gain information in the field had higher protective function. According to Davoudian Talab et al., there was a significant relationship between the training in the form of lectures and class participation and personal protection against radiation [15].

Furthermore, in this study, a significant association was found between gender and

protection function. Here, women displayed a more favorable performance than men. The findings showed that with aging, the chance of having a score above average performance reduces. But, the DavoudianTalab and Chaparian studies showed that there was no significant association between age and gender and protection function [15, 21]. However, the results of Tohidnia study showed that men had higher protective performance as compared to women [7].

According to the results of this study, it is necessary for all health centers in the country to protect employees and other people against radiation, so that the risks can be controlled as much as possible. These results suggest that radiation protection as significant occupational hazards should be embedded in the nursing professional education, especially for ICU nurses. Moreover, much of the low performance of nurses is due to deficiency in protective equipment. Therefore, it is recommended that this equipment should be provided and available in sufficient numbers for nurses. The limitations of this study can be the presence of the researcher as observer, which can affect the performance of the samples.

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Author contributions
All authors have agreed on the final version and meet at least one of the following criteria [recommended by the ICMJE (http://www.icmje.org/recommendations/):

-Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;

-Drafting the article or revising it critically for important intellectual content.

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