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Original Research Article

Effect of Structured Training Program on Knowledge Regarding Radiation Safety Practices among Technical and Supporting Staff Handling Portable X-Ray Machines at a Tertiary Care Hospital in Garhwal Region of Uttarakhand

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Abstract:

Context: Portable radiography devices are utilized routinely for radiological examinations who are hospitalized, necessitating healthcare workers to possess knowledge and follow radiation safety practices.

Aims: The study was conducted to determine the effect of structured training program on knowledge regarding radiation exposure and its preventive measures among technician and supporting staff while working on portable X-ray machines in indoor settings.

Subject and Methods: A hospital based cross-sectional study was conducted among radio-technicians, nursing officers and supporting staffs who were directly involved in the process of handling and operation of portable x-ray machine. A pre-tested semi structured questionnaire was administered to all healthcare workers who consented to participate. Radiation safety practices were assessed using observatory checklist. The knowledge and practices were reassessed after three months of structured training program.

Statistical analysis used: The difference in pre- and post-training knowledge and practices was assessed using paired t-test, and McNemar's test was used for paired categorical data analysis. $P < 0.05$ was considered to be statistically significant.

Results: Of 60 subjects enrolled in study, 22 (36.6%) were radio technicians, 20 (33.3 %) nursing officers and 18 (30.0%) were supporting staffs. Baseline knowledge score of radiation hazard and radiation protection was found significantly higher among radio technicians (7.27±2.45) as compared to nursing officer (6.28±2.01) and the supporting staff (5.31±1.20). Post-training knowledge scores were significantly higher among nursing officer and supporting staffs as compared to baseline. Favourable change in practices of supporting staff for use of thyroid shield and lead gloves was observed.

Conclusions: Portable radiological examinations did not expose healthcare providers to high doses of ionizing radiation. Nurses' radiation protection knowledge was limited and hence, they require in-service education programs.

Keywords: Radiation safety, practices, structured training program, healthcare worker, and portable radiological machines.

Introduction

Radiation exposure remains a significant occupational hazard in healthcare. Epidemiological studies on populations exposed to radiation showed a significant increase of cancer risk at doses above threshold of 100 mSv/yr. [1] Technical and supporting staff involved in operating portable X-ray machines are particularly vulnerable because of their direct proximity to the radiation source. Many patients are admitted in units where they are typically linked to various medical devices, with numerous catheters and tubes in place. Consequently, transferring them to the radiology unit for radiological examinations is not feasible. Hence, radiological examinations in indoor settings are usually performed by using portable radiography devices. The use of these portable devices in isolation wards was evident in the recent concluded global COVID-19 pandemic. Portable radiological examinations dramatically increase healthcare worker's exposure to ionizing radiation. [2,3]

Despite the undeniable advantages of portable X-ray machines in terms of mobility and convenience, it's crucial to emphasize the need for comprehensive knowledge and strict adherence to preventive measures due to the potential health risks associated with radiation exposure. The studies related to knowledge and practices regarding radiation protection while using portable devices are minimal in Indian context.

Even no single study could be retrieved in Indian scenario that highlighted the effect of radiation safety training on adaptation of preventive measures among healthcare workers, particularly those working with portable X-ray machines in indoor settings. Understanding their level of knowledge and awareness in this specific context is crucial for ensuring adequate radiation protection protocols and enhancing the overall safety culture. By addressing these gaps, we can strive towards a safer work environment and promote a culture of radiation safety in healthcare facilities. Therefore, the study was conducted to evaluate the effect of structured training program on knowledge regarding radiation exposure and its preventive measures among technical and supporting staff while working on portable X-ray machines in indoor settings.

Material and methods

Study Design: Hospital Based Cross-sectional study

Study Settings: HNB Base Teaching Hospital, Veer Chandra Singh Garhwali Government Medical Science and Research Institute, Srinagar

Study Duration: Duration of study was from July 2021 to June 2022

Study Population: Healthcare worker (Radio-technicians, Nursing Officer and other supporting staff/ ward attendants)

Sample size & Sampling Method: Complete enumeration process was used for sampling. The healthcare workers (Radio-technicians, Nursing Officer and supporting staff) involved in the process of portable X-Ray machine handling and radiographic procedure were included in the study. The healthcare worker who refused to consent was excluded from the study.

