

# Radiological protection in the perspective of health professionals exposed to radiation

*Proteção radiológica na perspectiva dos profissionais de saúde expostos à radiação*  
*Protección radiológica en la perspectiva de los profesionales de la salud expuestos a la radiación*

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## ABSTRACT

**Objective:** To evaluate the knowledge of health professionals about radiological protection and to implement educational actions to promote a safe working environment for professionals, patients and companions. **Method:** An exploratory cross-sectional study, applying a questionnaire to 59 participants from different sectors of a teaching hospital. Open-ended questions were analyzed through the discourse of the collective subject and closed-ended questions were analyzed through quantitative analysis. **Results:** In the opinion of the participants, their professional training did not offer radioprotection class or the training was insufficient for the practice. In addition, the work environment does not provide regulatory norms and training on radioprotection. Most participants do not have solid knowledge and do not present safe behavior in radioprotection. In the internal week for the prevention of work accidents, a lecture and a theatricalisation about the topic of radioprotection were conducted and a booklet was distributed. **Conclusion:** Radiation protection education is necessary in the curricula of the training courses for health professionals and in the work environment.

**Descriptors:** Ionizing Radiation; Radiation Protection; Protective Devices; Health Education; Occupational Health.

## RESUMO

**Objetivo:** Avaliar o conhecimento que os profissionais de saúde têm sobre proteção radiológica e implementar ações educativas para promover um ambiente de trabalho seguro aos profissionais, pacientes e acompanhantes. **Método:** Estudo transversal exploratório, aplicando-se um questionário a 59 participantes de diferentes setores de um hospital de ensino. Questões abertas foram analisadas pelo discurso do sujeito coletivo. Questões fechadas tiveram análise quantitativa. **Resultados:** Na opinião dos participantes, o curso que fizeram não ofereceu formação sobre radioproteção ou foi insuficiente para a prática. O ambiente de trabalho também não disponibiliza normas regulatórias e formação sobre radioproteção. A maioria dos participantes não tem conhecimento sólido e comportamento seguro em radioproteção. Na semana interna de prevenção de acidentes de trabalho, foram feitas palestra e teatralização sobre o tema radioproteção e distribuída cartilha. **Conclusões:** São necessárias inserções educativas em radioproteção nas grades curriculares dos cursos formadores de profissionais de saúde e no ambiente de trabalho.

**Descritores:** Radiação Ionizante; Proteção Radiológica; Equipamentos de Proteção; Educação em Saúde; Saúde do Trabalhador.

## RESUMEN

**Objetivo:** Evaluar los conocimientos de los profesionales de la salud sobre la protección radiológica con el intuito de implementar acciones educativas para promover un ambiente de trabajo seguro para los profesionales, pacientes y acompañantes. **Método:** Se trata de un estudio transversal exploratorio, desarrollado por medio de un cuestionario aplicado a 59 participantes de diferentes sectores de un hospital de enseñanza. Se analizaron las cuestiones abiertas mediante el discurso del sujeto colectivo, y las cerradas, mediante análisis cuantitativo. **Resultados:** Según la opinión de los participantes, el curso no sumó conocimiento sobre la radioprotección o fue insuficiente para la práctica. El ambiente de trabajo tampoco pone a disposición normas reguladoras y formación sobre el tema. La mayoría de los participantes no poseen conocimiento sólido y comportamiento seguro en radioprotección. Durante la semana interna de prevención de accidentes de trabajo, se realizaron conferencias y teatralización sobre el tema radioprotección y se distribuyeron cartillas. **Conclusión:** Es necesario la inclusión educativa sobre radioprotección en los planes de estudio de los cursos formadores de profesionales de la salud y en el ambiente de trabajo.

