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# Assessment of Health Professionals' Knowledge Regarding Risk Factors During Home Radiography

***Panagiotis Bidikoudis, Radiology-Radiotherapy Technologist, PhD(c)***
***Konstantinos Athanasakis, Assistant Professor***
Public Health Policy Department, University of West Attica, Greece
***Christos Michail, Assistant Professor***
Biomedical Engineering Department, University of West Attica, Greece
***Georgios Farantos, Postdoc fellow***
***Georgios Dounias, Professor***
Public Health Policy Department, University of West Attica, Greece

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## Abstract

**Aim and purpose:** The knowledge of health professionals about the potential risks of using ionizing radiation plays an important role in protecting themselves and patients. The use of mobile radiography units poses several threats to workers such as radiation exposure, ergonomic injuries and musculoskeletal disorders from the constant use of lead feet and moving the portable radiography machine. The aim of the study is to highlight the knowledge background of healthcare professionals on radiation and radiation protection. **Methodology:** 72 questionnaires were distributed and 60 were returned with an overall response rate of 83%. The main sections addressed through the questionnaire were demographic data, knowledge background on radiation dose and radiation protection rules and measures. Statistical analysis of the data was performed using SPSS software. **Results:** From the results, the deficit of the knowledge background of health professionals on radiation and radiation protection is evident. It emerged that health professionals, especially medical doctors - radiologists have knowledge of the dose received by the patient when performing a chest X-ray in a percentage of 75%. Also, 6.6% of the respondents stated that they rarely or never use a protective lead apron, while 5% of the respondents stated that they never use a personal dosimeter. **Conclusion:** The guidelines for radiation protection of workers and patients when performing home radiography should be based on the pillars of continuous training of staff, but also on adherence to the very basic principle of justification.

**Keywords:** Ionizing radiation, portable radiology unit, home care, occupational hazard, radiation protection

## Introduction

All health care workers face a range of occupational hazards related to biological (Frinkenzeller et al, 2021), chemical, physical (Yoshinaga S et al, 2004), ergonomic (Siewert B et al, 2013) and psychosocial risks (Ashong G.G.N.A et al, 2016; Alhasan M et al 2014; Zhang Z et al, 2020) that affect the safety of both health care workers and patients.

The main harmful factor for workers during home radiography is ionising radiation and its harmful effects and consequences. Ionising radiation affects the cell nucleus either directly by acting directly on DNA or other large molecules (proteins, RNA enzymes) or indirectly by interacting with water molecules and causing ionisation. Ionisations result in the formation of free radicals that attack DNA and cause breakage in the double helix. By delayed or stochastic effects we refer to the likelihood of malignancy usually after many years (>20-30 years) either in the exposed individual or in the offsprings.

In the case of mobile radiography units, as in the case of radiological laboratories, occupational radiation dose limits have been established by the competent authorities on the basis of the recommendations of the International Commission on Radiological Protection (Valentin 2007). The aim of these limits is to ensure the health and safety of health professionals involved in the use of ionising radiation. According to the Euratom Directive 2013/59 (ESR, 2015) the annual dose limit for occupationally exposed persons is 20 mSv/year. However, in special cases or for specific exposure situations identified in national legislation, a higher active dose of up to 50 mSv may be allowed by the competent authority for an individual year if and when the average annual dose for five consecutive years including years for which the limit has been exceeded does not exceed 20 mSv.

Following the ICRP guidelines, the new guidelines for eye lens protection modify the dose equivalent limit for the eye lens to 20 mSv/year from the previous value of 150 mSv/year. The dose equivalent limits for the

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skin and extremities should not exceed 500 mSv/year. This limit applies to the average dose to any $1cm^2$ skin area, irrespective of the exposed area.

Literature points out that all health professionals working in radiology laboratories and mobile radiography units can reduce the risks of ionizing radiation by applying established radiation protection principles such as ALARA, the 10-day rule, the three basic principles (time, distance, shielding), as well as the use of appropriate radiation protective clothing and dosimetry (Mattews and Brennan, 2008).

