ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 09, Issue, 05, pp. 27871-27876, May 2019

RESEARCH ARTICLE OPEN ACCESS

RADIOLOGICAL PROTECTION ELEMENTS OF THE DAILY ROUTINE OF A HOSPITAL RADIOLOGY SERVICE

***[1]Andrea Huhn, [2]Mara Ambrosina De Oliveira Vargas, [3]Jorge Lorenzetti, [4]Juliana de Melo, [5]Franciele Budziareck das Neves, [6]Patrícia Fernanda Dorow and [7]Laurete Medeiros Borges**

[1]Doctoral student PEN/UFSC. Professor of the Undergraduate Program in Radiology Technology and the Master Degree in Radiological Protection of the Federal Institute of Santa Catarina (IFSC). Florianópolis, Santa Catarina, Brazil
[2]Ph.D. in Nursing Philosophy. Professor, Nursing Department and PEN/UFSC. Florianópolis, Santa Catarina, Brazil
[3]Ph.D. in Nursing. Professor, Nursing Department and PEN/UFSC. Professor, Nursing Department and PEN/UFSC. Florianópolis, Santa Catarina, Brazil
[4]Ph.D. in Nursing. Professor, Nursing Department and PEN/UFSC. Professor of the Undergraduate Program in Radiology Technology and the Master Degree in Radiological Protection of the Federal Institute of Santa Catarina (IFSC). Florianópolis, Santa Catarina, Brazil
[5]Doctoral student at the Graduate Program in Nursing (PEN), Federal University of Santa Catarina (UFSC). Florianópolis, Santa Catarina, Brazil
[6]Ph.D. in Engineering and Knowledge Management. Professor of the Undergraduate Program in Radiology Technology and the Master Degree in Radiological Protection of the Federal Institute of Santa Catarina (IFSC). Florianópolis, Santa Catarina, Brazil
[7]Ph.D. in Nursing. Professor, Nursing Department and PEN/UFSC. Professor of the Undergraduate Program in Radiology Technology and the Master Degree in Radiological Protection of the Federal Institute of Santa Catarina (IFSC). Florianópolis, Santa Catarina, Brazil

ARTICLE INFO

Article History:

Received 21st February, 2019
Received in revised form
07th March, 2019
Accepted 13th April, 2019
Published online 30th May, 2019

Key Words:

Radiation Protection;
Diagnostic Imaging;
Hospital Administration.

ABSTRACT

The overall objective of this study was to elaborate an instrument with the elements that need to be considered in the daily routine of a hospital radiodiagnosis service. Qualitative, exploratory and descriptive research was performed. The data were collected through non-participant observation of the daily life of 13 workers who work in the radiodiagnosis service of a public hospital in the south of the country. The content analysis technique was used to analyze the data. In the results, two main categories emerged: a) Between what is prescribed in the current legislation and the one described in the Radiological Protection Program of a hospital radiology service and b) Evaluation instrument with elements that should be considered in the Radiological Protection Program and in the daily life of a multiprofessional team service in a hospital radiology service. An evaluation instrument was also prepared with elements that need to be considered in the Radiological Protection Program and in the daily routine of the multiprofessional health team. It is concluded that the Radiation Protection Program is a fundamental document for the workers, since it presents the necessary elements for the effective management of Radiological Protection.

Copyright © 2019, Andrea Huhn et at. *This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.*

Citation: Andrea Huhn, Mara Ambrosina De Oliveira Vargas, Jorge Lorenzetti *et al.* 2019. "Radiological protection elements of the daily routine of a hospital radiology service", *International Journal of Development Research*, 09, (05), 27871-27876.

INTRODUCTION

Ionizing radiation is used on a large scale in the health sector and, as a consequence, exposure of workers and users in these sectors is also higher.

