



Assessing the Impact of Regulations on Radiation Safety Culture and Practices in Radiology Departments

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Abstract

Background: The need to establish a strong culture around radiation safety is derived from the assertion that medical practitioners, patients, and third parties should not be exposed to unnecessary radiation. Authorities have endeavored to enact policies to protect all employers and patients in radiology departments. **Objectives:** To assess the impact of radiation safety practices and regulations on the ongoing improvements in radiation safety culture and practices in radiology departments. This will be achieved through a subjective assessment of national and international rules and regulations by healthcare professionals. **Materials and Methods:** We conducted a questionnaire survey in the radiology departments of three JCI-accredited hospitals in the Riyadh region to identify and assess the impact of national radiation regulations and the accompanying processes on the improvement of radiation safety culture and practices in radiology departments. **Results:** There were statistically significant differences in the grading system results among various groups of respondents, based on their educational level. Also, there are statistically significant differences between the assessments of safety level results in the answers provided by various groups of respondents according to education level in favor of the master's degree. **Conclusion:** The study concludes that technicians with a diploma degree require stricter regulation. Furthermore, the results of this study suggest that an exposure tracking system and a regulatory action supporting it may be useful in the ongoing task of improving patients'

radiation safety.

Keywords

Impact, Radiation Safety Culture, Regulations, Accreditation, Practice, Radiology Departments

1. Introduction

The health, safety, and wellness of healthcare practitioners and patients rely on the successful implementation of the workplace safety policy and professional code of conduct. Technological advancements in the healthcare sector have enabled the use of various systems [1] [2]. The increased global interest in accreditation is significant because it is considered an important tool for improving the quality and safety of healthcare services [3]. However, a perceived gap exists in the knowledge concerned with the evaluation of accreditation impact on healthcare organizations [4]. Therefore, the radiology department of healthcare facilities is expected to be governed by a radiation safety culture and practice to enhance the care of both medical experts and patients [5]. This study aims to identify and assess the impact of regulations and processes on improving the radiation safety culture and practices in radiology departments. This assessment will also help evaluate the knowledge and behavior of medical staff regarding radiation safety policies and procedures enforced in their departments. This study methodology includes a questionnaire for employees working in the radiology departments of the aforementioned hospitals. The goal is to obtain workers' opinions on current radiation safety practices, the efficacy of these standards, and the application of regulations.

2. Methods

2.1. Survey Participants

We conducted this study in the radiology departments of three JCI-accredited hospitals in the Riyadh Region. Concerning the scope of the services offered in the three hospitals, the radiology departments offer all radiology procedures, and all healthcare providers in the radiology departments hold a valid license from the Saudi Commission for Health Specialties, which includes all radiologists (consultants, registrars, and residents), technologists, specialists, and technicians working in all aspects of diagnostic radiology. Morgan's law was used to determine the sample size with a confidence level of 90% and a margin of error of 5%. The sample size of PSMC was 160, the sample size of KSMC was 136, and the sample size of SHH was 46. As a result, the study sample consisted of 342 employees. On a voluntary basis, the participants were selected through the convenience sampling strategy of all healthcare providers in the radiology departments. All participants were informed that the results would only be used for this scientific study.

2.2. Measurement Tool

After reviewing the literature on the subject of the study, a questionnaire was designed and prepared to identify and assess the impact of national radiation regulations and the accompanying process on the improvement of radiation safety culture and practices in radiology departments [6] [7]. The questionnaire included 15 multiple-choice questions that offered between three and five possible answers. Some of the questions allowed the participants to select more than one answer. The questionnaire sought three types of information: 1) the demographic information of the respondents; 2) the opinion of the professionals about the impact of regulations on safety and the creation of a safety culture; 3) an assessment of radiation safety levels. The demographic information of the respondents included gender (male or female), education level (diploma, bachelor's, master's, doctorate, or other), job experience (less than a year, 2 - 5 years, 6 - 10 years, or over 10 years), and professional specialty (radiologist, technician/technologist, specialist, or other).

2.3. Statistical Analysis

For the analysis, the statistical package for the social sciences (SPSS) version 16 tool was used. Spreadsheets were used to analyze the responses, and a grading system was used to evaluate the answers. Each possible answer was given a score, ranging from 0 to 1. The maximum score that could be obtained per question was one, meaning that the attainable scores for groups of questions were 6 and 5 for (a) and (b), respectively. A high total score in each group indicated that the participants (a) agreed that the regulations had a positive impact toward enhancing radiation safety in radiology departments and creating a radiation safety culture; (b) indicated high levels of radiation safety.

3. Results

Characteristics of the respondents who filled out the questionnaire are given in **Table 1**. The frequencies and percentages of the sample were calculated according to the following variables: gender, education level, work specialty, and job experience. From the sample size, a total of 342 participants filled out their questionnaires.

