

# Assessment of physicians' knowledge and awareness about the hazards of radiological examinations on the health of their patients

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## تقييم معارف ووعي الأطباء حول مخاطر الفحوصات الشعاعية على صحة مرضاهم أحمد حمارشة، منى حميد

الخلاصة: أظهرت دراسات سابقة أن الأطباء يميلون لتخفيف تقديراتهم لمخاطر تعرض مرضاهم للإشعاع. وقد أجرى الباحثان هذه الدراسة في مستشفيين في فلسطين بهدف تقييم معارف الأطباء حول المخاطر التي ترافق الفحوصات الشعاعية، فأعدا استمارة استجاب لها 163 طبيباً، وظهر فيها فجوات متعددة في معارفهم؛ إذ تلقى ثلث الأطباء فقط دورات تدريبية حول الحماية من الإشعاع خلال دراساتهم قبل التخرج أو في مواقع عملهم. واستطاع عدد قليل من الأطباء تقديم إجابات صحيحة على الكثير. من الأسئلة العلمية وذات الأساس المعرفي. فعلى سبيل المثال استطاع 6.1% فقط من الأطباء التعرف على مبادئ الحماية من الإشعاع ALARA. ولم يعرف 98.2% منهم ما ورد في ملخصات المجلد 18-8 للترجمة العربية منه، والتي توضح أنه لا يوجد حدود لجرعة آمنة وفقاً للتوصيات الدولية. كما كانت ممارسات الأطباء التي تتمثل بتكرار استخدام الفحوصات الشعاعية الروتينية ومناقشة مخاطرها مع المرضى سيئة. وتشير هذه النتائج بوضوح إلى الحاجة لزيادة المعرفة والوعي لدى الأطباء الفلسطينيين حول المخاطر التي ترافق استخدام الفحوصات الشعاعية.

ABSTRACT Previous studies have shown that physicians tend to underestimate the risks to patients of radiation exposure. This study in 2 Palestinian hospitals aimed to assess physicians' knowledge about the risks associated with the use of radiological examinations. A questionnaire answered by 163 physicians revealed many gaps in knowledge. Only one-third of physicians had received a radiation protection course during their undergraduate study or in the workplace. Few physicians were able to answer correctly many scientific, knowledge-based questions. For example, only 6.1% of the respondents were able to identify the ALARA principle and 98.2% did not know that there is no safe dose limit according to international recommendations. Physicians' practices in terms of frequency of use of routine X-rays and discussing the risks with patients were also poor. These results clearly indicate the need to increase Palestinian physicians' knowledge and awareness about the potential hazards associated with the use of radiological examinations.

## Évaluation des connaissances et de la sensibilisation des médecins sur les dangers des examens radiologiques pour la santé de leurs patients

RÉSUMÉ Des études antérieures ont démontré que les médecins avaient tendance à sous-estimer les risques de l'exposition radiologique pour leurs patients. La présente étude menée dans deux hôpitaux palestiniens visait à évaluer les connaissances des médecins en termes de risques associés à l'utilisation des examens radiologiques. Un questionnaire rempli par 163 médecins a révélé de nombreuses lacunes. Seul un tiers des médecins avaient suivi une formation sur la protection radiologique au cours de leur premier cycle d'études ou sur leur lieu de travail. Les médecins qui étaient capables de répondre correctement aux nombreuses questions scientifiques de base étaient peu nombreux. Par exemple, seuls 6,1 % des répondants étaient capables de décrire le principe ALARA et 98,2 % ignoraient qu'il n'existait pas de seuil en dessous duquel une dose est sans danger, selon les recommandations internationales. Les pratiques des médecins en termes de fréquence d'utilisation des examens radiologiques routiniers et de discussion sur les risques avec leurs patients étaient aussi médiocres. Ces résultats pointent clairement la nécessité d'augmenter le niveau de connaissances et de sensibilisation des médecins palestiniens au sujet des dangers potentiels associés aux examens radiologiques.

