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ORIGINAL ARTICLE

Radiation Safety Awareness amongst Staff and Patients in the Hospitals

ALI DEHGHANI[1*], MOHAMMAD RANJBARIAN[1], ARASH MOHAMMADI[2], MANSOUR SOLEIMAN ZADE[2], and ALI DADASHPOUR AHANGAR[3]

[1,2] Department of Occupational Health Engineering, School of Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran; [3] Department of Occupational Health Engineering, Faculty of Medicine, Tarbiat Modaress University, Tehran, Iran.

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ABSTRACT

This study aimed to evaluate the radiation safety condition and the level of radiation-awareness amongst staff and patients in 18 hospitals of Shahid Beheshti University of Medical Sciences, Tehran, Iran. This descriptive, cross–sectional study was administered to patients and personnel, also making a review on the radiation-safety status in the hospitals. In evaluating the level of awareness, 218 patients and 173 staff took part in the survey. A12-question inventory was used for evaluating radiation-safety status. In addition, 2 questionnaires including 15 and 6 questions were used in order to evaluate the level of radiation awareness among staffs and patients respectively. The questionnaires used included personal and general questions and its validity and reliability had been confirmed (Cronbach's alpha=0.711). The results have shown 71.1% good radiation-safety awareness among staff. Moreover, the level of staff awareness was not associated with educational level, gender, field of study, age and job experience. Conversely, only 6% of the patients have shown a good awareness level. In addition, as it depicted by the results there was a significant relation between awareness level and age (P<0.017), job (p<0.000) and educational level (p<0.004). Furthermore, the radiation safety status in 5 medical nuclear center and 18 radiology facility was 70% and 74%, in turn. Unfortunately, radiation safety awareness is generally inadequate among radiologists and particularly poor in patients. The authors firmly recommend that patients should have more practical training and information available in this context.

Keywords: *Awareness, Radiation Protection, Radiation Center, Safety Status, Staff*

INTRODUCTION

Radiation exposure from medical procedures is a threat to health affecting millions worldwide. As can be seen by the recent report of the National Council on Radiation Protection and Measurements (NCRP), twofold increase in the total exposure to ionizing radiation in the USA over the past 20 years become a major concern. Moreover, in 2006, about half of total ionizing radiation exposure was the result of medical imaging [1]. Regrettably, the occurrence of radiation exposure from a medical procedure will continue to increase at an exponential rate for many causes.

Firstly, ever-advancing imaging technology has enabled physicians to evaluate both the anatomy and function using x-ray and nuclear medicine-based techniques, both of which are noteworthy radiation sources. Second, physicians' dependence on medical imaging for patient management is in high level. Finally, patients are demanding more testing for reassurance of accurate diagnosis and treatment [2]. In spite of ever-growing radiation usage, patients are not

*** Corresponding author:** Ali Dehghani, Email:Dehghani.herfee @gmail.com

Table 1. Radiation safety awareness level among staff

Variables	Group (N)	Mean	SD	*p-value*
Gender	Male (71)	11.8	0.65	0.805
	Female (102)	11.1	0.5	
Age (yr)	20-30 (78)	10.8	0.83	0.487
	31-40 (49)	11.6	0.55	
	41-50 (36)	11.5	0.50	
	50< (10)	11	0.51	
Educational level	Diploma (4)	9.5	0.57	0.397
	AD (30)	10.94	2.55	
	B. Sc (126)	11.17	2.3	
	Post grad- (13)	12	1.92	
Field of study	Radiology (130)	11.07	0.57	0.892
	Medical physics (11)	11	0.55	
	Nuclear engineering(22)	11.7	0.70	
	Others (nurse) (10)	10.6	1.02	
Job tenure	<5 (64)	10.8	0.62	0.561
	5-10 (37)	11.46	0.58	
	11-15 (36)	11.4	1.00	
	16-20 (14)	10.4	0.80	
	21-25 (14)	10.6	0.47	
	25< (14)	10.9	0.65	

appropriately informed about radiation level they are exposed to when experiencing a radiological examination [3]. Lee et al. [4], reported that almost all patients experiencing CT scans were not informed about the radiation risk. This may be partially demonstrated by lacking the knowledge among referring doctors concerning the radiation dose of commonly carried out examinations [5-7], despite years of clinical experience [8-10]. Working in hospitals and medical institutes has effects on the personnel's health. In the United States, daily 9000 health care provider experience occupational related injuries [11]. Furthermore, 75% of the reports propose that the hospital staffs in England are exposed to deleterious factors and 17% are vulnerable to a number of work-related diseases [12].