**Descriptores:** Radiación Ionizante; Protección radiológica; Equipos de seguridad; Educación en salud; Salud laboral.

## INTRODUCTION

X-rays are a type of radiation that has enough energy to pass through opaque bodies. These rays produced by the electrons that move from the cathode to the anode inside the x-ray tube, accelerated by a high voltage, whose energy is used for the production of photons (1%) and increase of the temperature of the anode (99%). The photons are the radiation that will be used to produce the radiographic image. The radiation that comes out from the x-ray tube is called primary radiation. When the primary beam passes through the bodies, it is attenuated as the photons interact with the internal structures of the body they pass through. When they leave on the other side, they will impress a film (traditional x-ray) or will be captured by a system capable of scanning the image, resulting in different intensities that define the radiographic image<sup>(1)</sup>.

Biological molecules are primarily made up of atoms of carbon, hydrogen, oxygen, and nitrogen. Electrons can be removed from these molecules when they are irradiated, producing ions, which is called ionizing radiation. For the ionization of biological material to occur, the energy released by radiation must be greater than the binding energy holding the electrons and the atoms of these elements. The energy released by radiation can also put the atoms in excited state, break molecules and, as a consequence, can form highly reactive ions and free radicals, which can attack very important molecules (like DNA) in the cell nucleus, causing damage. The effect of ionizing radiation on an individual depends primarily on the absorbed dose, the exposure time (short/prolonged) and extent of exposure (whole body/localized). The biological effects of radiation can manifest in the short and long term<sup>(1)</sup>. Short-term effects occur with high doses of radiation, usually in accidents. The chronic effects of ionizing radiation can occur in people exposed to high doses of radiation (accidents) who have survived and, more often, in people who were exposed to low, repeated, cumulative doses of radiation<sup>(1)</sup>. These are more worrying as they only cause symptoms after a long time of exposure, when serious illnesses are manifested. Among the consequences of long-term ionizing radiation are an increased risk of developing cancer, particularly in the immune and hematological systems, and mutations in the reproductive cells that may pass to future generations<sup>(1)</sup>.

Healthcare professionals, particularly those working in imaging sectors and in hospitals, are more exposed to ionizing radiation. If they do not take adequate protective measures, they will be at greater risk of developing different types of cancer<sup>(2-7)</sup>. These risks have been known for decades; however, the curricula for the training of health professionals, whether in college or vocational training courses, rarely include radiation protection education. When they do include this topic, they focus on individual protection and neglect the protection of patients, family members and others in the hospital or health care setting.

The broad concept of radiological protection addresses the prevention of possible damages caused by ionizing radiation, which depend on the absorbed dose and are a consequence of the dose of each exposure and the accumulation of repeated doses. Thus, all care actions that reduce exposure to ionizing radiation are considered as radioprotection, such as indication

of only appropriate and indispensable radiological examinations, the use of the minimum dose of radiation required for a quality exam, restricting exposure to the areas of interest and the use of personal protective equipment by the technician and the people who are nearby and for some reason can not move away from the source of radiation<sup>(1,8-9)</sup>. The International Commission on Radiological Protection proposes three fundamental principles guiding radioprotection care: justification (there must be a precise medical indication for the examination), optimization (care related to the exam and control of the professionals who are exposed) and dose limitation (to the minimum necessary and sufficient to perform a quality examination, also known as ALARA principle - *As Low As Reasonably Achievable*)<sup>(1,9)</sup>.

Radiological protection norms and legislation began to be established in 1928 and today are quite comprehensive, complete and universal, including the Brazilian legislation<sup>(1,8-11)</sup>. However, these norms are rarely observed in their entirety, resulting in unnecessary risk to health care workers and users. Recently, the International Association for Radiological Protection proposed the concept of a "Radiation Protection Culture", which can be summarized as

the combination of knowledge, values, behaviors and experiences of radiation protection in all its aspects for patients, workers, population and environment, and in all exposure situations, combining scientific and social dimension<sup>(12)</sup>.