Tool: A pre-tested semi-structured questionnaire was used for the study. It consisted of three section. First section was regarding demographics, household characteristics and baseline knowledge regarding radiation exposure. Second section consist of awareness of radiation hazard and radiation protection questionnaire having ten objective questions on principle of radiation protection (2 questions), information about dosimeters (2 questions), quality and material used for making individual protective devices (3 questions), organs effected (1 questions) by radiation and permissible doses of radiation (2 questions).

The section of questionnaire was prepared in consultation with expert and was pilot tested before use. Score of one was given to each correct response and total score was calculated. Third section was an observatory checklist for assessing the preventive measures practiced by the health workers. A minimum of three observations were made on each study subject at three instances both before and after training. The healthcare worker found not adhering to set standard protocol in any of the three observations, was considered non-compliance to radiation safety practices. However, it was always assured and intervention was immediately done for any unfavorable non-compliant practices before the x-ray machines start to avoid any type undue radiation exposure. A structured training program was conducted through lectures, job aids and onsite demonstration. The knowledge and practices were reassessed after three months of training using questionnaire and observatory checklist.

Data Analysis: Data were compiled and analysed using the statistical software. The significant difference between the baseline and post-training knowledge score among three categories of healthcare professional was assessed using ANOVA (Analysis of Variance). Any significant changes in knowledge pertaining to various aspects of radiation safety related practices before and after structured training programme were assessed using paired t-test and McNemar's test. A p-value of $\leq$ 0.05 was considered statistically significant.

Ethical Issues: Ethics approval was obtained from Institutional Ethics Committee of the Veer Chandra

Singh Garhwali Govt. Medical Science and Research Institute, Srinagar India before conducting the study. Ascent/consent will be taken from participant before the interview.

Results

A total 60 study participants were enrolled in the study who were directly involved in the process of handling and operation of portable x -ray machine in which 22 (36.6%) were radio technician, 20 (33.3 %) were the nursing officer and 18 (30.0%) were supporting staff including attendant. Around 56.4% of the study participants were males and 43.3% were females. About one-third (35.0%) of the study participants had experience of working with portable x-ray machines between 1-3 years. Almost half of the study participants received any formal training on radiation exposure hazards and prevention, among which 56.3% received training more than three years ago. [Table no. 1]

Knowledge about radiation protection and preventive measures was found to increase significantly after structured training program. Knowledge regarding highest permitted level of occupational radiation exposure, place for installing barrier to protect staff against radiation, methods enhancing radiation safety were found to increase significantly after structured training program among all staff including radio technician, nursing officers and supporting staff /attendant. However, no significant effect of structured training program was observed among radio technician regarding best material for manufacturing protective equipment, about safe distance from source of radiation while performing portable radiography. Also, no significant change was observed after training among nursing officer in respect to their knowledge regarding dose or quality of portable x-ray radiography and knowledge about best protective equipment in case of any environmental radiation exposure. The most favourable effect was observed among supporting staff whose knowledge increase significantly among all the domains of radiation safety and preventive measures. [Table no. 2] Baseline knowledge score of radiation hazard and radiation protection was found significantly higher among radio technicians (7.27±2.45) as compared to nursing officer (6.28±2.01) and the supporting staff (5.31±1.20).

However, no such difference was observed in post-training program. Post-training knowledge scores were significantly higher among nursing officer and supporting staffs as compared to the baseline scores. [Table no. 3]

The most favourable finding of the study was that all (100%) of the study participants involved in operation of portable x-ray machine were at least wearing the lead aprons or used to stand behind screening wall at the time of procedure.

Also, for other domains of practices (wearing thyroid shield, lead gloves and use of TLD badges), almost all the radio technician and nursing officer were following satisfactory radiation protection practices.

Therefore, no significant change was observed after structured training program. However, change in proportional (in terms of number of individuals) increase was observed among paramedical staff for practices concerned with radiation safety measures.