Referring to **Table 2**, based on the questionnaire data, 80.49% of the participants agreed with the assertion that the staff working in radiological facilities should have the necessary qualifications and experience. The results show that 81.42% of the participants agree that assigning the responsibility for radiation safety in regulations to the head of the organization aids implementation. At the same time, 65.33% of the participants agree that assigning the responsibility for radiation safety in regulations to the head of the organization raises safety awareness at the managerial level. Also, 54.60% of the participants agree that the radiation practice regulations have motivated them and their department to estimate patient doses and compare them with reference/guidance levels. Otherwise, they would not have received much attention.

Table 1. Characteristics of participants.

		Number (N)	Rate (%)
Gender	Male	212	61.99
	Female	130	38.01
Education Level	Diploma	66	19.35
	Bachelor's	146	48.09
	Master's	42	12.32
	Doctorate	69	20.23
	Other	6	1.75
Work Specialty	Radiologist	104	30.77
	Technician	82	24.26
	Technologist/Specialist	152	44.97
	Other	8	2.34
Job Experience	Less than a year	35	10.39
	Less than a year	90	26.71
	Less than a year	91	27.00
	Over 10 years	121	35.91

Table 2. Questions addressed to professionals participated to probe their opinion about (a) impact of regulations and (b) assessment of safety levels. Value in parentheses represent the percentage of each answers a fraction of the total answers for each question.

(a) Impact of Regulations					
No.	Question	Possible Answers	Score	N	%
1	Staff working in radiological facilities should meet the necessary qualifications and experience is important because... (Multiple answers are allowed)	(a) It assures safety.	0.5	252	67.83
		(b) It helps developing manpower equipped with safety skills.	0.5	264	80.49
		(c) It is not really important.	0	5	1.52
		(d) I do not know.	0	9	2.74
2	Assigning responsibility for radiation safety in the national regulations to the head of the organization... (Multiple answers are allowed)	(a) Helps in implementing radiation safety in the hospital	0.5	263	81.42
		(b) Contributes to safety awareness at the management level	0.5	211	65.33
		(c) Exists on paper without the person knowing his/her responsibilities	0	27	8.36
		(d) Does not contribute to the safety culture at the operator level	0	15	4.64
		(e) I do not know.	0	9	2.79
3	Did the regulation of radiation practice motivate you or your department to estimate patient doses and compare them with reference/guidance levels?	(a) Yes, otherwise it would not have received much attention.	1	172	54.60
		(b) Yes, but it did not change our practice.	0.5	56	17.78
		(c) We would do this regardless of regulations.	0	38	12.06
		(d) No	0	21	6.67
		(e) I do not know.	0	28	8.89

Continued

		(a) Yes, otherwise it would not have received much attention.	1	153	48.73
		(b) Yes, but it did not change our practice.	0.5	73	23.25
4	How do requirements to perform regular QC tests on radiological equipment affect your practice?	(c) We would do it regardless of regulations.	0	46	14.65
		(d) No	0	4	1.27
		(e) I do not know.	0	38	12.10
		(a) Helps in obtaining resources from the management	1	173	55.99
5	Requirement of regulation in radiation practice to optimize patient doses...	(b) Has no influence on our practice as we would do this regardless of the regulations	0	78	25.24
		(c) Increases our workload	0	30	9.71
		(d) I am not aware of this requirement.	0	28	9.06
		(a) Is very useful for improving patient protection	1	210	68.85
		(b) Is good but is not yet implemented in our facility	0.25	43	14.10
6	The requirement to keep records of patient doses or exposure parameters...	(c) Has no influence on our practice as we would do this regardless of the regulations	0	14	4.59
		(d) Increases the amount of record-keeping workload with no clear benefits	0	17	5.57
		(e) I am not aware of this requirement.	0	21	6.89
(b) Assessment of Safety Levels					
		(a) Regularly	1	184	60.33
		(b) Sometimes	0.5	47	15.41
1	How often QC checks are performed?	(c) When there are problems	0.25	40	13.11
		(d) We do not perform these checks.	0	5	1.64
		(e) I do not know.	0	29	9.51
		(a) Yes, we evaluate them regularly.	1	151	49.51
2	Is patient exposure in your institution compared with diagnostic reference levels or with exposure in other institutions?	(b) Yes, but we evaluate them sometimes.	0.5	43	14.10
		(c) No	0	40	13.11
		(d) I do not know.	0	71	23.28
		(a) By the radiologist referring to the clinician and discussing the case	0.5	196	64.26
3	How are radiological procedures justified? (Multiple answers are allowed)	(b) By the radiologist deciding which examination is more appropriate than the examination requested by the clinician	0.5	193	63.28
		(c) By always following the clinician's request	0	89	29.18
		(d) I do not know.	0	16	5.25
		(a) Yes, it is very easy to acquire these records.	1	213	70.30
4	Is the information on the number of radiological procedures a patient has undergone readily available in your facility?	(b) It is not easy to acquire these records.	0.5	43	14.19
		(c) It is not possible.	0	11	3.63
		(d) I do not know.	0	36	11.88