Regarding the experience in health care environments, the observation of the behavior and attitudes of health professionals in hospitals and radiological clinics shows that people have attitudes of individual protection, but have no knowledge and training to support these actions. Thus, this study focuses on the practices and measures of protection taken by health professionals in the context of radioprotection.

## OBJECTIVE

To assess knowledge, attitudes and social representation related to radioprotection among health professionals in a teaching hospital. From the data obtained we sought to encourage among health professionals reflection about practices related to exposure and radiological protection in their daily life and to stimulate the managers of the hospital to have systematic attitudes of radiological protection.

## METHOD

### Ethical aspects

The research project and the informed consent form were submitted and approved by the Research Ethics Committee (REC) of the institution, and the investigation was initiated after its approval. All the study material and the identity of the participants were kept confidential by the researchers. At the end of the study, the results and the technical analysis were communicated to the REC and to those in charge of the radioprotection in the hospital. The researchers requested a moment to share the results with all the community involved, during the Internal Week for the Prevention of Work Accidents (SIPAT).

## Type of study

This is an exploratory cross-sectional study, with quantitative analysis of the closed-ended questions and qualitative analysis of the open-ended questions.

## Theoretical and methodological framework

The theoretical model used was the Italian Workers' Model (IWM), a method developed by the Italian workers in the 1960s and 1970s. This method seeks to identify the risks and damages to which workers are exposed, through the reconstruction of work processes and with technical advice from professionals with knowledge about work processes and work risk (physician, psychologists, engineers, social assistants). Based on the knowledge obtained, actions to repair and prevent these risks are proposed, transforming the working conditions with the objective of promoting well-being and protecting the workers' health<sup>(13-14)</sup>.

## Methodological procedures

### Study scenario

The study was conducted in a teaching hospital belonging to the foundation that maintains a community university. It has 150 beds available for the different hospitalization areas, and also has an outpatient clinic for users of the Unified Health System (SUS) and of the Supplementary Health System. The staff consists of 240 administrative staff, 238 nursing professionals, 10 radiology technicians and a clinical staff with approximately 200 physicians. The imaging service performs procedures involving ionizing radiation in x-ray rooms, computerized tomography, bone densitometry, mammography, hemodynamics, surgical center and uses portable equipment for examinations in all the infirmaries and in the adult and neonatal intensive care units (ICUs).

### Data Source

All employees in the "controlled areas" (areas at risk of radiation exposure) of the hospital, specifically the hemodynamics sector and the imaging sector, were invited to participate in the study. All health professionals from the clinical, surgical, pediatric and ICU units who are exposed to ionizing radiation, even if only eventually, were also invited. Participants received all information about the project, read and signed the informed consent term before undertaking any study procedure.

### Data collection and organization

After signing the informed consent form, the participants received a questionnaire built by the authors to evaluate their previous knowledge about radiation protection. The questionnaire was divided into 2 parts: the first one (general) was answered by all the participants and consisted of personal data, formal education and 17 questions related to radioprotection, most of them closed-ended (yes-no questions); the second part of

the questionnaire was specifically for professionals working in "controlled areas" and contained 11 other questions. Participants received the questionnaire shortly after starting their work shift and should answer it until the end of the shift, when it was collected. The questionnaire was reviewed by three independent judges, two imaging specialists and one radiology technician, who made few suggestions which were accepted and incorporated by the authors.