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## Introduction

Nowadays, medical imaging procedures involving the use of ionizing radiation are used daily in hospitals and clinics, making possible more accurate diagnosis of diseases and injuries. However, the use of ionizing radiation such as X-rays is also associated with potentially harmful biological effects. Specifically, high radiation doses tend to kill cells, while low doses tend to damage or alter the DNA of irradiated cells [1,2]. In recent times, many studies have clearly documented the harmful effects of radiological examinations [3–7]. Brenner estimated that of 600 000 children given abdominal and head computed tomography (CT) examinations annually in the United States of America (USA), 500 might ultimately die from cancer attributable to the radiation [3]. In the United Kingdom (UK) an estimated 250 people die annually as a result of cancer secondary to medical radiation exposure [6]. Yet many studies indicate that primary care providers are unaware of the hazards associated with the use of radiation. Physicians who are responsible for requesting radiological examinations tend to underestimate the actual doses involved, have poor knowledge about the possible risks to the health of populations and do not discuss the potential risks of CT scans with their patients [8–15].

In the West Bank, 2 universities have medical schools that offer a 6-year baccalaureate degree in medicine. However, neither of these offers a radiology course for their students during their undergraduate studies. This is striking, since, after graduation, these physicians will be the only health professionals having the authority to request radiological examinations. In addition, the literature reveals a lack of studies in Palestine about the hazards of unnecessary use of radiological examinations. The aim of this study was to assess the knowledge and awareness of Palestinian physicians regarding the hazards of utilizing

radiological examinations with patients in their clinical practice.

## Methods

### Target population and setting

A cross-sectional study design was utilized. The participants of the study were physicians who were recruited from the 2 largest referral hospitals in Palestine: Al-Makassed hospital (250 beds), located on the Mount of Olives in Jerusalem and offering both inpatient and outpatient services in most medical specialties, and Ramalla government hospital (150 beds), located in the centre of Ramalla city. Both of them are fully accredited for postgraduate training in 6 medical specialties, including internal medicine, surgery, paediatrics, gynaecology, and orthopaedics, by both the Jordanian and the Palestinian Medical Councils. Annually these 2 hospitals together treat more than 150 000 people. There were 107 physicians working in Al-Makassed hospital and 60 physicians in Ramalla government hospital.

### Instrument

The measurement tool was a self-reported questionnaire which was developed from 5 previous published studies [9,10,13,16,17]. The questionnaire consisted of 2 sections: section 1 requested information about sociodemographic variables such as workplace, sex, occupation, specialty, country of medical graduation and years of clinical practice, while section 2 consisted of items related to the physicians' knowledge of radiation hazards. (The questionnaire is available on request from the first author.)

The validity of the instrument was checked by a committee of 9 physicians and 4 other experts in medicine and radiation, who reviewed the content, the clarity and the relevance of the items. The questionnaire was written in the English language in response to the

committee's request, since English is the normal language for these physicians in their everyday clinical practice.

### Data collection and analysis

The administrations of the 2 hospitals were approached and gave permission for the authors to conduct the study. The questionnaires were individually hand delivered to the physicians in each setting, accompanied by an information sheet explaining the purpose of the study. This sheet endorsed the right of the participants not to participate, and that their consent to participate was implied by the return of the questionnaire. The data collection was from June 2008 to November 2009. Most of the questionnaires were collected during the first days of data collection in both hospitals, while physicians who were on leave filled in the questionnaires after their return to work.

The data was managed and analysed by using SPSS, version 15. The characteristics of the participants were obtained through descriptive analysis using frequencies and percentages

## Results

### Background characteristics

Out of the 167 physicians, 163 returned the completed questionnaire, thus the response rate was high (97.6%). As shown in Table 1, the great majority of the respondents were males (85.3%). Also 43.6% were consultants, 47.9% were residents engaged in medical qualification programmes under consultant supervision and 8.6% belonged to other medical practice categories. The largest specialty groups of respondents were internal medicine specialists (19.6%) and surgeons (18.4%).

Less than half of the respondents (43.6%) graduated from medical programmes in Arab countries such as Palestine, Jordan and Egypt, 19.6% graduated from former Soviet Union countries, 12.3% from Europe and the

**Table 1 Background characteristics of the participating physicians from 2 Palestinian hospitals (n = 163)**

Item	No.	%
<b>Workplace</b>		
Al Makassed hospital	103	63.2
Ramalla government hospital	60	36.8
<b>Sex</b>		
Male	139	85.3
Female	24	14.7
<b>Occupation</b>		
Consultant	71	43.6
Resident	78	47.9
Other	14	8.6
<b>Specialty</b>		
Surgery	30	18.4
Medicine	32	19.6
Paediatrics	22	13.5
Gynaecology	14	8.6
Orthopaedics	14	8.6
Anaesthesia	13	8.0
Emergency	9	5.5
Data missing	29	17.8
<b>Country of medical graduation</b>		
European country/United States	20	12.3
Arab country	71	43.6
Former Soviet Union country	32	19.6
Other	8	4.9
Data missing	32	19.6
<b>Years of clinical practice</b>		
< 5	57	35.0
5–10	52	31.9
11–20	23	14.1
>20	31	19.0

United States. The work experience of the respondents ranged from < 5 years to > 20 years, with more than one-third of the participants (35.0%) indicating work experience of < 5 years.