Continued

	(a) I check my doses regularly.	1	137	45.21	
	(b) I check my doses sometimes.	0.75	40	14.21	
5	Do you use a personal dosimeter? If yes, do you keep track of your personal doses?	(c) I use the dosimeter, but I do not know where to check the badge report.	0.5	61	21.13
		(d) I regularly get a dosimeter, but I do not use it regularly.	0.1	17	5.61
		(e) I have not been issued a personal dosimeter.	0	48	15.83

The results show that 55.99% of the participants agree that the requirement for optimizing patient radiation practice helps in obtaining resources from management. Moreover, 68.85% of the participants agree that the requirement for keeping records on patient doses and exposure parameters is beneficial for improving patient protection. At the same time, 14.10% of the participants agree that this requirement is reasonable but not yet implemented in their facility. Further, 6.89% of the participants agree that the condition will increase their record-keeping workload with no explicit benefit. Also, the results show that 60.33% of the participants agree that QC checks are performed regularly, while 15.41% of them think that they are performed sometimes. The results indicate that 49.51% of the participants concur that their institution regularly exposes patients to radiation, compared to diagnostic reference levels or other institutions. However, 23.28% of the respondents did not give an opinion on this matter.

The results show that 70.30% of the participants agree that there is straightforward access to information on the number of radiological procedures in records. Furthermore, 45.21% of the participants check their doses on a regular basis, with 13.20% doing so occasionally. Meanwhile, 20.13% of the participants use the dosimeter. However, 21.13%, they do not know where to check the report of the badge.

There are statistically significant differences between the grading system results in the answers provided by the various groups of respondents according to work specialty, job experience, education level, and gender. These results are explained below.

Work Specialty

To validate this hypothesis, we used the one-way ANOVA test. **Table 3** displays the results, revealing statistically significant differences in the grading system results among different groups of respondents based on their work specialty.

We used the results of the LSD test, as shown in **Table 4**, to determine whether the differences were in favor of any work specialty. We conclude that there are statistically significant differences in the impact of regulations in the answers provided by various groups of respondents according to work specialty, favoring technicians.

Job Experience

To validate this hypothesis, we used the one-way ANOVA test. **Table 5** displays the results, revealing no statistically significant differences in the grading system results among the various groups of respondents based on job experience.

Table 3. Results of the impact of regulations and assessment of safety level.

		Sum of Squares	df	Mean Square	F	Sig.
Impact of Regulations	Between Groups	18.962	3	6.321	42.408	0.000
	Within Groups	50.378	338	0.149		
	Total	69.341	341			
Assessment of Safety Level	Between Groups	45.812	3	15.271	34.059	0.000
	Within Groups	151.546	338	0.448		
	Total	197.358	341			

Table 4. Work specialty results of the impact of regulations and assessment of safety level.

Dependent variable	(I) Work	(J) Work	Mean Difference			95% Confidence Interval	
			(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Impact of regulations	Radiologist	Technician	-0.34938	0.05702	0.000	-0.4615	0.2372
		Technologist/Specialist	0.13497	0.04913	0.006	0.0383	0.2316
		Other	1.24630	0.19671	0.000	0.8594	1.6332
	Technician	Radiologist	0.34938	0.05702	0.000	0.2372	0.4615
		Technologist/Specialist	0.48435	0.05290	0.000	0.3803	0.5884
		Other	1.59568	0.19769	0.000	1.2068	1.9845
	Technologist/Specialist	Radiologist	-0.13497	0.04913	0.006	-0.2316	-0.0383
		Technician	-0.48435	0.05290	0.000	-0.5884	-0.3803
		Other	1.11134	0.19556	0.000	0.7267	1.4960
Assessment of Safety Level	Radiologist	Technician	-0.85290	0.09889	0.000	-1.0474	-0.6584
		Technologist/Specialist	-0.35444	0.08521	0.000	-0.5221	-0.1868
		Other	1.40625	0.34118	0.000	0.7352	2.0773
	Technician	Radiologist	0.85290	0.09889	0.000	0.6584	1.0474
		Technologist/Specialist	0.49846	0.09175	0.000	0.3180	0.6789
		Other	2.25915	0.34287	0.000	1.5847	2.9336
	Technologist/Specialist	Radiologist	0.35444	0.08521	0.000	0.1868	0.5221
		Technician	-0.49846	0.09175	0.000	-0.6789	-0.3180
		Other	1.76069	0.33918	0.000	1.0935	2.4279

Table 5. Job experience results of the impact of regulations and assessment of safety level.