*Corresponding author: Andrea Huhn,
Doctoral student PEN/UFSC. Professor of the Undergraduate Program in Radiology Technology and the Master Degree in Radiological Protection of the Federal Institute of Santa Catarina (IFSC). Florianópolis, Santa Catarina, Brazil

Although some government agencies are concerned about transmitting information related to Radiological protection activities, there is still little knowledge, even among professionals in the field, of the damages caused by excessive radiation exposure (Azevedo, 2012). The increased exacerbation of the use of ionizing radiation for medical imaging in recent years increases the risks and existing standards to preserve the health of workers who use it often are

not taken into account in performing diagnostic tests (Brody, 2012). From the perspective of radiation protection, it is prudent to assume that any dose of radiation is associated with a probability of occurrence of biological effects, no matter how low that dose. In most cases, the damage occurs due to prolonged exposure. The risks associated with prolonged or repeated low-dose exposures are more relevant for health professionals and individuals in the public, and may cause irreversible damage to them (Xavier *et at*., 2006; Leuraud *et at*., 2015). Thus, it is inferred that there is no safe dose for the use of radiation. Therefore, the occupationally exposed worker, who is the person supposed to have the most contact with ionizing radiation, must follow the precepts of the current legislation, using, for example, radiation protective clothing as a thyroid protector, gloves and lead gloves and glasses with plumbing glass, in order to avoid damages to their own health, that of users of the service and the general public (possible companions of the users and other people that circulate in the radiodiagnostics service). In addition to wearing radiation protective clothing, the occupationally exposed worker should use an individual radiation dose meter and the model most commonly used in radiodiagnostic services is referred to as a thermoluminescent dosimeter. These meters are ionizing radiation sensitive devices used to determine how much radiation the worker has been exposed for a month. Both the contracting of the monitoring service of the workers as well as the instructions for use are obligations of the employer, but this does not exempt the obligation of the proper use of this device by the worker (Tilly, 2010).

The concern with radiological protection in Brazil began in 1978, with the guidelines of Occupational Safety and Medicine, determined by Ordinance No. 3,214, of June 8, 1978 (Brazil, 1978). Subsequently, the Portaria of the Secretary of Health Surveillance of the Ministry of Health - Portaria SVS / MS 453 of June 1, 1998, was published, which deals with the risks inherent to the use of ionizing radiation and the need to establish a national policy of PR in the radiodiagnosis area (Brazil, 1998). In 2005, the Ministry of Labor and Employment approved Regulatory Standard 32 (NR 32), which emphasizes health and safety at work in health services, mentioning in item 32.4 the ionizing radiation. It also mentions radiological protection in relation to exposure to ionizing radiation, but emphasizes in item 1.2.5 that medical and dental radiodiagnostic practices are regulated by Portaria SVS / MS 453/98 (Brazil, 2005). In view of this assertion, the present study used as basis the precepts of this Ordinance. Ordinance SVS / MS nº 453/98 approves the Technical Regulation that establishes the basic guidelines of radiological protection in medical and dental radiodiagnosis, disposes on the use of diagnostic X-rays throughout the national territory and provides other measures. Among the provisions, in item 3.9, requires a Descriptive Memorial, which aims to develop the appropriate forms of control of the physical risk to ionizing radiation, both for occupational purposes and to minimize the dose in the patient, containing as second item a Radiological Protection Program, required by the National Agency of Sanitary Surveillance (ANVISA), for the operation of radiodiagnostic sectors (Brazil, 1998). Despite the regulations, the public radiodiagnostic services present difficulties to keep the Descriptive Memorial and the radiological protection plan current. In this sense, it is considered that the professionals do not know the relevant legislation and most of the members of the multiprofessional team do not participate or did not participate in the elaboration and implementation of these documents in the respective radiodiagnostic services (Huhn *et at*., 2016). In addition, it is inferred that health institutions and the multiprofessional team do not mean, as a management function, the question of maintaining a functional radiation protection sector, capable of charging the multiprofessional health team attitudes compatible with radiological protection.
Finally, it is assumed that it is necessary to consider several elements / aspects that workers involved in the radiodiagnosis sector need to know and implement in order to promote an adequate management of the radiological protection for themselves and the users of this service. Therefore, it was the objective of this study to elaborate an evaluation tool with the elements that need to be considered in the daily routine of a hospital radiology service, so that what is prescribed in the legislation becomes concrete in the practice of the service.