The aim of this study is to highlight the knowledge background of health care professionals on radiation and radiation protection.

## Methods

It is a cross-sectional study which was conducted among working physicians, nurses and technologists - radiologists at the Radiology Laboratory of the General Hospital of Nikaia, the Health Center of Piraeus and the company providing home X-ray imaging "X-ray Imaging Express". 72 questionnaires were distributed and 60 were returned (with a response rate of 83%). The questionnaire was completed after written consent was obtained from the participants. Exclusion criteria were incomplete completion of the questionnaire.

The practical part of the study started with the preparation of a 12-question closed-ended multiple-choice questionnaire based on Greek and international literature. The questionnaire included 4 sections. The first section contained questions about demographic characteristics. This section of the questionnaire consisted of general questions (gender, age, work experience, education, work position, work institution). The second section included questions about knowledge background and theoretical issues about radiation. The third section explored knowledge about the rules and principles of radiation protection and radiobiology. Finally, the fourth section included questions exploring the attitudes of health professionals regarding radiation protection issues in practice.

After collecting the questionnaires, the responses were first coded and assigned to appropriate variables. They were then entered into the SPSS statistical software package for analysis.

This was followed by descriptive statistical analysis of the data as well as Crosstabs analysis of some selected questions based on the theoretical background of the participants, knowledge about radiation protection and radiobiology rules and daily practical use of radiation protection agents, with gender, experience and professional status as factors.

## Results

The majority of the participants at 46.67% belonged to the age group 36 to 45 years old, followed by the age group 46 to 55 with 28.33%, the age group 56 to 65 with 20% and finally the age group 18 to 35 with 5%. 41.67% were post-secondary education graduates, 18.33% were university graduates, 38.33% were technology graduates and finally only 1.67% held a post-graduate degree. The majority of the employees had 13 or more years of experience in their field at 80% while the remaining 20% had between 1 month and 13 years. So, it seems that majority of the employees were experienced in their workplace. 36.67% of the workers were technologists/radiologists, 21.67% were nurses, 25% were radiology/radiology assistants and finally 16.67% were radiology physicians. 53.33% of the participants worked at the General State Hospital of Nikaia, 33.33% at the Piraeus Health Centre and finally 13.33% at the private home radiography company "Aktinoapikonisi Express".

In the field of questions that examines the knowledge background on radiation dose, which is presented in Table 1, the majority of the participants (55%) gave the wrong answer as 40% of the employees stated that the annual radiation dose received by each person from natural sources does not exceed 0.3mSv, 15% stated that they receive exactly 0.3 mSv and finally 45% believe that they receive more than 0.3mSv. According to the Greek Atomic Energy Commission, the right answer regarding to dose is 2.7 mSv.

**Table 1:** Radiation dose from natural sources per year

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | Below O,3 mSv | 24 | 40,0 | 40,0 |
| | O,3 mSv | 9 | 15,0 | 15,0 |
| | Over O,3 mSv | 27 | 45,0 | 45,0 |
| | Total | 60 | 100,0 | 100,0 |

According to the answers given about the knowledge of the dose received by the patient during a chest x-ray, which are listed in Table 2, radiology physicians at a percentage of 100% correctly consider that the radiation dose received by a patient is below 0.1 mSv, as not a single wrong answer was given. Among healthcare professionals, radiology assistants answered correctly at a percentage of 73.3%, nursing staff at a percentage of 69.2% and radiology technologists at a percentage of 68.1%.