Since ionizing radiations and other dangerous agents exist in hospitals, serious care is necessary for protecting both the staff and the patients [13].

However, to date, limited study has been done to estimate radiation knowledge among staff or patients. This study was conducted to investigate the staff and patients' awareness and radiation-safety condition in Shahid Beheshti University of Medical Sciences (SBMU) hospitals, Tehran, Iran in order to find out the deficiencies and improve the condition.

MATERIALS AND METHODS

The study adopted a descriptive, cross-sectional design with self-administered questionnaires to assess the level of awareness and attitude of radiation safety in the hospitals of SBMU. In order to evaluate the level of radiation awareness, the questionnaire was distributed to the study population comprising 173 personnel of Radiology imaging and Nuclear Medicine centers of 18 hospitals. In addition, 218 patients completed the questionnaire. Moreover, in order to assess the radiology facility radiation status, we used an inventory, which included 12 questions based on safety standard of Atomic Energy Organization of Iran.

All items of the inventory were observed by the researchers at hospitals. The assessed item was either supplied (yes) or not supplied (no). Right answer was scored one mark, while an incorrect answer or omission received a mark of 0. The summation of all score of items in the checklist indicated the overall safety outcome. Moreover, 2 questionnaires (radiation safety knowledge) including 15 and 6 questions were used in order to evaluate the level of radiation awareness among staff and patients respectively. The questionnaires used in this study included personal and general questions

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and its validity and data collection was performed by completed checklists impartially.

Statistical reliability had been confirmed (Cronbach's alpha =0.711). At the beginning, the legal procedures and hospital manager's consultation were performed. The analyses were performed using SPSS version 17.0 (Chicago, IL, USA). The data was analyzed by inferential statistics and ANOVA test. The P values were set at < 0.05.

RESULTS

Totally, 173 staff & 218 patients, participated in survey, had returned their questionnaires out of 420 sent. The demographic characteristics of these participants are provided in Tables 1 and 2. As shown in the Table 1, of the 173 personnel, 71 (41%) were male and 102 (59%) were female, the age of participants ranged from 20–57 years with a mean age of 34.28 (SD: 7.7) and 75.1% subject's field of study were Radiology. In addition, the Table 2 demonstrated the patients proportion, of the 218 participants, 124 (56.9%) were male and 94 (43.1%) were female, the age of participants ranged from 18–71 years with a mean age of 24.8 (SD: 15.7), moreover a large number of them (36.7%) were self-employment. Additionally, the education level of patients was relatively high (77.5% participants were received university or above education, 13.8%, AD; 57.8%, BSc and 6%, post grad).

Table 1 depicts the level of staff radiation safety knowledge. There was not any significant relation between radiation-safety knowledge and age, gender, field of study and level of education (p>0.05). Here, the maximum score was 11.46; in addition, radiation safety awareness was at a good level. In other words, 71.1% had good awareness; conversely, 8% had the worst level. In addition, the medium level included 21%.

Statistical analysis of these data showed a significant difference between the patient's radiation-safety score and their level of education (p<0.004), job type (p<0.000) and age (p<0.017) (Table 2). In addition, while 5% of patients have shown good awareness, the majority of them lacking the awareness namely, 58% and the others have shown a median level, 37%.

The radiation safety status was compared in 18 hospitals of SBMU based on safety standard of hospital radiology and nuclear centers (Fig. 1). As statistical test has shown the difference of safety statuses among hospitals of SBMU was significant (p<0.001).The scores shown that 3 hospitals had the highest level of radiation safety namely 10, and the lowest radiation safety score was 4.

DISCUSSION

According to results of this investigation, radiation safety awareness is generally inadequate among employees and particularly poor in patients. There are plenty of studies done on occupational exposure to radiation [2-4]. Radiation is a constant concern in modern medicine, as it is related to dangerous health