MATERIALS AND METHODS

An exploratory and descriptive qualitative study that used data from the non-participant observation of the daily life of the workers who worked in the radiology service of a public teaching hospital in the south of the country and the documentary analysis of the descriptive memorial that contains the Radiological Protection Plan of the place, comparison between what is foreseen in the Brazilian legislation, regarding radiological protection and what exists in the service researched. The hospital was intentionally chosen for having a functioning radiation protection sector. For data collection, documentary analysis and non-participant observation were used. The documentary analysis followed a predetermined route, starting with the analysis of Administrative Rule 453/98 and later comparing the established in the same with the Radiological Protection Plan of the place searched. This analysis lasted three weeks. Subsequently, the non-participant observation of the occupationally exposed and occupationally exposed professionals, that is, professionals of radiological techniques that perform radiodiagnostic exams and professionals who at some time were involved in the exams were performed. This stage occurred during the months of July and August of 2014, in the morning and afternoon periods, coinciding with the schedule that concentrates more number of exams. During this period, 24 exams were observed in the radiology service, each lasting about 20 minutes, from the beginning of the exam until the patient was released, in order to identify how the multiprofessional health team behaved in this context. the legislation recommended by the law was implemented in practice, for example, if they wear radiation protective clothing and offer it to users and caregivers when necessary.

Thirteen workers from the radiology service participated in the observation phase, out of a total of 46 professionals working in the service. Of the 13 participants, four were female and nine were male. Thus, a nursing assistant, a nurse, a technician, in nursing, nine radiology technicians and two radiology technologists participated. These had, on average, 15 years of service in the radiology service at the research site. For observation, the researcher acquired a dose gauge, of the thermoluminescent dosimeter type, to guarantee the recording of a possible dose received in that period. The inclusion criterion was the assets in the work scale of the service and excluded those who were retired, in a state of health or maternity leave, during the period of data collection. The sample was considered sufficient when data saturation occurred. For the analysis of the data, obtained from the

documentary study and the non-participant observation, the content analysis, based in Bardin, was organized in three phases: pre-analysis, material exploration and treatment of results (Bardin, 2012). In the pre-analysis, the documents related to the radiological protection and the Radiological Protection Plan found in the service were separated as part of the Descriptive Memorial, part of the Radiological Protection Plan and some manuals of equipment emitting ionizing radiation. During the exploration of the material, the documents found were read in full and, subsequently, the documentation of the Radiological Protection Plan and the radiological protection was documented, comparing them with what is foreseen in the legislation and with which occurred during the observation of the activities of the workers working in the radiology service researched, to present the results. The research was evaluated and released by the Committee of Ethics in Research, under Opinion n ° 717.660 and Certificate of Presentation for Ethical Assessment CAAE: 25382813.8.0000.0121. The entire study was guided and obeyed the ethical care placed by Resolution No. 466/2012 of the National Health Council.

