Short communication

Knowledge and awareness of radiation hazards among Palestinian radio technologists

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تقييم المعلومات والوعي لدى تكنولوجيي الأشعة الفلسطينيين بمخاطر وأضرار الإشعاعات الناجمة عن الإشعاع: دراسة مقطعية

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الخلاصة: هذه الدراسة لتقييم مستويات المعلومات والمعرفة لدى تكونولوجيي الأشعة الفلسطينيين بمخاطر وأضرار الإشعاعات الناجمة عن الفحوصات الإشعاعية. تم دراسة 94.4٪ من مجموع تكنولوجيي الأشعة في فلسطين. كان المتوسط العام للإجابات الصحيحة لأسئلة المعلومات والوعي 26.4٪. وكانت النسبة المئوية للإجابات الصحيحة التي دلت على معرفة التكنولوجيين بنظرية الألارا والهارموسيس 66.5٪ و17.2٪ على التوالي. ووجدت الدراسة مستويات أعلى من المعلومات والوعي لدى التكنولوجيين ذوي المستوى الأعلى من التعليم والذين لديهم أقل من خمس سنوات من الخبرة في مجال العمل. وتم تحديد الأعضاء الأكثر حساسية للتأثر بالإشعاعات بشكل صحيح على النحو التالي: الرئتين 6.9٪، المعدة 4.9٪ والغدد التناسلية 2.5٪ وتم الكشف عن أن التزام أفضل بقواعد السلامة لدى تكنولوجيي الأشعة العاملين في المؤسسات والمستشفيات الفلسطينية غير الحكومية. وتكشف هذه النتائج عن نقص كبير في المعلومات والوعي لدى تكنولوجيي الأشعة الفلسطينيين والذي من شأنه تعريض المرضى إلى جرعات غير ضرورية من الأشعة المؤينة. يعكس هذا الحاجة إلى التدريب الإلزامي والتعليم المستمر حول الحماية من الإشعاع في جميع مؤسسات الرعاية الصحية الفلسطينية.

ABSTRACT This study investigated 94.4% of Palestinian radio technologists and the mean percentage of correct answers for knowledge and awareness questions was 26.4%. The percentage of correct answers for questions testing knowledge of the ALARA (As Low As Reasonably Achievable) principle and hormesis hypothesis was 66.5% and 17.2%, respectively. Radio technologists with education level higher than bachelor degree and < 5 years' work experience showed a significantly higher level of knowledge. The most radiosensitive organs were correctly identified as the lungs and stomach by 6.9% and 4.9%, respectively, and 2.5% correctly identified the gonads as the next most radiosensitive organ. There was a serious deficit in knowledge and awareness of radiation hazards among Palestinian radio technologists, which may expose patients to unnecessary doses of ionizing radiation. This indicates the need for mandatory training and education about radiation protection in all Palestinian healthcare institutions.

Connaissances et prise de conscience des techniciens en radiologie palestiniens en matière de risques découlant de l'exposition aux rayonnements

RÉSUMÉ La présente étude couvrait 94,4 % des techniciens en radiologie palestiniens. La moyenne générale de réponses correctes pour les questions sur les connaissances et la prise de conscience était de 26,4 %. Le pourcentage des réponses correctes pour les questions examinant la connaissance du principe ALARA (*As Low As Reasonably Achievable* en anglais ou principe d'optimisation) et de l'effet d'hormèse étaient respectivement de 66,5 % et de 17,2 %. Les techniciens en radiologie ayant un niveau d'éducation plus élevé et une expérience de travail de moins de cinq ans ont montré un niveau de connaissances significativement plus élevé. Les organes les plus sensibles aux radiations ont été correctement identifiés comme étant les poumons et l'estomac respectivement par 6,9 % et 4,9 % des techniciens tandis que 2,5 % ont correctement identifié les gonades comme étant l'autre organe le plus sensible aux radiations. On observe un déficit grave de connaissances et de prise de conscience parmi les techniciens en radiologie palestiniens, pouvant exposer les patients à des doses inutiles de rayonnements ionisants. Ceci reflète le besoin d'une formation obligatoire et d'une éducation portant sur la protection contre les rayonnements dans tous les établissements de soins de santé en Palestine.

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Introduction

Medical imaging procedures involving the use of ionizing radiation are associated with potentially harmful biological effects, especially after long-term exposure or high doses of radiation (*1–3*). Detrimental health effects, such as cancer or genetic defects, resulting from exposure to any dose of radiation have been described in the linear-no-threshold hypothesis (*4*). The application of this hypothesis in practice is the ALARA principle (As Low As Reasonably Achievable), which aims to minimize radiation dose and the release of radioactive materials (*5*). Conversely, the radiation hormesis hypothesis assumes that adaptive/protective mechanisms are stimulated by low-dose radiation and prevent spontaneous and toxicant-related cancers, as well as other adverse health effects (*6-8*).

In the West Bank and East Jerusalem, 437 medical imaging units operated by 370 radio technologists are registered by the Palestinian Ministry of Health and the Palestinian Medical Imaging Association. A previous study has shown poor knowledge and awareness of the potential hazards associated with radiological examinations among Palestinian physicians (*9*). However, knowledge and awareness of these hazards among Palestinian radio technologists has thus far not been investigated.