### Data analysis

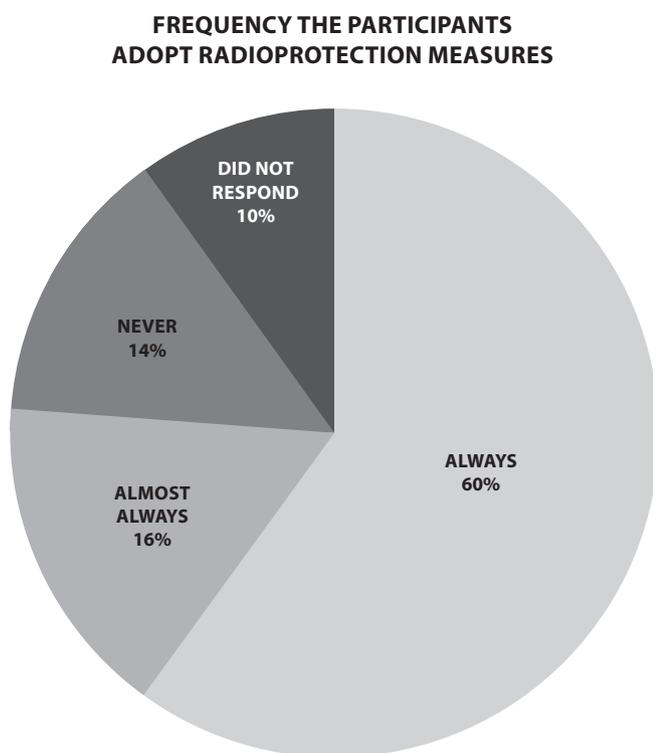
There were two open questions that required specific knowledge. For that reason, they were corrected by an independent educator with training in the area, who, based on a correction script pre-established by the researchers, classified the response as "correct" (when most of the conceptual elements of radioprotection were present), "incorrect" (when the conceptual elements of radioprotection were absent) and "partially correct" (when only some conceptual elements of radioprotection were present). The standard response to the first question of the questionnaire (*what does the term "radiation protection" or "radioprotection" mean for you?*) provided to the corrective educator was "considering that the risk posed by ionizing radiation is cumulative, radioprotection can be understood as the set of actions aimed at reducing to the minimum possible the radiation load received by any person who is present in places of exposure (patients, employees and companions) and includes attitudes such as: indication of only appropriate and indispensable radiological examination for the diagnosis, with the lowest risk; examinations respecting techniques and norms that guarantee less exposure and quality result; use of individual and collective protective equipment to prevent the progression of the radiation".

Descriptive statistics were used for the analysis of the yes-no questions. The first 17 questions applied to all professionals who answered the questionnaire will be presented as a whole (Table 1). The last 11 questions addressed to professionals working in "controlled areas" will be presented separately (Table 2). Open responses (qualitative data) were analyzed by the method Discourse of the Collective Subject (DCS)<sup>(15)</sup>. The DCS method is a technique of tabulation and organization of qualitative data, developed by Fernando Lefevre and Ana Maria Cavalcante Lefevre at the end of the 1990s, based on Serge Moscovici's Theory of Social Representation<sup>(16-17)</sup>. The DCS consists of a synthesis discourse written in the first person singular, which associates parts of discourses with similar meaning that are categorized through standardized systematic procedures. It allows to know the thoughts, representations, beliefs and values of a collectivity about a given subject, using scientific and reproducible methods<sup>(16-17)</sup>. The application of the DCS technique in a large number of researches in the field of health and also in other areas of knowledge has demonstrated its effectiveness to process and express collective opinions. The technique consists in selecting the key expressions in individual answers, which are the most significant parts of the answers. These key expressions correspond to the central ideas, which are the synthesis of the manifested discursive content, in which the thought of a group or collectivity appears as if it were an individual discourse<sup>(16-17)</sup>.

## RESULTS

A total of 59 people (45 women) participated in the research. The mean age of the participants was 33.0 years (SD 7.2 years) and they were from areas of hemodynamics, imaging, adult and neonatal ICU, pediatrics, surgical center, nursing, cleaning and clinical engineering. They were health professionals from different areas, most from the nursing team (n=45, 13 with higher education and 32 with technical training). There were also 4 physicians, 2 professionals from the imaging sector (1 with higher education and 1 technician) and 8 other professionals from other areas (6 with higher education and 2 with complete high school).

