Reflection Article

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# Nursing care management in radiation protection in interventional radiology

*Gestão do cuidado em enfermagem na proteção radiológica em radiologia intervencionista*

*Gestion del cuidado de enfermeria en la protección radiológica em radiologia intervencionista*

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## ABSTRACT

**Objective:** To reflect on the elements of nursing care management in radiological protection in interventional radiology.

**Methodology:** A reflection paper based on national and international articles and laws addressing the nursing care management issue and radiological protection in interventional radiology.

**Results:** From the conceptions of nursing care management and professional practice, the following elements were perceived in this management: expertise and applicability of the radiological protection principles, biological effects of ionizing radiation, occupational dose monitoring, personal and collective protective equipment, patient safety, training in radiological protection, quality assurance program.

**Conclusion:** The management of nursing care in radiological protection in interventional radiology is implemented in an elementary way regarding care aimed at dose reduction, either for workers or patients. There is a need to recognize, understand and characterize the management of nursing care in this scenario.

**Keywords:** Radiation protection. Radiology, interventional. Health management. Nursing care. Radiology department, hospital.

## RESUMO

**Objetivo:** Refletir sobre os elementos da gestão do cuidado em enfermagem na proteção radiológica em radiologia intervencionista.

**Metodologia:** Estudo reflexivo realizado a partir de artigos e legislação nacional e internacional abordando a temática da gestão do cuidado em enfermagem e proteção radiológica em radiologia intervencionista.

**Resultados:** A partir das concepções de gestão do cuidado em enfermagem e atuação profissional na prática vislumbrou-se como elementos dessa gestão: conhecimentos e aplicabilidade dos princípios de proteção radiológica, efeitos biológicos da radiação ionizante, monitoramento de dose ocupacional, equipamentos de proteção individual e coletiva, segurança do paciente, educação em proteção radiológica, programa de garantia de qualidade.

**Conclusão:** A gestão do cuidado em enfermagem em proteção radiológica em radiologia intervencionista é implementada de forma incipiente no que tange aos cuidados voltados para redução de dose, seja para trabalhadores ou paciente. Torna-se necessário reconhecer, compreender e caracterizar a gestão do cuidado em enfermagem nesse cenário.

**Palavras-chaves:** Proteção radiológica. Radiologia intervencionista. Gestão em saúde. Cuidados de enfermagem. Serviço hospitalar de radiologia.

## RESUMEN

**Objetivo:** Reflexionar sobre los elementos de la gestión del cuidado de enfermeria en la protección radiológica en radiología intervencionista.

**Metodología:** Estudio reflexivo realizado a partir de artículos y legislación nacional e internacional que abordan el tema de la gestión de cuidados de enfermería y protección radiológica en radiología intervencionista.

**Resultados:** A partir de las concepciones de la gestión del cuidado de enfermería y la actuación profesional en la práctica, se apreciaron los siguientes elementos de esta gestión: conocimientos y aplicabilidad de los principios de protección radiológica, efectos biológicos de las radiaciones ionizantes, monitorización de dosisocupacional, equipos de protección individual y colectiva, seguridad del paciente, educación en protección radiológica, programa de garantía de calidad.

**Conclusión:** La gestión de los cuidados de enfermería en protección radiológica en radiología intervencionista se implementa de forma incipiente en lo que respecta a los cuidados dirigidos a la reducción de dosis, ya sea para trabajadores o pacientes. Es necesario reconocer, comprender y caracterizar la gestión de los cuidados de enfermería en este escenario.

**Palabras claves:** Protección radiológica. Radiología intervencionista. Gestión en salud. Atención de enfermería. Servicio de radiología hospitalaria.

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## INTRODUCTION

Nursing care management is a concept that aims to avoid the dichotomy between caring and managing, in order to demonstrate that care is intrinsic to any nursing action, whether in managing, educating, or direct care.

Nursing care management is exercised in all scenarios of the nursing work process, among them, the radiological nursing scenario. This specialty is responsible for patient care provided in diagnostic, interventional or therapeutic support services that use technologies that employ the use of ionizing radiation[1].

Interventional radiology procedures are often complex, requiring long exposure times, high dose rates and acquisition of numerous images. Therefore, they expose both patients and healthcare professionals to high doses of radiation[2].