The participants were asked if they had attended any radiation protection courses, either during their medical studies or in their workplace. Interestingly, 115 (70.6%) of the respondents indicated that they had not attended a radiation protection course during their studies, and only 50 (30.7%) indicated that they had received such a course at their workplaces.

### Knowledge about radiation risks

Among the knowledge questions, as shown in Table 2, the participants were asked if they knew the ALARA principle (As Low As Reasonably Achievable), which is considered to embody the basic principles of radiation protection. The majority of the participants (93.9%) indicated that they did not know this principle. Less than half of the respondents (46.0%) were aware of any articles published in recent years in the main scientific journals concerning radiation hazards associated with

CT scans, especially among children, and only 54.6% knew that the Food and Drug Administration (FDA) in the USA has listed medical X-rays as a known carcinogen.

To further test their level of knowledge, respondents were asked to select which type of device delivers a higher radiation dose to the patient: single-slice helical scanners or multi-slice CT scanners; only 13.5% selected the correct answer, the multi-slice CT scanner. When asked about the percentage of total ionizing radiation the general public is exposed to which comes from “medical radiation”, only 8.0% of the respondents knew that it constitutes 15%–30% of radiation, while the majority of respondents (63.2%) did not know. Furthermore, the respondents were asked about the whole-body dose limit for a patient, which has been established by radiation protection regulations; and only 1.8% of the respondents indicated correctly that there is in fact no dose limit defined for patients, while the majority (81.0%) indicated that they did not know. Regarding the International Commission on Radiological Protection (ICRP) recommendations defining professional responsibility for protecting patients from unnecessary radiation doses, one-third of the respondents (31.9%) knew that these recommendations forbid unjustified exposure to ionizing radiation and place responsibility for protecting patients from unnecessary radiation doses on both the prescriber and the practitioner; more than half of respondents (57.7%) did not know the answer.

To assess their knowledge in more depth, the respondents were asked to rank the radiation sensitivity of each of 5 bodily organs from 1 (lowest) to 4 (highest). Table 3 shows that less than half of the respondents (44.8%) knew that the gonads were the most radiosensitive organ, only 19.6% identified the lungs as the second most radiosensitive and few of them (5.5%) were able to select the stomach as the second most radiosensitive organ.

**Table 2 Physicians' knowledge about the risks of radiation (n = 163)**

Item	No.	%
<b>Aware of ALARA principle</b>		
Yes	153	93.9
No	10	6.1
<b>Know any published articles on radiation hazards</b>		
Yes	75	46.0
No	88	54.0
<b>Know about FDA listing medical X-rays as a known carcinogen</b>		
Yes	89	54.6
No	74	45.4
<b>Think radiation dose to patient from multi-slice CT scanner is:</b>		
Higher than single-slice helical scanner <sup>a</sup>	22	13.5
Lower than single-slice helical scanner	36	22.1
Similar to single-slice helical scanner	11	6.7
Don't know	94	57.7
<b>% of total ionizing radiation the general public is exposed to from medical radiation</b>		
1-10	21	12.9
15-30 <sup>a</sup>	13	8.0
35-45	11	6.7
60-75	9	5.5
80-95	6	3.7
Don't know	103	63.2
<b>Recommended patient dose limit for medical radiation (msv)</b>		
100	5	3.1
50	7	4.2
20	5	3.1
5	6	3.7
0.5	5	3.1
No dose limit <sup>a</sup>	3	1.8
Don't know	132	81.0
<b>ICRP recommendations for professional responsibility for protecting patients</b>		
According to the freedom of prescription	2	1.2
Prescriber, not practitioner	5	3.1
Practitioner, not prescriber	10	6.1
Both prescriber and practitioner <sup>a</sup>	52	31.9
Don't know	94	57.7

<sup>a</sup>Correct answer.