After collecting personal information, the first question in the questionnaire was: *What does the term "radiation protection" or "radioprotection" mean for you?* Because it was an open question, it was submitted to correction by an independent educator as previously described (methods). Figure 1 shows the percentage of correct, incorrect and partially correct responses to the concept of radioprotection.



**Figure 1** - Correction of Participants' Answers to the Question: *What does the term "radiation protection" or "radioprotection" mean for you?*

Ten participants (17%) did not respond. Of the total, only 34% of the participants expressed a concept of radioprotection considered correct. An example of a correct answer was:

I believe it must be referring to the use of protective clothing and equipment by the professional and the patient when they are exposed to the x-ray and to the use of the dosimeter to measure the monthly radiation the technician is exposed to.

The analysis of the responses through the DCS technique revealed 4 main categories. The first one includes the responses

of 25 participants and was defined as "protection of health professionals against the risks of radiation". In this category, the DCS to the question *What does the term "radiation protection" or "radioprotection" mean for you?* can be summarized as:

I understand it to be a set of actions, attitudes and measures, including the use of equipment and signing, used during x-ray examinations and procedures, in order to mitigate the risks of radiation that may be harmful to health and cause carcinogenic effects and degenerative diseases.

Still on the same question, another category with a large number of responses was "the use of personal protective equipment", given by 15 participants. This DCS can be expressed as:

I understand that radiation protection is the use of protective equipment made of lead to protect or attenuate the exposure of the professional when performing radiological exams.

Six participants responded in ways that categorized radiation protection as "personal and collective protection". Although the DCS resulted in a broad (non-specific) description, it was the closest to the correct and comprehensive concept of radioprotection. The DCS for this category can be elaborated as follows:

I understand radioprotection as measures, mechanisms, attitudes and all resources that can be used to protect professionals, employees and patients directly or indirectly exposed to ionizing radiation.

For two participants, radiological protection was categorized as "documents and standards to be followed," with the DCS:

I understand it as a document that points out areas exposed to ionizing radiation, providing solutions for the professional to remain safe and based on Ministry of Health ordinance 453, which establishes dose limits for occupationally exposed individuals.

Other responses referred to the company's role in ensuring the protection of the worker by monitoring and providing training for activities involving risk of exposure to ionizing radiation.

Table 1 presents the answers of the participants (n=59) to the general questions related to radioprotection, while Table 2 presents the responses of participants who work in controlled areas (n=18), who are subjected to a higher risk of exposure to radiation and who answered more technical questions about radiation protection.

As shown in Table 1, the majority of the participants consider that the undergraduate or technical course did not offer adequate training in radioprotection for their professional practice in the health area. Likewise, the employer does not offer training in radioprotection or provides normative or educational material in the workplace. It is interesting to note that in question five 85% of participants report that they know how to take appropriate action when exposed to radiation at the workplace. The next question (question 6) asked them to explain how they protected themselves in the conditions of radiation exposure and was analyzed by the DSC, as it was an open question. A technical correction like the first one was conducted. In contrast to the answer to question 5, in which the majority (85%) reported knowing how to protect themselves, the correction of open answers revealed that only part of the participants (24%)

were able to correctly point out the measures necessary to protect themselves from exposure to x-rays in their work environment, while 46% showed partial knowledge about these measures and 30% did not respond or were mistaken. Regarding this question, the analysis of the responses by the DCS technique allowed to identify an important category that included the responses of 20 participants, synthesized by “keeping distance from the source of radiation”. The discourse that best represents the collective speech is as follows:

I can protect myself from ionizing radiation by moving away from the x-ray tube, following the guidance of the radiology technician and moving to another sector during the examination.