In this study, we assessed the level of knowledge and awareness among Palestinian radio technologists working in Central Palestinian hospitals about the radiation hazards, possible risks caused by radiological examinations, and knowledge and attitudes toward the ALARA principle and hormesis hypothesis.

Methods

We conducted a cross-sectional study in the West Bank and East Jerusalem among radio technologists working in 11 governmental and 9 nongovernmental Palestinian hospitals. The selected hospitals are all main healthcare providers and have 67% of the total number of beds (n = 2181) in the study area. We investigated 215 radio technologists who were working in these hospitals, which comprised 65% of the registered radio technologists in the West Bank and East Jerusalem (*10*).

A self-administered questionnaire consisting of 2 sections was developed. The first section assessed the following sociodemographic variables: workplace, gender, level of education, years of experience in practice, and the country and university in which they graduated. The second section consisted of 27 questions assessing the level of knowledge and awareness of radiation hazards. All questions were multiple choice with 4–8 possible answers. The questionnaire was based on previously published research (*11–16*).

Cronbach's α was calculated to assess the reliability of the questionnaire using SPSS for Windows version 22.0 and was found to be 0.82. In addition, a committee of 4 experts in radiology and ionizing radiation and a focus group of 20 radio technologists agreed that the questionnaire was valid. Data collection was during July–August 2015. Data were managed and analysed using SPSS for Windows version 22.0. We performed descriptive analysis using frequencies and percentages. The χ^2 and Fisher's exact tests were used where applicable. Level of statistical significance was set at $P < 0.05$.

The study was revised and approved by the Ethics Committee at Al-Makassed Hospital in East Jerusalem.

Results

Out of 215 radio technologists, 203 (94.4%) returned completed questionnaires (Table 1). One hundred and nineteen (58.6%) participants worked in governmental hospitals and 84 (41.4%) in nongovernmental hospitals. Most of the radio technologists were male (83.3%), had bachelor degrees in medical imaging programmes (71.9%)

Table 1 Descriptive data for radio technologists working in 20 hospitals in West Bank and East Jerusalem

Workplace	*n* = 203	%
Governmental	119	58.6
Nongovernmental	84	41.4
Gender		
Male	169	83.3
Female	34	16.7
Education		
Diploma	37	18.3
Bachelor	146	71.8
Higher than bachelor degree	20	9.9
Country of graduation		
Palestine	158	77.8
Arab countries	27	13.3
Foreign countries	18	8.9
Years of experience		
< 5	62	30.5
5–10	46	22.7
10–20	42	20.7
> 20	53	26.1

and had graduated from Palestinian universities (77.8%). Their work experience ranged from < 5 years (30.5%) to > 20 years (26.1%). The overall mean percentage of correct answers for the knowledge and awareness questions was 26.4%. However, 6 questions were answered correctly by ≤ 10% of the participants.

One hundred and thirty-five (66.5%) and 35 (17.2%) radio technologists were aware of the ALARA principle and the hormesis hypothesis, respectively. However, participants with a level of education higher than bachelor degree had a significantly higher level of knowledge about radiation risks (P = 0.001). Participants with < 5 years work experience had a significantly higher level of knowledge (P = 0.005). Ninety-six (47.3%) participants had attended at least 1 course or lecture at their workplaces and 91 (44.8%) were aware of any published articles concerning the radiation hazards. Moreover, 65 (32%) answered correctly that multislice computed tomography (CT) scanners delivered a higher radiation dose than the single-slice helical scanners. Significant differences were seen among respondents based on their level of education (2 years diploma, bachelor degree, and higher than bachelor degree); more correct answers were given by those who had a higher level of education (55%) (n=11), followed by diploma (37.8%) (n=14) and bachelor degree (27.6%) (n=40). A significantly higher number of correct answers was given by those who graduated from Al-Quds University, Jerusalem 14/20 (70%; P = 0.003) and radio technologists working in nongovernmental hospitals 15/20 (75%; P = 0.001).

Radio technologists were asked about the percentage of ionizing radiation to which the public is exposed from medical applications. The correct answer was given by 59 (29.1%) of the respondents. Furthermore, only 20 (9.9%) participants answered correctly that there was in fact no dose limit defined for patients. Participants were asked about the International Commission on Radiological Protection (ICRP) recommendations that define professional responsibility for protecting patients from unnecessary radiation doses. Eighty-nine (43.8%) participants knew that these recommendations forbid unjustified exposure to ionizing radiation and place the responsibility for protecting patients from unnecessary radiation doses on both the prescribing physician and the radio technologists. Moreover, 63 (31%) of the participants correctly answered that maximizing the distance from the radiation source was the most effective method of radiation protection.

We assessed the knowledge of radio technologists about sensitivity of organs to ionizing radiation, taking into consideration the tissue weighting factors according to ICRP 103 (*17*). The most radiosensitive organs were correctly identified as the lungs and stomach by 14 (6.9%) and 10 (4.9%), respectively. The gonads were correctly identified as the next most radiosensitive organ by 5 (2.5%). The bladder and liver were correctly identified as the third most radiosensitive organ by 46 (22.7%) and 53 (26.1%), respectively.