**Table 2:** Dose of radiation received by a patient during a chest x-ray, depending on the work position

| | | Working Position | | | | Total |
|---|---|---|---|---|---|---|
| | | Radiologist Technologist | Doctor | Nursing | Radiologist | |
| 1 mSv | Count | 2 | 0 | 2 | 2 | 6 |
| | % of | 3,3% | 0,0% | 3,3% | 3,3% | 10,0% |
| Below O,1 mSv | Count | 11 | 10 | 9 | 15 | 45 |
| | % of | 18,3% | 16,7% | 15,0% | 25,0% | 75,0% |
| Over 1 mSv | Count | 2 | 0 | 2 | 5 | 9 |
| | % of | 3,3% | 0,0% | 3,3% | 8,3% | 15,0% |
| Total | Count | 15 | 10 | 13 | 22 | 60 |
| | % of | 25,0% | 16,7% | 21,7% | 36,7% | 100,0% |

According to the answers given about the knowledge background about the rules and principles of radiation protection, which are listed in Table 3, 71.6% of the participants stated that they consider it likely/very likely to stay 1 meter away from the patient during a chest X-ray using a portable unit.

**Table 3:** Maintain a distance of 1 meter during irradiation

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | NOT AT ALL LIKELY | 5 | 8,3 | 8,3 |
| | SLIGHTLY LIKELY | 5 | 8,3 | 8,3 |
| | MODERATE | 7 | 11,7 | 11,7 |
| | LIKELY | 14 | 23,3 | 23,3 |
| | VERY LIKELY | 29 | 48,3 | 48,3 |
| | Total | 60 | 100,0 | 100,0 |

As shown in Figure 1, 51.7% of the participants stated that they considered it likely/very likely to remain behind a lead curtain when performing a chest radiograph with a mobile radiology unit.

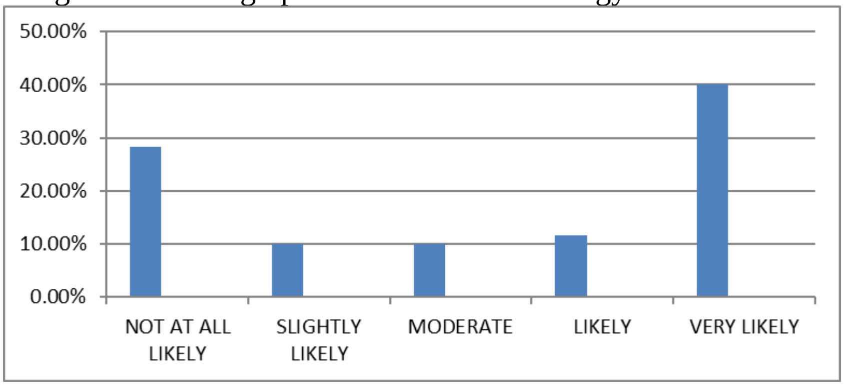


**Figure 1:** Percentage of responders who remain behind a lead shield during a chest x-ray with a portable x-ray machine

As shown in Table 4, 68.3% of participants stated it is likely/very likely to remain behind a remote wall during the examination with a mobile radiology unit.

**Table 4:** Frequency of using a molybdenum remote wall for radiation protection when performing an x-ray with a mobile x-ray unit

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | NOT AT ALL LIKELY | 5 | 8,3 | 8,3 |
| | SLIGHTLY LIKELY | 10 | 16,7 | 16,7 |
| | MODERATE | 4 | 6,7 | 6,7 |
| | LIKELY | 17 | 28,3 | 28,3 |
| | VERY LIKELY | 24 | 40,0 | 40,0 |
| | Total | 60 | 100,0 | 100,0 |

70% of participants are likely/very likely to move away from patient attendants during an examination with a portable radiology unit.

Finally, in the question section on the knowledge background about radiation protection practices, as shown in Table 5, 91.7% of the participants stated that they always/very often/frequently use the personal dosimeter.