RESULTS

After analyzing the legislation regarding the Radiological Protection Plan and radiological protection, comparing the Radiological Protection Plan of the service with that recommended in the legislation and non-participating observation of the service, site of the present investigation, two categories emerged, named 'Between prescribed in current legislation and the one described in the Radiological Protection Plan of a radiology hospital 'and' Evaluation instrument with elements that need to be considered in the Radiation Protection Plan and in the daily life of a multiprofessional health team working in a hospital radiology service'. In the category entitled 'Between what is prescribed in the current legislation and the one described in the Radiation Protection Plan of a radiology hospital service', the data were extracted from the documentary analysis. Portaria 453/98 was analyzed and the reason for deepening the understanding of the content was due to the fact that this refers more specifically to the services that use equipment emitting ionizing radiation, which is the case of the hospital under investigation. At the same time, all documents leased in the radiological protection sector were analyzed, which were related to the Radiological Protection Plan of the radiology service, such as memoranda referring to the quality control of ionizing radiation emitting equipment, equipment manuals and dosimetry annexes of the workers. Afterwards, this data was crossed with the understanding of Portaria 453/98. In ordinance rule 453/98 it is explicit, among other aspects, that the Radiation Protection Plan must be within the validity period, ie, the operating license of the service is valid for a maximum of two years and its renewal must be requested by the holder of the service, instructed of: application and terms of responsibility (according to own models of the sanitary authority); (or equivalent certification, recognized by the Ministry of Health) and document of update of the Descriptive Memorial of Radiological Protection, if there have been changes not notified in the period (Brazil, 1998). On the operating license, the service was in accordance with the legislation, ie the documents relating to the charter were within the validity period. The service did not have quality program reports of all the equipment emitting ionizing radiation and the Radiological Protection Plan was incomplete, lacking the description of some radiological procedures performed and some equipment. It should be noted that the Radiological Protection sector has been in operation since 2009, has a trainee, radiology technologist, who with the help of other professionals of the service, seeks to maintain the specific actions of radiological protection. In the Radiation Protection sector you will find all documentation regarding the equipment emitting ionizing radiation, such as manuals and quality control tests related to them. Some of these do not have stored documentation, probably because they were lost prior to the implementation of the industry. For the construction and analysis of the second category, we used data from the non-participant observation of the daily life of the workers occupationally and for occupationally exposed of the radiology service of the hospital, in order to analyze how the workers carry out the routine of work with equipment emitting ionizing radiation and if they apply the radiological protection guidelines established by the current legislation for the care of themselves, the users and other persons present during the radiodiagnostic exams. During the observation, it was noticed that the workers are more careful with themselves than with the users and other people. This was made explicit at various times, especially during examinations of two children, at about seven years of age, who were accompanied by their father or mother. The parents did not receive radiation protective clothing for their protection, in contrast, in all examinations workers positioned themselves behind the lead screen to shoot the radiation beam, ensuring their protection. In addition, they all used a dose gauge, a thermoluminescent dosimeter type.

Another relevant and worrying fact was the accomplishment of three exams with the door of the room without complete closure, being that in front of the doors of the rooms are corridors with chairs so that the patients await to carry out examinations. Other workers and accompanying patients also circulate in the hall. The doors of the examination rooms that have ionizing radiation emitting equipment, as well as every room, have lead shielding which makes them heavier than unshielded doors. In order to point out the elements that need to be considered in the daily life of a multiprofessional health team working in a hospital radiology service for the management of radiological protection to be effective, an evaluation instrument was prepared with elements that need to be considered in the Plan of Radiological and daily protection of a multiprofessional health team working in a hospital radiology service. The creation of the checklist occurred when the lack of documents that should be part of the Descriptive Memorial for Radiological Protection was detected. It is inferred that these were possibly lost, which made it impossible to evaluate the mandatory minimum requirements for the validation of the Descriptive Memorial and, consequently, the Radiological Protection Plan of the place searched. In this sense, a checklist was elaborated, based on the precepts of Administrative Rule 453/98, adding data observed in the daily life of the multiprofessional health team considered important so that the Radiological Protection Plan is effectively used in the practice of the service, being relevant both for workers and users, as well as to the Hospital as a whole. The instrument describes the items that must be included in the Descriptive Memorandum of Radiological Protection, which contains the Radiological Protection Plan, as recommended by Administrative Rule 453/98, and suggestions for possible increases are presented to facilitate the understanding by the supervisory authorities and workers, as shown in Table 1.