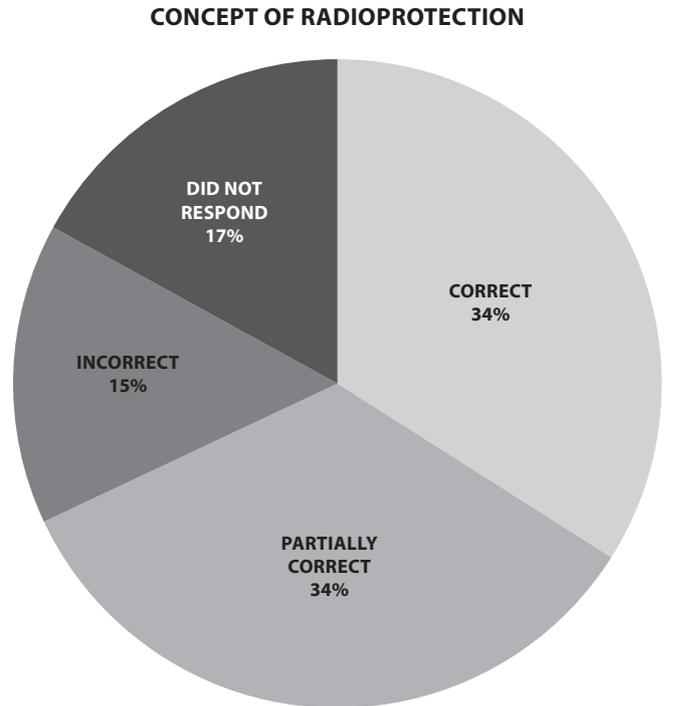
**Table 1** - Responses of All Participants to the General Questionnaire about Radioprotection

Question	Participants (n=59)	Yes (%)	No (%)	NR (%)
2. Did your vocational training or undergraduate course offer training in individual and collective radiation protection?		37	61	2
If yes, do you consider this training sufficient for your professional protection?		41	59	-
3. In your work environment, have you been offered any training in radiation protection?		24	74	2
4. Are you aware of any regulatory standards or ordinances for radiation protection adopted by the hospital?		29	68	3
If yes, is it available for consultation on the work environment?		71	24	5
5. Do you know how to protect yourself from x-rays when the exam is conducted on patients in your work environment?		85	12	3
If yes, what measures should be taken? *				
How often do you take these measures? **				
7. Would you be interested in participating in a permanent education process about radioprotection in the hospital?		87	13	-
8. Is there a written protocol to be observed for radiation protection in your work environment?		14	74	12
9. Is there a radiation supervisor?		14	72	14
10. Is a copy of the SVS/MS Ordinance No. 453/1998 available in the sector? ***		44	31	25
11. Are there individual dosimeters available for health professionals working in the radiology sectors?		42	42	16
12. Is there written and periodic monitoring of radiation dose in exposed professionals?		42	42	16
13. Do the professionals receive the results of the dosimeter readings and the clinical exams performed?		39	46	15
14. Is there registered training on basic occupational hazard information?		24	64	12
15. Is there written documentation of routine work procedures, including radiological protection plan?		17	64	19
16. Are the facilities where ionizing radiation is used well signaled?		64	25	11
17. Do the doors closed allow the perfect isolation of the rooms?		62	19	19

Note: NR – no response. \* Because it was an open question, it was analyzed by the discourse of the collective subject and in the correction shown in Figure 1. \*\* Results presented in Figure 2. \*\*\* No SVS/MS No. 453/1998 copies were found in the locations researched.

One participant mentioned as a protective measure “not to exceed the daily work shift allowed by law”.

When asked to say how often they adopted the radioprotection attitudes they have described, only 60% of the participants reported adopting them “always” (Figure 2).



**Figure 2** - Frequency the Participants Reported Adopting Radioprotection Attitudes in Their Work Environment

Still in Table 1, regarding questions 7 to 10, it appears that the participants are interested in receiving training and want to have radioprotection standards in their work environment. Many believe that these standards are available, which is not true. In more technical questions, such as question 10 and later in Table 2, it is verified that the opinions are more divergent, that a good part of the participants does not respond, and that the answers are distributed among the three alternatives, which suggests ignorance about the subject.