On the other hand, structured training was found to have favourable effect on supporting staff for use of thyroid shield and lead gloves for radiation protection. [Table no. 4]

Table 1: Distribution of study population on the basis of sociodemographic characteristics and job profile (N=60)

Sociodemographic Characteristics and Job profile	Number	Percentage (%)
Age-group (in years)		
20-30	23	38.3
31-40	21	35.0
More than 40 years	16	26.6
Gender		
Male	34	56.6
Female	26	43.3
Educational Qualification and designation		
General Nursing & Midwifery (GNM) /BSc Nursing (Nursing officer)	20	33.3
BSc Radio-technicians (X-ray technicians)	22	36.6
Intermediate and below (Supporting staff/attendants)	18	30.0
Total experience on working with portable x-ray machine (in years)		
<1	12	19.3
1-3	21	35.0
4-6	13	21.6
7-9	11	18.3
10 years and above	3	5.0

Received any formal training on radiation exposure hazards and prevention		
Yes	32	53.3
No	28	46.6
If yes how long before training was received (n=32)		
< 3 Years	14	43.7
≥ 3 Years	18	56.3

Table 2: Comparison of knowledge of healthcare worker before and after the structured training program (N=60)

Knowledge about radiation protection		**Radio Technicians (n=22)**			**Nursing officer (n=20)**				**Supporting staff/attendants (n=18)**			
		Post-training			**Post-training**				**Post-training**			
		Yes	No	#p		Yes	No	#p		Yes	No	#p
Highest permitted level of occupation radiation exposure												
Pre-training	Yes (n=17)	17 (100)	0 (0.0)	**0.04***	Yes (n=	12 (100)	0 (0.0)	**0.01***	Yes (n=5)	5 (100)	0 (0.0)	**0.001***
	No (n=5)	4 (80.0)	1 (20)		No (n=8)	6(75)	2(25)		No (n=13)	10 (76.9)	3 (23.0)	
Total		21	1			18	2			15	3	
Best place for installing barriers to protect technical and supporting staff against radiation												
Pre-training	Yes (n=12)	12 (100.0)	0 (0.0)	**0.002***	Yes (n=	12 (92.3)	1 (7.6)	**0.03***	Yes (n=8)	8 (100)	0 (0.0)	**0.008***
	No (n=10)	9 (90.0)	1 (10)		No (n=7)	7 (100.0)	0 (0.0)		No (n=1	7 (70.0)	3 (30.0)	
Total		21	1			19	1			15	3	
Best material for manufacturing protective clothes												
Pre-training	Yes (n=18)	18 (100.0)	0 (0.0)	0.15	Yes (n=	12 (100)	0 (0.0)	**0.01***	Yes (n=6)	6 (100)	0 (0.0)	**0.008***
	No (n=4)	2 (50.0)	2 (50)		No (n=8)	6 (75.0)	2 (25.0)		No (n=1	7 (58.3)	5 (41.6)	
Total		20	2			18	2			13	5	
Methods that enhance radiation safety												
Pre-training	Yes (n=12)	12 (100.0)	0 (0.0)	**0.008***	Yes (n=	12 (100)	0 (0.0)	**0.08***	Yes (n=7)	7 (100)	0 (0.0)	**0.02***
	No (n=10)	7 (70.0)	3 (30.0)		No (n=8)	6 (75.0)	2 (25.0)		No (n=1	5 (45.4)	6 (54.5)	
Total		19	3			19	1			12	6	
Dose and the quality of portable radiography compared with other imaging procedures												
Pre-training	Yes (n=11)	11 (100.0)	0 (0.0)	**0.008**	Yes (n=	16 (94.1)	1 (5.88)	0.56	Yes (n=1)	1 (100)	0 (0.0)	**0.0005****
	No (n=11)	7 (63.6)	4 (36.36)		No (n=3)	2 (66.6)	1(33.33)		No (n=17)	12 (70.5)	5 (29.41)	
Total		18	4			18	2			13	5	
Best protective equipment for technical and supporting staff during portable radiography												
Pre-training	Yes (n=18)	18 (100.0)	0 (0.0)	0.31	Yes (n=	15 (100)	0 (0.0)	**0.08***	Yes (n=6)	6 (100.)	0 (0.0)	**0.02***
	No (n=4)	1 (25.0)	2 (50)		No (n=5)	3 (60.0)	2 (40.0)		No (n=1	5 (41.6)	7 (58.3)	
Total		19	3			18	2			13	7	
Safe distance from the source of radiation when performing portable radiography												
Pre-training	Yes (n=18)	18 (100.0)	0 (0.0)	0.15	Yes (n=13)	12 (92.3)	1 (7.6)	**0.01***	Yes (n=8)	8 (100.0)	0 (0.0)	**0.01***
	No (n=4)	2 (50.0)	2 (50.0)		No (n=7)	5 (71.4)	2 (28.5)		No (n=10)	6 (60.0)	4 (40.0)	
Total		20	2			17	3			14	4	
Best protective equipment in case of any environmental radiation exposure												
Pre-training	Yes (n=14)	14 (100.0)	0 (0.0)	**0.004***	Yes (n=	12 (100.0)	0 (0.0)	0.15	Yes (n=9)	9 (100)	0 (0.0)	**0.01***
	No (n=8)	8(100.0)	0 (0.0)		No (n=8)	2 (25.0)	6 (75.0)		No (n=9)	6 (66.6)	3 (33.3)	
Total		22	0			14	6			15	3	