		Sum of Squares	df	Mean Square	F	Sig.
Impact of regulations	Between Groups	26.071	3	8.690	67.884	0.137
	Within Groups	43.270	338	0.128		
	Total	69.341	341			

Continued

	Between Groups	58.171	3	19.390	47.087	0.089
Assessment of safety level	Within Groups	139.187	338	0.412		
	Total	197.358	341			

4. Discussion

This study evaluated the knowledge and behavior of medical staff regarding radiation safety regulations and procedures, as well as the impact of national radiation protection regulations on minimizing radiation exposure in all medical practices. We designed this study to gather comprehensive information about the impact of regulations and safety levels from radiologists working in three JCI-accredited hospitals in the Riyadh Region, each with different funding support mechanisms.

All individuals working in radiological facilities should comply with certain requirements to enhance safety [8]. Therefore, 80.49% of the respondents stated that the requirements help develop manpower equipped with safety skills. The responsibility for radiation protection rests with the health managers of the facilities, who, according to 81.42% of the respondents, assist in implementing radiation safety in hospitals.

Optimization is a key concept in radiation protection. In practice, this mainly involves compromising image quality and doses given to patients [8]. However, 54.60% of respondents stated that radiation practice regulation motivates them to estimate patient doses and compare them with reference levels. Furthermore, 17.78% of the respondents stated that it did not alter their practice, with 12.06% saying that they would do it regardless of regulations.

Potential reduction in patient doses is crucial to minimizing the risk of exposure [8]. Similar findings were observed regarding the requirement for keeping records of patient doses. In this study, 68.85% of the respondents stated that the requirement was very useful for protecting patients. The SDFA requires data management systems for keeping records of personnel and patients to ensure safe practice in radiological services in healthcare facilities. However, healthcare providers should provide radiation monitoring badges to improve safety for all staff members who might encounter 10% of the public dose limit while working [9].

Participants' responses to the questions in this area demonstrated the suitability of these questions. Many participants (60.33%) said that the QC checks were performed regularly. However, 15.41% of them stated that the checks were performed sometimes, and 13.11% said that the checks should be performed when there are problems.

Justification, optimization, and limitation are the core concepts of radiation protection and safety [7] [9]. As for justification, radiological practices should be performed by radiologists, and cases should be discussed with clinicians. It is clear that the regulatory requirements should include written protocols and that radiological procedures should be enforced more strictly. Furthermore, according to

63.28% of the respondents, radiologists were responsible for justifying radiological procedures and making appropriate test decisions [8]. The revised International Basic Safety Standards require that the responsibility to justify the procedures be shared between clinicians and radiologists [10]-[12]. Therefore, consultation between referring clinicians and radiologists could reduce the number of unnecessary examinations. However, 29.28% of the respondents said they always followed the clinicians' requests.

Regulating actions to enhance the tracking and recording of previous radiological procedures and doses received by patients is also necessary [13]. Further, 70.30% of the respondents stated that obtaining information on the number of radiological procedures from the records was straightforward, while 14.19% of them claimed that it was impossible to access information on previous procedures.

5. Conclusion

This study questionnaire was sent to the radiology departments of three JCI-accredited hospitals in the Riyadh Region. The results illustrated the impact of regulations on enhancing patient safety. The importance of creating a safety culture was appreciated by the respondents, notably among specialists compared with technicians. The results are encouraging because they indicate a relatively high correlation between the use of regulatory tools and a high academic level. Responses suggest that safety levels in the participating facilities are satisfactory. Radiation safety levels concern national and international regulatory bodies who are responsible for strengthening regulatory frameworks, especially regarding the evaluation and consideration of patient doses and the use of written protocols for radiological procedures. Also, this questionnaire recognized the need to strengthen regulations for technicians with a diploma degree. The results of this study suggest that an exposure tracking system and a regulatory action that supports it may be useful in the ongoing task of improving patients' radiation safety.

6. Limitations and Recommendations

This study has some limitations. One limitation is that it was only carried out in departments that had services under their umbrella for their target people. Second, the time for data collection was short for introducing a self-intervention to increase the response rate. Thirdly, I encountered challenges in reaching out to most participants due to their varying work shifts. Further studies with larger populations and multiple centers will provide more insight into this issue. Future studies should focus on technicians with a diploma degree and investigate the extent of their knowledge of legislation and regulations governing radiation safety practices in radiology departments.

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and for all departments that gave me access to their target participants.

Ethical Considerations

The study proposal was approved by PSMMC, and ethical approval was obtained from PSMMC's ethical committee.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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