Table 2 displays the answers to the questions directed to professionals working in controlled areas who, for this reason, are expected to be more familiar with the norms and appropriate behaviors of radiological protection. The answers in fact point in this direction, since most of the participants respond positively to the questions regarding the adequacy to the norms and procedures of radioprotection. However, three issues are striking and indicate concern about the institution’s attitudes: most participants indicate that there is no one representing the imaging sector in the Internal Commission for Accident Prevention (CIPA); that there are no protocols available for accidents or emergencies; and that there are no thyroid and genital protectors available to companions who may be exposed to radiation.

**Table 2** - Answers of Participants Working in Controlled Areas (Higher Risk of Exposure to Ionizing Radiation) to Specific Questions about Radiological Protection

Question	Participants (n=18)	Yes (%)	No (%)	DR (%)
18. The location of the control cabin allows observing the access door		82	18	-
19. Is there a quality control program and regular preventive maintenance to ensure that the equipment meets performance specifications?		80	20	-
20. Are there warning signs when ionizing radiation is active inside the room?		100	0	-
21. Do the technicians adapt the dose used according to protocols pre-established in the equipment?		73	27	-
22. Is there a sign in a visible place requesting women to inform the doctor or technician about pregnancy or suspicion of pregnancy before the examination?		65	35	-
23. Is there a person representing the imaging service at the CIPA (Internal Commission for Accident Prevention)?		56	44	-
24. Is PPE (Personal Protective Equipment) available on the service?		94	6	-
25. Are there enough lead aprons available during the examination?		94	6	-
26. Are there protocols/flowcharts regarding procedures to be adopted in case of accidents or emergencies?		30	70	-
27. Are there genital and thyroid protectors available for patients and companion?		50	50	-
28. Are there written guidelines about the disposal of waste generated by the radiology service?		81	19	-

Note: NR- No Response.

### Actions proposed given what was observed in the research

Activities for the Internal Week for the Prevention of Work Accidents (SIPAT) were proposed and promptly accepted. These activities consisted of a lecture and theatricalisation through skits with the participation of hospital employees usually involved in work activities with exposure to radiation. During the SIPAT, a comic strip was also distributed, whose plot included exposure to risk, negligence of the health professional and the possible consequences of this behavior.

Also as a result of the study and coinciding with the recently published Interministry Ordinance No. 285, which regulates the certification of teaching hospitals and includes in Article 6, Section "I", item "j", the obligation to establish a Commission of Radiological Protection in teaching hospitals, the Hospital's Board of Directors implemented the Radiological Protection Commission in the hospital, which from then on operates regulated by an internal regiment and with its own work schedule<sup>(18)</sup>.

### DISCUSSION

Despite the difficulty in recruiting professionals for the study, the sample is representative regarding the proportion of participants

in each area, with the exception of physicians, who were less interested. Nursing professionals, who are the majority among employees in the hospital, were represented by approximately 20% of the total, while the most exposed professionals, who work in the controlled areas, had an expressive participation. As the research topic involves technical issues, which are ruled by specific norms, there may have been stronger resistance from employees to participate because they fear exposing their ignorance on the subject. Even among those who were willing to answer the questionnaire, some chose not to answer the questions that demanded a written answer and not just the choice between "yes" or "no".

At the beginning of the questionnaire, most of the participants had difficulties to define radioprotection and only 34% had correct answers containing most of the conceptual elements of radioprotection. In another written question, in which they are asked to explain radioprotection measures taken when they are exposed to radiation in their work environment, it is again evident that only part of the professionals (24%) can describe how to effectively protect themselves. Then, in the next question, only 60% indicate that they "always" adopt the radioprotection measures they have described. Despite this, it is important to recognize that the health professionals demonstrate interest and willingness to play a better role in the task of radiological protection.

The open questions analyzed and categorized by the DCS show that the most frequent responses emphasize individual protection and the use of protective equipment. In this sense, only few describe the concern with patients, relatives and other people present in the work environment.