Table 1. Elements that need to be included in the descriptive memorial of radiological protection

Elements that need to describe in the descriptive memory of radiological protection				
Items you need to describe in the radiological protection memory (MDPR) *	Consists	Not included	Incomplete	Indicate what is stated
Descriptive Memorial of Radiation Protection (MDPR)				
1-PPR (within the validity period)				
2-Nominal relation of the team (assignments, responsibilities, qualification and workload, identify especially the responsible professional and his eventual substitute as effective members of the service work team)				
3-Written instructions for team (execution of activities in safety conditions)				
4-Periodic training program and radiographic procedures performed				
5-Signaling, warnings and control of areas (preferably include photos proving the existence **)				
6-Area monitoring program (including verification of shields and safety devices)				
7-Individual monitoring program, with dose limitation and occupational health control (Radiation Protection Supervisor should investigate and take action when necessary)				
8-Description of individual protective clothing (with respective quantities per room)				
9-Description of the settlement system (list of radiographic procedures performed)				
10-Quality assurance program (including maintenance program for x-ray equipment and processors.				
11-Procedures for cases of accidental exposures (of patients, staff or public, including system of notification and registration)				
12-Radiometric survey report, issued by a specialist in radiodiagnostic physics (proof of compliance with the dose restriction levels established in Ordinance 453/98 and certificate of suitability of the head shield issued by the manufacturer, must be attached to the PPR).				
13-Each equipment has its own PPR attached to the Descriptive Memorial (not obligatory **)				

*Descriptive Memorial of radiological protection (MDPR) is the document that must have, besides the PPR the description of the establishment, service identification, relation of the radiological procedures implemented, description of the equipment, the system of registration of images and system of processing)

**This information is not contained in Administrative Rule 453/98, but is suggested to be included in the MDPR to facilitate the management of the service.

DISCUSSION

It is considered as a relevant aspect in the routine of a hospital radiology service, initially, to know the Descriptive Memorial, which contains the Radiological Protection Plan of the radiology sector in which one works. It should be noted that this document should have, in addition to the Radiological Protection Plan, a description of the establishment, a list of the radiological procedures implemented, a description of the equipment and the radiological protection clothing available in each examination room, among other items, as recommended by legislation that addresses the issue, ie, Administrative Rule 453/98. All items that make up the Radiological Protection Plan must be fully described in order to guarantee the safety of the workers and users of the service, in addition to complying with legal requirements and providing adequate management Radiological Protection, taking into consideration the principle of ALARA (low as reasonably achievable), ie using as low a dose of ionizing radiation as possible to generate an acceptable quality examination for radiodiagnosis. The use of this principle is the responsibility of physicians who request examinations and equipment operators that generate images (Zhou *et at*., 2010). Thus the risks and benefits of any investigations or requested procedures in the management of a patient are essential for the health of the same and radiodiagnostic exams are no exception. In the case of the researched sector, it can be noticed during the collection of the documentary and observation data, that all the items requested in the legislation were not registered. This fact prompted the authors of this study to elaborate an instrument with 13 items, to facilitate the identification and description of the radiology service. The first item, Radiological Protection Plan, is considered the most relevant, since it should be described all the steps to be taken to achieve adequate radiological protection for workers and users of the same, in addition to the need for its periodic review for the maintain the effectiveness of the management of Radiological Protection.

The second, third and fourth items refer to the work team that acts in the service. According to Administrative Rule 453/98, these items should make explicit responsibility for the assignments, qualification and workload of all workers, especially identifying the professional responsible for the sector, leave written instructions for the team to perform exams safely and maintain periodic training so that the team always keep in mind continuing education, reinforcing and updating knowledge. In this sense, a fact detected in the observation of the routine of the workers refers to the doors of the examination rooms not completely closed during the examination, this can be due to the fact of the weight of the same by the shield of lead, but it is not justified and it was understood as negligence of the radiological protection of patients who were sitting, often with other individuals of the public, in a corridor located in front of the rooms awaiting the completion if their examination. Other workers in the hospital also circulate in the corridor, who could also receive radiation.

Often the intense work routine causes the diagnostic radiology service workers to stop performing important actions related to radiological protection, for example, to observe that the patient is positioned correctly, to make sure that the examination room door is completely closed at the time of exposure and to correctly use radiation protection clothing (Tilly, 2010).