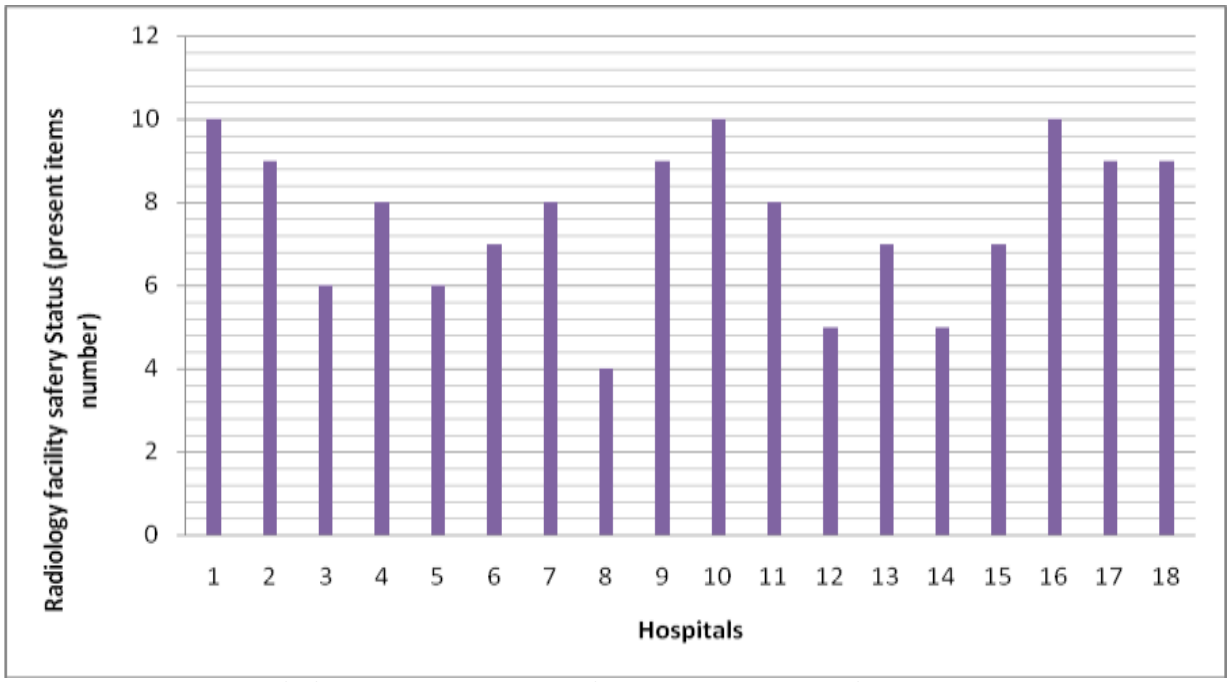

Fig. 1. Comparison of safety status among the hospitals of Shahid Beheshti University of Medical Sciences, Tehran, Iran

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Table 2. Radiation safety awareness level among patients

Variables	Group (N)	Mean	SD	*p-value*
Gender	Male (124)	1.7	1.02	0.350
	Female (94)	1.3	0.92	
Age (yr)	<20 (78)	1.25	0.96	0.017
	20-30 (49)	2.30	1.25	
	31-40 (36)	1.44	0.90	
	41-50 (10)	1.40	0.85	
	51-60	1.20	0.70	
	60<	0.70	0.50	
Educational level	Under diploma (4)	1.30	0.77	0.004
	Diploma (4)	1.40	1.15	
	AD (30)	2.00	1.05	
	B. Sc (126)	2.50	1.20	
	Post grad- (13)	2.70	1.02	
Job type	Housewife (65)	1	0.77	0.000
	Student (30)	2.3	1.15	
	Government employee (43)	2.43	1.05	
	Self-employment(80)	1.35	1.2	

effects. The approximated cancer risk ascribed to x-rays in the UK and the USA are respectively 500 and 5700 deaths per year [14]. The results of this survey showed that 71.1% of staff had a good awareness. The same results were found in a number of studies [5, 9], and it shows a prevalent deficiency in radiation safety awareness among medical imaging staff throughout the countries. Since radiology and the health effect of radiation are important matters and are repeatedly encountered in clinical application, knowledge about it should be taught to personnel [3]. It is worth pointing that we failed to find significant differences of radiation awareness among different genders, educational level, age, field of study and years of employment, though we found a difference of radiation awareness among those people. Commonly, staffs had better awareness about radiation safety than patients due to their basic training in radiology physics and radiation protection; however, awareness of this aspect is still inadequate and performance is not optimal.

In addition, no significant relationship between job experience and safety awareness was seen, in accord to a previous study [4]. However, radiologists with job experience more than 15-year, were observed to have a poorer awareness than junior radiologists.

The effectiveness of higher educational level in acceptance and learning of the safety rules seems reasonable [15].

Several studies have shown that imparting of radiation safety information in the medical imaging professionals is mostly poor. Moreover, patients' attitudes toward undergoing a radiological imaging are often biased or based on inappropriate information. Therefore, staff have a commitment to their patients [16-19].