#McNemar's test, *p<0.05 (considered as significant)

Table 3: Comparison of radiation hazard and radiation protection score of healthcare personnel before and after structured training program

Radiation hazard and radiation protection score (Mean±SD)	Radio Technicians (n=22)	Nursing officer (n=20)	Supporting staff/attendants (n=18)	$^{\#\#}$p-value
Pre-training	**7.27±2.45**	**6.28±2.01**	**5.31±1.20**	**0.012***
Post-training	**8.40±1.32**	**8.12±2.20**	**7.22±2.11**	**0.139***
$^{\#}$p-value	0.06	**0.006***	**0.002***	

$^{\#}$paired t-test, $^{\#\#}$ANOVA, *p<0.05 (considered as significant)

Table 4: Comparison of radiation protection practices of healthcare worker before and after the structured training program (N=60)

Radiation protection practices		Radio Technicians (n=22)			Nursing officer (n=20)				Supporting staff/attendants (n=18)			
		Post-training			Post-training				Post-training			
		Yes	No	$^{\#}$p		Yes	No	$^{\#}$p		Yes	No	$^{\#}$p
Use of lead apron/standing behind screened wall@												
Pre-training	Yes (n=22)	22 (100)	0 (0.0)	**NA**	Yes (n=22)	22 (100.0)	0 (0.0)	**NA**	Yes (n=22)	22 (100)	0 (0.0)	**NA**
	No(n=0)	0 (0.0)	0 (0.0)		No (n=0)	0 (0.0)	0 (0.0)		No (n=0)	0 (0.0)	0 (0.0)	
Total		22	0			22	0			22	0	
Using of thyroid shield												
Pre-training	Yes (n=21)	21 (100)	0 (0.0)	0.31	Yes (n=18)	18 (100.0)	0 (0.0)	0.15	Yes (n=12)	12 (100)	0 (0.0)	**0.02***
	No (n=1)	1 (100)	0 (0.0)		No (n=2)	2 (100.0)	0 (0.0)		No (n=6)	5 (83.3)	1 (16.6)	
Total		22	0			20	0			17	1	
Using of lead gloves												
Pre-training	Yes (n=20)	20 (100)	0 (0.0)	0.15	Yes (n=18)	18 (100.0)	0 (0.0)	0.15	Yes (n=12)	12 (100)	0 (0.0)	**0.02***
	No (n=2)	2 (100)	0 (0.0)		No (n=2)	2 (100.0)	0 (0.0)		No (n=6)	5 (83.3)	1 (16.6)	
Total		22	0			20	0			17	1	
Using dosimeters (TLD devices)												
Pre-training	Yes (n=20)	20 (100.0)	0 (0.0)	0.31	Yes (n=19)	19(100)	0(0)	0.31	Yes (n=15)	15 (100.0)	0 (0.0)	0.31
	No(n=2)	1(50.0)	1(50.0)		No(n=1)	1(100.0)	0(0.0)		No(n=3)	1(33.3)	2(66.6)	
Total		21	1			20	0			16	2	