This could be avoided or minimized if there were periodic trainings for workers and warnings of closing doors were completely fixed in the doors themselves, as mentioned in the fifth item of the instrument. Items six, seven and eight refer to the Area Monitoring Program, Individual Monitoring Program, with dose limitation and occupational health control, respectively. These monitoring programs should consider that radiation protection aims to reduce the likelihood of radiation-induced stochastic effects, in particular cancer, and prevent deterministic effects, also called tissue reactions (Desouky *et at*., 2015). The Radiation Protection Supervisor should be responsible, taking appropriate measures in cases of changes in

the occupational health examinations that are related to the work with ionizing radiation (Brazil, 1998). The eighth item is intended to describe the radiation protection clothing in each examination room and to make its use fulfill the role of radiological protection for workers and users of the service. A fact that attracted attention was the issue of radiological protection of patients and caregivers, pediatric and adult patients underwent examinations, and companions remained in the examination room, without the provision of radiation protection clothing, when these could be used without interfering with the quality of the examination. that the companions were present to help contain the movements of the patient. The use of radiation protective clothing during radiodiagnostic exams is the simplest, most effective and inexpensive way to protect workers, patients and possible accompaniments exposed to ionizing radiation (Soares, Pereira; Flôr, 2011).

Item nine provides for the description of the settlements, that is, the detailed specification of the examinations that are performed in the service. If the standardized description of all the examinations, including radiation protection clothing to be used for the execution of each examination to protect workers, users and possible companions, as recommended in Ordinance 453/98, the above described fact could have been avoided and the management of radiological protection would take place in the practice of the service. The Quality Assurance Program, mentioned in item 10, according to the aforementioned ordinance, should include maintenance program of the x-ray equipment and manual of the equipment in Portuguese at the reach of the operators. At the site of this investigation, there were no documents, for example, equipment manuals. This situation makes it difficult in practice to calculate the ideal dose to perform the examination of each patient, since for this calculation is necessary the constant of the equipment that is in its own manual. Items 11 and 12 provide for procedures for accidental exposures (of patients, staff members or the public, including notification and registration system) and Radiometric survey report issued by a specialist in radiodiagnostic physics (proof of compliance with the dose restriction levels established in Ordinance 453/98 and the certificate of suitability of the head shield issued by the manufacturer, this item must be attached to the Radiation Protection Plan). In this sense, it should be pointed out that accidents can be avoided, since radiodiagnostic exams should not be used in an uncontrolled way, with no plausible reason. Radiodiagnostic exams serve to confirm a clinical suspicion, except for the screening programs, which are performed examinations for the early detection of pathologies (Arias *et at*., 1997).

In the last item, this is in item 13, it is suggested that each room and each equipment have their own Radiological Protection Plan, in order to facilitate and streamline the management of the service, avoiding the need to search all the documentation to obtain information equipment or a single examination room. Thus, to improve methods, identify problems, implement preventive and corrective actions, generate valid results and reach a stable level, it is necessary to facilitate and optimize the radiological protection service (Lopes *et at*., 2014). The absence of part of the documentation that involves the Radiological Protection Plan, were projected as difficulties in the delineation of the present study, which undertook the combination of methodological strategies to guarantee, at this moment, the construction of the evaluation instrument. Another methodological study should be carried out, precisely to validate the instrument, now elaborated. The lack of documentation, coupled with observation of the daily life of occupationally exposed workers and documentary research carried out to understand the legislation on radiation protection, made the instrument better, with the intention of facilitating its completion and guiding the multiprofessional team of professionals.