ALARA = As Low As Reasonably Achievable; FDA = Food and Drug Administration; CT = computerized tomography; ICRP = International Commission on Radiological Protection.

Another aspect of the physicians' knowledge examined was their estimation of the effective doses of selected radiological examinations, including lumbar spine, abdominal CT scan and barium enema, expressed in terms of units equivalent to a single frontal posterior anterior chest X-ray (Table 4).

Only 4.3% of the participants knew that the radiation dose from 1 lumbar spine exam is equal to that from 65 posterior anterior chest X-rays; 8.6% knew that the radiation dose from 1 abdominal CT scan is equal to that from more than 250 chest X-rays; and 3.1% indicated correctly that the radiation dose from 1 barium enema is likewise equal to that from over 250 chest X-rays.

### Radiation practices

When the respondents were asked how often they requested routine X-ray examinations and CT scans for the diagnosis of their patients, 74.3% indicated that they requested routine X-ray examinations sometimes or often and 58.3% requested CT scans sometimes or often, while 40.5% rarely requested CT scans (Table 5).

Despite the physicians' frequent requests for these radiological examinations, more than half of them (55.2%) reported that they did not outline all the attendant risks and benefits of X-ray examinations to their patients or their families prior to conducting these examinations, while 44.8% reported that they did so. Participants were asked if the patients and their families requested information about the radiation doses and risks before consenting to undergoing radiological examinations. More than one-third of the respondents (38.7%) indicated that it happened rarely (approximately 1 in 100 patients).

Participants were asked about their intention to reduce their requests for various types of radiological examinations, including routine X-ray exams, CT scans and fluoroscopy if there were a proven increase in lifetime risk of cancer associated with these procedures (Table 6). The majority of respondents (61.4%) indicated that they would do so in the case of routine X-ray examinations, whereas 38.6% indicated that they would not. A majority (69.9%) reported that they would reduce their requests for CT scans.

**Table 3 Physicians' knowledge about the relative sensitivity of body organs to radiation**

Estimated sensitivity level <sup>a</sup>	Lungs		Bladder		Gonads		Kidneys		Stomach	
	No.	%	No.	%	No.	%	No.	%	No.	%
1	15	9.2	6	3.7	73	44.8	4	2.5	10	6.1
2	32	19.6	25	15.3	6	3.7	16	9.8	9	5.5
3	17	10.4	23	14.1	3	1.8	32	19.6	15	9.2
4	18	11.0	28	17.2	9	5.5	27	16.6	35	21.5
Don't know	75	46.0	73	44.8	72	44.2	77	47.2	81	49.7
Missing data	6	3.7	8	4.9	0	0.0	7	4.3	13	8.0
Total	163	100.0	163	100.0	163	100.0	163	100.0	163	100.0

<sup>a</sup>Participants rank the radiation sensitivity of organs from 1 (lowest) to 4 (highest).

## Discussion

In general, the results of the current study in Palestine are similar to the findings of previous studies in the literature and indicate a similar lack of knowledge among physicians regarding the possible risks of radiological examinations [6,11,14,15,18]

This lack of knowledge of radiological issues was certainly evident, with only 6.1% of our Palestinian physicians able to identify the ALARA principle, even though this principle comprises the core of radiation protection philosophy [19]. This percentage is in fact considerably lower than those found from other studies, which ranged from 15% to 48% [10,13]. Many diagnostic ionizing procedures that are performed every day can potentially expose both patients and the medical staff to high

levels of radiation, and this may cause negative health effects on the human body [20]. Our findings showed that the great majority of the respondents (98.2%) did not know that patients have no defined safe dose limit according to ICRP guidelines, and this percentage is higher than that reported by Quinn et al. (70%) [10].

Furthermore, physicians should have the ability to compare the radiation doses that are associated with the various medical imaging modalities and to express the effective doses in terms of chest X-ray equivalent units. This not only has proven useful in previous physician-based studies but is important in helping patients and their families to understand the relative risks [6,10,11]. On average, only 5% of the participants were able to identify the effective dose equivalent compared to a chest X-ray of a routine lumbar spine

X-ray examination, a barium enema and an abdominal and pelvic CT scan. The literature indicates similar results from other studies that on average fewer than 6% of physicians were able to distinguish these relative doses [8,9,16].