Knowledge of chest X-ray equivalents for each type of radiological examination was assessed (Table 2). Only 14 (6.9%) participants knew that the radiation dose from one lumbar spine X-ray equalled that from 65 posterior anterior chest X-rays. Moreover, 85 (41.9%) and 15 (7.4%) participants knew that each radiation dose from one abdominal CT scan and each from one barium enema, respectively, was equal to that from > 250 chest X-rays.

One hundred and nine (53.7%) radio technologists reported that they never used gonad shielding for children during X-ray examination. One hundred and nineteen (58.6%) participants reported that they often requested a consent form before performing an X-ray examination on pregnant women.

Table 2 Radio technologists' knowledge of radiation exposure measured in chest X-ray equivalents for each type of radiological examination

No. of chest X-ray equivalents	Lumber spine X-ray		Abdominal CT scan		Barium enema	
	n	(%)	*n*	(%)	*n*	(%)
10	114	(56.2)	1	(0.5)	7	(3.4)
35	41	(20.2)	5	(2.5)	55	(27.1)
65	14[a]	(6.9)	25	(12.3)	26	(12.8)
120	7	(3.4)	30	(14.8)	42	(20.7)
250	3	(1.5)	38	(18.1)	21	(10.3)
> 250	5	(2.5)	85[a]	(41.9)	15[a]	(7.4)
Don't know	19	(9.4)	19	(9.4)	37	(18.2)

[a]Correct answers to the question about the amount of radiation exposure in selected radiological examinations measured in single frontal posterior anterior chest X-ray equivalents. One lumbar spine X-ray is equal to that of 65 chest X-rays; each abdominal CT scan and each barium enema is equal to that of > 250 chest X-rays. The remaining answers were incorrect.

Participants working in nongovernmental hospitals showed a significantly better rate of requesting these consent forms ($P = 0.003$). Eighty-eight (43.3%) participants outlined all of the risks and benefits of X-ray examinations to the patients and their families and 95 (46.8%) reported that patients and their families rarely requested information about radiation doses and risks.

To assess their attitude toward radiation risks, the radio technologists were asked if they thought that there was a proven increase in lifetime risk of developing cancer attributed to different types of radiological examinations, including routine X-ray, fluoroscopy and CT scans (Table 3).

One hundred and sixty-seven (82.3%) radio technologists correctly identified children as the age group most sensitive to ionizing radiation. Moreover, 179 (88.2%) participants indicated the need for radiation protection officers in Palestinian hospitals.

Table 3 Radio technologists response to excess lifetime cancer risk attributed to radiological examinations

Risk of cancer	Yes		No	
	n	%	*n*	%
Routine X-ray	102	50.2	101	49.8
Fluoroscopy	67	33	136	67
CT scan	158	77.8	45	22.2

Discussion

The results of the current study indicate a lack of knowledge and awareness among Palestinian radio technologists regarding the possible risks of radiological examinations. This was not surprising since studies in many other countries have indicated similar results among radio technologists and other health professionals (*11–13, 15, 18–20*).

Although 47.3% of participants attended at least 1 course or lecture on radiation hazards in their workplaces, their level of knowledge was not significantly better than those who had not. Institutionalized training on radiation hazards and protection for all Palestinian health professionals should be regularly provided. Moreover, we recommend that access to electronic journals and resources should be made available.

Identification of children as the most radiosensitive age group may reflect awareness that children are in a dynamic state of growth, and are therefore more sensitive to environmental hazards than adults are (*12*). Radio technologists should be aware of the ALARA principle and aim to minimize each patient's dose when conducting any radiological examination. These findings highlight the need to increase awareness among Palestinian radio technologists about the dose limits in ICRP guidelines and the need to protect patients from radiation hazards. This can be achieved by educating radio technologists and clarifying for them the meaning of the ALARA principle.

Radio technologists should have the ability to compare radiation doses associated with different medical imaging modalities and to express the effective doses in terms of chest X-ray equivalent units. This has proven useful in helping patients and their families understand the relative risks of radiation (*5, 21, 22, 23*). We reported an unacceptable level of knowledge about X-ray equivalent units among our study participants. These results could be related to the training and academic curricula in Palestinian medical imaging schools, which do not focus on teaching about the universal communication skills needed to explain radiation risks. These skills are recommended by many radiation protection bodies worldwide. However, our study was limited to the Palestinian central hospitals, hence generalization of the findings to other health settings may be limited.

In conclusion, the results of our study reflect a serious deficit in the knowledge and awareness of radiation hazards among radio technologists in Palestine. This suggests that there is a need for regular training and workshops in hospitals, which take into consideration the frequent changes in the available biological and physical information and radiation safety standards. Moreover, a legal framework is needed that outlines the responsibilities of prescribers and radio technologists in protecting patients and to ensure that patients are treated safely. Further research is required to assess the level of knowledge about the hazards of radiation among final year medical imaging students and among other health professionals.

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