CONCLUSIONS

It is relevant to elaborate an evaluation instrument about the Descriptive Memorial of Radiological Protection, which contains the Radiological Protection Plan, in order to meet the needs of the radiology service of a public hospital. The premise is that this service has a specific instrument that facilitates the updating of the Radiological Protection Plan, allowing it to meet the requirements of Administrative Rule 453/98. It should be remembered that bureaucratic and financial difficulties are inherent in most public hospitals and, since the hospital has been surveyed in a public hospital, it has numerous difficulties to adapt to new situations. In addition, the radiation protection sector had, at that moment, only one trainee in a shift, to account for the demand for radiological protection of every hospital. The construction of instruments to update the Radiological Protection Plan becomes useful, with substantial significance for subsidizing the various professionals in the field of radiological protection, in radiodiagnosis. The workers can benefit from a document containing all the necessary elements so that management of the radiological protection is effective in the service and serves as a basis for consulting doubts such as: quality control of radiodiagnostic service equipment, screening of the rooms, doses emitted by equipment, validity of the image quality control tests, amount of radiation protection clothing available per room, among others. At the same time, users would benefit from radiological protection, considering that if the equipment is properly adjusted and workers act in compliance with the legislation, examinations will be performed with exact doses, with better image quality, generating more reliable diagnoses, avoiding until tests are repeated. Similar works can generate more knowledge and point out tools that ensure the quality of the programs developed, thus contributing to the management of radiological protection.

REFERENCES

Arias C, Borrás C, Castellanos Robayo J, Miguel MAD, Hanson G, Khatib S, Skvarca J. 1997. Organización, desarrollo, garantía de calidad y radioprotección en los servicios de radiología: imaginología y radioterapia. Organización Panamericana de la Salud.

Azevedo ACP. 2012. Radioprotection in Health Services. Rio de Janeiro: Oswaldo Cruz Foundation; Secretary of State of Health of Rio de Janeiro.

Bardin L. 2012. Content analysis. Translation Luís Antero Reto and Augusto Pinheiro. Lisbon, pp. 1-70.

Brazil 2005. Ministry of Labor and Employment. Norma Regulamentadora NR 32 Safety and health at work in health services. Official Gazette of the Federative Republic of Brazil, Brasília, pp. 12-46.

Brazil, 1998. National Health Surveillance Agency. Ordinance MS / SVS No. 453, June 1, 1998. Brasília: Federal Official Gazette.

Brody JE. 2012. Medical radiation soars, with risks often overlooked. *The New York Times*.

Desouky O, Ding N, Zhou G. 2015. Targeted and non-targeted effects of ionizing radiation. *Journal of Radiation Research and Applied Sciences*, *8*:2-254.

Huhn A, Melo JÁ, Vargas MA, Schneider DG, Lança L, Trentin D. 2016. Proteção radiológica: da legislação à prática de um serviço. *Enfermagem em Foco*, *7*:2-31.

Leuraud K, Richardson DB, Cardis E, Daniels RD, Gillies M, O'Hagan JA, Schubauer-Berigan, M. K. 2015. Ionising radiation and risk of death from leukaemia and lymphoma in radiation-monitored workers (INWORKS): an international cohort study. *The Lancet Haematology*, *2*(7), e276-e281.

Lopes I, Santos L, Pereira MF, Vaz P, Alves JG 2014. Implementation of the quality management system at the Laboratory of Radiological Protection and Safety (LPSR) in Portugal. *Accreditation and Quality Assurance*. 19: 355-60.

Soares FAP, Pereira AG, Flôr RC 2011. Use of radiation protective clothing to reduce absorbed dose: an integrative review of the literature. *Radiologia Brasileira*. 44: 2-103.

Tilly JGJ 2010. Radiological physics. 1.ed. Guanabara Koogan, Rio de Janeiro, pp 1-276.

Xavier AM, Moro JT, Heilbron PF 2006. Princípios básicos de segurança e proteção radiológica. Universidade Federal do Rio Grande do Sul Comissão Nacional de Energia Nuclear, pp 181-190.

Zhou GZ, Wong DD, Nguyen LK, Mendelson RM 2010. Student and intern awareness of ionising radiation exposure from common diagnostic imaging procedures. *J Med Imaging Radiat Oncol.* 54:1-23.

****