It is noteworthy that most professionals consider that their high school, technical or higher education did not qualify them to have radioprotection attitudes. In fact, health education curricula do not provide training for radiation protection, with rare exceptions.

In the following questions, it is clear that the institution also neglects the training of professionals and users involved in radioprotection. In this sense, there are movements in health sectors and in society as a whole seeking to fill this gap, particularly pursuing patient and worker safety and health<sup>(19-20)</sup>. However, these initiatives do not address the issue of radiation protection. It should be noted that the recent Interministry Ordinance regulating the standards for the certification of Teaching Hospitals includes the obligation of the existence of a Radiation Protection Commission<sup>(18)</sup>. This norm will certainly be a great incentive to the culture of radiological protection, since, from the teaching hospitals, where health professionals spend a good part of their training, radiological protection can spread to other work places.

In recent years, the International Association for Radiological Protection, recognizing the difficulties and non-observance of radiation protection standards, implemented, through the concept of a "radiation protection culture", a policy that involves the whole body of workers, users and people who should be involved in actions and continuous attitudes related to radioprotection<sup>(12)</sup>. The United States hosts The Image Gently® Alliance, which is probably the initiative with the broadest adherence of health care organizations, with more than 90 entities from different countries. Its main objective is to encourage radiological protection, particularly for

children, since they are more sensitive to the effects of radiation<sup>(21-22)</sup>. Inspired by this initiative, a radioprotection campaign was recently implemented in another hospital in the city, which belongs to a cooperative of the supplementary health system. The campaign included training of the professional team, adequacy of radiation doses to each test and the creation of a card of individual radioprotection for children up to 12 years old, in which all radiological exams already performed are recorded<sup>(23-24)</sup>. The process had wide acceptance and participation of all involved. As a result, in the year after the implementation of the radioprotection campaign and card, there was a 22% decrease in requests for radiological exams in the pediatric emergency and emergency department<sup>(23-24)</sup>.

It is possible to perceive that radiological protection is becoming a topic increasingly known, studied and discussed, resulting in the adoption of norms or in the encouragement to attitudes that aim to protect the health of the user and the worker<sup>(9-10,21,25-26)</sup>. Every opportunity offered should be used to stimulate the culture of radiological protection, since the tests that emit ionizing radiation are still necessary in health care. In this sense, radiation protection education must be seen as indispensable in the curricula of training courses for health professionals and in continuing education and it must be understood as a strategy for the primary prevention of diseases and health promotion<sup>(27)</sup>.

### Study limitations

We consider as the main limitation of the study the low participation of health professionals of the teaching hospital, particularly of physicians. We believe that this was due to the characteristics of the questionnaire applied, which addressed specific knowledge about radiation protection, so it might have made professionals feel embarrassed.

### Contributions to the area of nursing, health or public policy

On the other hand, most of the participants were nursing professionals, with technical or higher education. The study also contributed to identify the fragile points regarding radiation protection education in the training of health professionals. This can support the insertion of the theme of radioprotection in the academic training and in the work environment of health professionals.

### FINAL CONSIDERATIONS

Our study identified that the majority of the health professionals that participated in the research have a misconception or incomplete concept of radiation protection. This condition is present in the hospital work environment because the training in undergraduate or vocational training courses was insufficient and the employer, also responsible for the training of the worker, does not play its complementary role. However, the professional is available and interested in receiving the necessary training.

For most of the health professionals participating in the study, the social representation of radioprotection is restricted to individual protection, mainly regarding equipment and attitudes. Few refer to the broader form of protection, which includes everyone involved in the process of radiation exams, particularly in the workplace.

There is ample space to implement the necessary culture of radiological protection, education and inclusion of all health professionals, users and families is the best way to do it. In this sense, managers have a fundamental role in inducing and facilitating meaningful learning and establishing the radioprotection culture.

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