**Table 5:** Frequency of use of a personal dosimeter with the aim of radiation protection during mobile x ray examinations

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | ALWAYS | 45 | 75,0 | 75,0 |
| | VERY OFTEN | 10 | 16,7 | 16,7 |
| | NEVER | 3 | 5,0 | 5,0 |
| | OFTEN | 2 | 3,3 | 3,3 |
| | Total | 60 | 100,0 | 100,0 |

51,7 % of the participants stated that they always/very often/frequently use the lead screen when performing radiographs with mobile radiology units. 93,3 % of the participants stated that they always/very often/frequently use the protective lead apron when performing radiographs using a mobile radiology unit.

While, as shown in Table 6, 65 % of the participants stated that they always/very often/frequently use the lead radiation protective collar.

**Table 6:** Frequency of use of lead radiation protection collar with the aim of protecting yourself during the performance of radiography with a mobile x ray unit

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | ALWAYS | 26 | 43,3 | 43,3 |
| | VERY OFTEN | 6 | 10,0 | 10,0 |
| | NEVER | 13 | 21,7 | 21,7 |
| | RARELY | 8 | 13,3 | 13,3 |
| | OFTEN | 7 | 11,7 | 11,7 |
| | Total | 60 | 100,0 | 100,0 |

## Discussion

The aim of this study was to investigate the knowledge background of health professionals working in areas with ionizing radiation, regarding the radiation dose received by the patient and the knowledge of the principles and rules of personal radiation protection when performing examinations with a mobile radiological unit.

The results showed that health professionals and especially physicians - radiologists have knowledge of the dose received by the patient during the performance of a chest X-ray, at a rate of 75%, while on the contrary, the lack of knowledge on radiation dose from natural sources is evident, as more than 50% of the respondents were not aware of the dose received by the person from natural radiation sources. This result is consistent with previous studies (Konstantarogianni, 2015; Koukouletsos 2020).

However, an interesting finding of this study is that the knowledge of the majority of the participants, in terms of the qualitative measure of body burden when various radiological examinations are performed, is extremely low. Radiology technologists and physicians, in general, appear to be more knowledgeable than nursing staff but they too show a knowledge deficit especially in dosage issues of various imaging examinations. This result is in agreement with the findings of previous studies (Shiralkar et al , 2003).

One of the encouraging results of the study is that almost all participants report that they almost always take all necessary personal radiation protection equipment. However, despite the recognised risks arising from radiation exposure, there appears to be a proportion of 6.6% who state that they rarely or never use a protective lead apron. It is also surprising that 5 % of respondents stated that they never use a personal dosimeter. In previous studies the corresponding percentage is much higher (Muhammad A.J.,2015). There is also a lack of information about the rules of radiation protection when performing radiographs with a mobile radiography unit.

The results of the present study combined with the results of previous studies emphasize the need for more and more complete information and continuous education of health professionals about ionizing radiation used in various examinations, the risks of radiation exposure and the need for personal radiation protection and patient protection. It is considered essential that staff should have and use radiation protection equipment correctly.

It is evident that the overall picture of the knowledge background on radiation by health professionals shows weaknesses, which may however lead to the design of targeted interventions that will increase the awareness of health workers.

## Conclusions

The development of biomedical technology has contributed to the radiation protection of workers as it is now possible to use machines remotely and with the interposition of radiation protection materials, compared to the past.

In perfect harmony with the above, the latest update of the radiation protection guidelines emphasises the radiation protection of patients considering workers to be sufficiently radioprotected now. However, when performing home radiographs, the advantages of the development of biomedical technology are not visible, as the presence of the technologist-radiologist in close proximity to the patient is required.

Therefore, the main concern should be to ensure that health professionals comply with radiation protection measures, which will be maximised through awareness-raising and continuous training of workers. Staff training is the most important preventive measure in the field of occupational health and safety. The benefits of training relate both to the knowledge and management of workplace risks and the development of a safety culture which is key to the success of prevention.

**Declaration for Human Participants:** This study has been approved by the Scientific and Ethical Committee of the University of West Attica, School of Public health and the principles of the Helsinki Declaration were followed.

**Conflict of Interest:** The authors reported no conflict of interest.

**Data Availability:** All data are included in the content of the paper.

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