Physicians' knowledge of the public's overall exposure to ionizing radiation is another important aspect of their clinical practice. Only 8% of the participants knew that medical radiation accounts for 15% to 30% of the general public's total exposure to ionizing radiation from all sources, which include radon, gamma rays and cosmic radiation. Also, only 9.2% of our respondents were able to estimate the increased cancer risk from radiation exposure connected with an abdominal and pelvic CT scan (1:1000). This result is similar to the 6% found in another study [13], but inconsistent with the 31% reported in Rice's study [9]. This difference could be due

**Table 4 Physicians' knowledge of chest X-ray equivalents for each type of radiological examination**

No. of chest X-ray equivalents	Lumbar spine X-ray		Abdominal CT scan		Barium enema	
	No.	%	No.	%	No.	%
<1	6	3.7	7	4.3	6	3.7
10	24	14.7	6	3.7	10	6.1
65 <sup>a</sup>	7	4.3	15	9.2	14	8.6
120	0	0.0	7	4.3	9	5.5
250	0	0.0	7	4.3	2	1.2
> 250	2	1.2	14	8.6	5	3.1
Don't know	124	76.1	107	65.6	117	71.8
Total	163	100.0	163	100.0	163	100.0

<sup>a</sup>Correct answer.

CT = computerized tomography.

**Table 5 Physicians' reported frequency of requests for examinations**

Frequency of requests	Routine X-ray		CT scan	
	No.	%	No.	%
Never	2	1.2	2	1.2
Rarely (< 25% of the time)	40	24.5	66	40.5
Sometimes (25%–75% of the time)	64	39.3	73	44.8
Often (> 75% of the time)	57	35.0	22	13.5
Total	163	100.0	163	100.0

CT = computerized tomography.

to the recent focus in the media in the USA and other developed countries on the risks of over-requesting CT scans, as well as to increased concern among medical faculties about radiation issues [9].

On other hand, a fairly high percentage of our participants (46.0%) indicated that they had read articles published in scientific or professional journals or in the general media regarding radiation hazards, such as cancers that have been associated with CT scans; this result is similar to the 48% found by another study [13]. However, our respondents' answers to the specific scientific questions posed were not consistent with this positive finding, as discussed previously. Also, considering that these 2 hospitals are the largest referral hospitals in Palestine, and both offer 4-year clinical training programmes leading to specialty certification in various fields, this percentage is lower than expected. It is known that physicians at Palestinian hospitals have difficulty accessing scientific journals and the related electronic databases and therefore greater access should be offered to these physicians in order to increase their knowledge and awareness regarding

the radiation hazards of radiological examinations.

The results of the study raise a relevant question: If these physicians are aware of the known carcinogenic effects of radiological examination as they reported, why did they not reduce their requests for these examinations in order to protect their patients, recalling that the majority indicated that they request such examinations often, i.e. more than 75% of the time. This is a much higher level than that found in similar previous research (32%) [11]. These findings would seem to support those of the ICRP reports, which indicated that many radiological examinations worldwide are ordered without adequate justification [21].

Our results showed that less than one-third of the physicians had participated in a radiation protection course during their undergraduate study or at their workplace (29.4% and 30.7% respectively). This situation suggests the need to design and conduct such courses or training workshops, both within the medical schools and in hospital workplaces, taking into consideration the frequent changes in the available biological and physical

information and radiation safety standards [21].

The limitations of the study include the use of a self-reported questionnaire, making it difficult to validate the accuracy of the findings since some participants may exaggerate their knowledge. Also, this study involved only the 2 largest referral hospitals in Palestine, thus the generalization of the findings to other health settings may be limited. Further research is required to assess the level of radiological knowledge among medical students in their final year of medical studies and among other health professionals, such as radiological technologists. Finally, further qualitative study would be helpful in exploring in depth the factors contributing to physicians' lack of knowledge, as well as the physicians' actual practices.

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**Table 6 Physicians' attitudes towards reducing their use of different types of examinations**

Will reduce use of method	Routine X-ray		Fluoroscopy		CT scan	
	No.	%	No.	%	No.	%
Yes	100	61.3	98	60.1	114	69.9
No	63	38.7	65	39.9	49	30.1
Total	163	100.0	163	100.0	163	100.0

CT = computerized tomography.

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