In Shiraz hospitals, the results indicated that 70% of personnel were aware of protection in radiograghy room [20]. Furthermore, the study in Northern Ireland to assess awareness of radiation dose among health professionals showed that the mean score achieved was 7.1 out of 18 [21].

Moreover, 58.4% of the hospital staff stated that they had been trained about radiation controlling, 93.6% of them used the filmbadge dosimeter, Bahari also advised the necessity of the routine monitoring of radiation exposure for radiation related diseases prevention [22]. Sanders expressed the consideration of extremity dosimetry for surgeons routinely using x-ray [23]. Additionally, 92% had known to require the use of personal protective equipment. The staff's level of knowledge about TLV and absorbed dose was estimated namely 84.4% and 61.8%, respectively. The average level of staff radiation protection in Kerman hospitals was 57.5% [16]. These results are due to the inadequate radiation safety knowledge of the hospital staff as well as the absence of regular training courses.

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Our investigation has shown that the patient's radiation knowledge was drastically at low level namely 5% of patients put in good level. Conversely 58% of them where taking place in weak level of safety awareness. Unified the findings, it is seen that the public knowledge was evidently inadequate whereas this deficiency existed difference among various individuals. As shown in our findings, higher educational level peoples' awareness was significantly higher than lower educational level. In addition, results depicted young people (20-30 yr) have a higher awareness level than other age groups. Furthermore, the employed patients demonstrated high level of radiation awareness. Generally, patients' results revealed that age, job type and the educational level are important factors to affect knowledge of radiation safety. It is noteworthy that we could not find significant difference of radiation awareness among different genders.

In this study, 78.4% of patients had not been informed about health and safety issues related to radiation exposure. Many published studies report that 93% of adult patients underwent CT scan do not receive any information about the radiation safety and possible risks associated with their investigation [24]. Therefore, availability of these data can help individual to make cognizant choices about their healthcare needs, if requested. As it can be seen in the recent survey that a brief leaflet of radiation safety, afforded to the parents of children undergoing common CT, betters parental knowledge of radiation-related risk and lead to parents accepting investigations requested by the physician [25]. Ricketts et al. reported that the multitude of patient (92%) were not informed of the radiation risks associated with tests that they were subjected to and had incorrect viewpoints about the use of radiation and its related risks [26].

Our study, in common with those previously published, confirmed that clinician awareness of the radiation safety did not impart very well during common imaging procedures, and the consequent risks to the patients are significant.

The findings showed that the hospital's radiology center status approximately experienced a good condition while, safety directives did not exist in the centers also workplace radiation monitoring did not perform, but 90% of the hospitals had a regular inspection and all of them had appropriate lead walls.

The results of a study conducted in the hospitals affiliated to the Mazandaran University of Medical Sciences showed that none of the studied hospitals had enough warning signs and 50% of hospitals had consistent with the international radiation protection regulation [27].

Our radiation sources almost calibrated annually, whereas Herscovici recommended that radiographic units should undertake calibration regularly (once every six-month) [28].

Altogether, the findings of this study amplify the magnitude of persistent training or periodic refresher courses in field of radiation safety for specialists and patients, which is important to enhance public health in the community.

CONCLUSION

Apparently, There are legal and ethical implications of exposure to ionizing radiation that need to be addressed, such as the right of a patient to be informed of the risks involved in the procedures to which he or she has been referred. Denying radiation safety may put both staff and patients at risk of undergoing increasing radiological investigations and thus increasing exposure to radiation hazards. Improvement in radiation safety awareness can promote the level of safety and health in the studied hospitals.

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REFERENCES

1. National Council on Radiation Protection and Measurements (NCRPM) report 160. Ionizing radiation exposure of the population of the United States. National Council on Radiation Protection and Measurements; MD, USA: 2009.
2. Patricia KN, Joseph CW. Radiation exposure from imaging tests: is there an increased cancer risk? *Expert Rev Cardiovasc Ther* 2011; 9(2): 177-183.
3. Ryan KLL, Winnie CWC, Colin AG, Timothy HR, Anil TA. Knowledge of radiation exposure in common radiological investigations: a comparison between radiologists and non-radiologists. *Emerg Med J* 2012; 29:306-308.
4. Lee CI, Haims AH, Monico EP, et al. Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. *Radiology* 2004; 231:393-8.
5. Shiralkar S, Rennie A, Snow M, Galland RB, Lewis MH, Gower-Thomas K. Doctors' knowledge of radiation exposure: questionnaire study. *BMJ* 2003; 327: 371-2.
6. Arslano_glu A, Bilgin S, Kubal Z, Ceyhan MN, Ilhan MN, Maral I. Doctors' and intern doctors' knowledge about patients' ionizing radiation exposure doses during common radiological examinations. *Diagn Interv Radiol* 2007; 13:53-5.
7. Heyer CM, Peters S, Lemburg S, Nikolas V. Awareness of radiation exposure of thoracic CT scans and conventional radiographs: what do non-radiologists know? *Rofo* 2007; 179: 261-7.
8. Mubeen SM, Abbas Q, Nisar N. Knowledge about ionising and non-ionising radiation among medical students. *J Ayub Med Coll Abbottabad* 2008; 20:118-21.
9. McCusker MW, de Blacam C, Keogan M, McDermott R, Beddy P. Survey of medical students and junior house doctors on the effects of medical radiation: is medical education deficient? *Ir J Med Sci* 2009; 178(4):479-83.