$^{\#}$McNemar's test,*p<0.05 (considered as significant), @ No change was observed

Discussion

The study primarily examined the baseline radiation protection knowledge and practices among paramedical and supporting staff involved in handling and usage of portable x-ray machines. Good knowledge of healthcare worker was observed in present study, which is quite comparable with the findings of the previous studies conducted in India [4, 5] and at global level [6,7]. In contradiction to that, when compared to the findings of few other studies which reported lack of knowledge in 60-80% of study subjects for various aspects (source, benefits, potential harm, and preventive measures) of radiation protection, knowledge of the healthcare worker in present study was found to be much higher. [2, 8, 9,10]. Dianati M., in their study conducted in Iran opined that this variation in radiation protection knowledge could be attributed to difference in institute-based and in-service educations about radiation safety and protection at different parts of world [2].

In the present study almost all the radio technician and nursing officer were found to have satisfactory radiation safety practices. This favourable behaviour might be attributed to their good knowledge. Similar findings were also reported in previous studies, where most of the paramedical staff were adhered to radiation protection strategies like using all protective equipment including Thermo luminescent dosimeter (TLD) devices. [11, 12]

Ideally the healthcare worker should be positioned as far as possible, away from the generator (X-ray tube), to reduce the exposure. The procedure should be done in isolated designated settings, but the same situation couldn't be adhered always, specially using portable x-ray machines like in intensive care units or operation theatres. Through structured training and complying with the standard protocol, one can avoid exposure. Similar to the findings reported in previous studies, knowledge about the radiation hazards and protective measures were found to increase proportionately in the present study after formal structured training program. [13,14,15]

This reflects that, even a short exposure to educational programs enhances practices and behaviours related to radiation protection, drawing upon knowledge of ALARA (as low as reasonably achievable) principles and their practical application. [16] Alavi et al., and Luntsi G, et al. also concluded that providing healthcare workers with in-service training that aligns with their educational needs, using qualified and current materials, enhances their practices. [10, 17] The consultation initiated by the IAEA also underscores that embracing a comprehensive approach to education and training in radiation protection would result in the qualification and competence of healthcare professionals. This, in turn, enables the application of stringent standards for quality and safety in the medical utilization of ionizing radiation. [18]

In present study, apart from theoretical classes onsite demonstration were done in the practical settings to sensitize for radiation protection practices in healthcare. In concordance with the same, in a previous research work it was suggested that optimal workplace training occurs from personalization to the target audience rather than reliance on traditional, theory-based learning methods. [19] In present study, structured training was found to have favourable effect on supporting staff and attendants for use of thyroid shield and lead gloves for radiation protection. Also, almost all the radio technician and nursing officers were complying to satisfactory radiation safety practices. Jadhav VT., in their study opined that this was perhaps because of the fear of radiation motivating them either ignorantly or intentionally adopt good radiation protection practices. [4]

Limitations of study: The study had limited sample size and hence the finding should be interpreted in the light of fact that the healthcare workers included were those involved in portable X-Ray machine handling and radiographic procedure. Since the study was conducted in single institute, its generalizability is quite limited. No reliable literature could be retrieved that assessed the knowledge and practices regarding radiation safety practices among supporting staffs, an important stake holder at every hospital.

The non-availability of previous research in context to supporting staffs limits any type of comparison with findings in context to supporting staff.

Conclusions

The implementation of a structured training program could be a pivotal step towards elevating radiation safety practices among the supporting staff in hospitals. This paper has delved into the multifaceted benefits of such programs, emphasizing their role in imparting comprehensive knowledge, instilling a culture of safety, and fostering continuous learning among healthcare professionals.

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