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10. Heyer CM, Hansmann J, Peters SA, Lemburg SP. Paediatrician awareness of radiation dose and inherent risks in chest imaging studiesda questionnaire study. *Eur J Radiol* 2010; 76:288-93.
11. Hatam N, Keshtkar V, Forouzan F, Bastani P. Patient Safety Culture Status in Teaching Hospitals: A Case of Shiraz University of Medical Sciences. *MEJSR* 2012; 12 (7): 970-975. (Persian)
12. Gunnell D, Peters T, Hawton K, House A. Variations in the hospital management of self harm in adults in England: observational study. *BMJ 2004;* 328:1108.
13. DelliFraine JL, Wang Z, McCaughey D, Langabeer JR, Erwin CO. The Use of Six Sigma in Health Care Management: Are We Using It to Its Full Potential? *Qual Manag Health Care 2013;* 22(3):210-223.
14. Berrington de Gonza´lez A, Darby S. Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries. *Lancet* 2004; 363:345-51.
15. O'Sullivan J, O'Connor OJ, O'Regan K, Clarke B, Burgoyne LN, Ryan MF, Maher MM. An assessment of medical students' awareness of radiation exposures associated with diagnostic imaging investigations. *Insights Imaging* 2010; 1:86–92.
16. Borhani P, Alizade MS. Assessment of staff performance in Kerman University of medical sciences hospitals. *Hormozgan MJ* 2003; 51-58. (Persian)
17. Quinn AD, Taylor CG, Sabharwal T, Sikdar T. Radiation protection awareness in non-radiologists. *Br J Radiol* 1997; 70:102–106
18. Jacob K, Vivian G, Steel JR. X-ray dose training: are we exposed to enough? *Clin Radiol* 2004; 59:928–934.
19. Freudenberg LS, Beyer T. Subjective Perception of Radiation Risk. *J Nucl Med*, 2011; 52 (12):29–35.
20. Amirzade F, Tabatabaei HR. Assessment of knowledge of the principles of radiation protection of workers employed in hospitals of Shiraz. *Iran J Nuclear Med* 2004; 13 (24).
21. SOYE JA, Paterson A. A survey of awareness of radiation dose among health professionals in Northern Ireland. *Br J Radiol* 2008; 81, 725-729.
22. Bahari S, Morris S, Broe D, Taylor C, Lenehan B, McElwain J. Radiation exposure of the hands and thyroid gland during percutaneous wiring of wrist and hand procedures. *Acta Orthop Belg* 2006; 72(2):194-8.
23. Sanders R, Koval KJ, DiPasquale T, Schmelling G, Stenzler S, Ross E. Exposure of the orthopaedic surgeon to radiation. *J Bone Joint Surg Am* 1993; 75(3):326-30.
24. Lee CI, Haims AH, Monico EP, Brink JA, Forman HP. Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. *Radiology* 2004; 231:393–8.
25. Larson DB, Rader SB, Forman HP, Fenton LZ. Informing parents about CT radiation exposure in children: it's ok to tell them. *AJR Am J Roentgenol* 2007; 189:271–5.
26. Ricketts ML, Baerlocher MO, Asch MR, Myers A. Perception of radiation exposure and risk among patients, medical students, and referring physicians at a tertiary care community hospital. *Can Assoc Radiol J* 2013; 64(3):208-12.
27. Rahimi A. Salar Sh. Evaluation of the Diagnostic Radiology department standards in Mazandaran University of Medical Sciences hospitals. *JMUM* 2002; 15 (49), 69-76. (Persian)
28. Herscovici DJr, Sanders RW. The effects, risks, and guidelines for radiation use in orthopaedic surgery. *Clin Orthop Relat Res* 2002; (375):126-32.

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