It is well known that exposure to ionizing radiation can impair the health of individuals, whether patients or professionals, causing radiogenic cataract and leukemia, among other disorders[3].

Radiological protection in interventional radiology can be defined as all care that reduces exposure to ionizing radiation, for professionals or patients, in order to protect humans and their descendants against possible unwanted effects caused by ionizing radiation[4].

Nursing care management aims to demonstrate that there is no difference between managing, caring and educating and rather a synergistic action between these three dimensions of care. Therefore, the management of nursing care must include implementation and elaboration of public policies, management of human and material resources, professional qualification and continuing education, training of critical-reflective professionals, organization of care, qualification of care through the implementation of evidence-based care, planning and evaluation of care through the use of nursing care systematization[5], as well as research in health and nursing.

Raising questions and reflections about what permeates or characterizes the management of nursing care in radiological protection in interventional radiology is essential. Therefore, the present article aims to reflect on the elements of nursing care management in radiological protection in interventional radiology.

## METHODOLOGY

This is a reflection paper on nursing care management in radiological protection in interventional radiology. In the search for more knowledge on the subject, national and international legislation on radiological protection was accessed. A search was also carried out in the VHL health database. The search with descriptors "radiological protection" and "interventional radiology" resulted in 295 items. The filters full text articles available in English, Portuguese and Spanish published over the last five years were used. In the present study, eight articles that addressed themes focused on the research objective, and which brought technological innovations on radiological protection in interventional radiology were included.

## ELEMENTS OF NURSING CARE MANAGEMENT IN RADIOLOGICAL PROTECTION IN INTERVENTIONAL RADIOLOGY

### Principles of radiological protection

Radiological protection is guided by the principles of dose justification and optimization, as well as the limitation of individual doses. According to the principle of justification, the benefit generated by the use of radiation must be greater than the damage caused by its application, and each case must be considered individually. As for the principle of optimization, it states that a diagnostically acceptable image quality should be achieved with the lowest possible radiation dose. Dose limitation establishes a control of doses received by occupationally exposed individuals, and these doses must not exceed the limits established by national and international legislations[6]. Among the principles of dose limitation, it is worth mentioning the ALARA principle (As Low As Reasonably Achievable), whose implementation aims to minimize the doses to which patients and workers are exposed, with the use of radiological protection measures. Time, distance and shielding are methods that can be used to achieve these goals[6].

Nursing care management regarding the principles of radiological protection can be seen in the nurses' behavior of being distant from the source of radiation for the longest time possible, of always position themselves beside the x-ray tube, taking turns between employees in the work

schedules, not entering the procedure room when the x-ray equipment is switched on emitting radiation, knowing in advance the type of examination to be performed, using radiation personal protective equipment (lead garments) and collective protection equipment during the procedures.

Real-time knowledge of medical radiation exposure allows the application of radiological protection principles, and this is already happening in some interventional radiology sectors around the world. The installation of automated real-time patient and staff dose monitoring systems allows identifying the types of interventions with either absolute or relatively high doses, and may allow for specific optimization of radiation protection[7].

## Biological effects of ionizing radiation

Nursing professionals are exposed to ionizing radiation during the work process in interventional radiology. This radiation is called primary radiation beam, as it is the x-ray beam prior to any interaction with the patient, and is called scatter or secondary radiation when it originates from an ionizing radiation that interacts with the patient's body[8]. Chronic exposure to ionizing radiation can lead to tissue damage, such as skin lesions, blood disorders, damage to genetic material, cataract and cancer[9].

Nursing professionals must be aware of these biological effects and adopt behaviors that allow them to be exposed as little as possible to primary radiation and scatter radiation emitted by the equipment. Therefore, these workers must be aware of the principles of radiological protection, staying distant from the source of radiation for the longest time possible and wearing personal and collective protective equipment.

Nursing professionals must recognize the stochastic and deterministic effects arising from chronic exposure to ionizing radiation, so that a safety culture can be implemented in the face of this occupational risk in the work process in interventional radiology. Nurses are responsible for evaluating professionals' dose reports and referring those whose standards are not consistent with the national legislation, for subsequent follow-up by the team of occupational health of nursing personnel. Nursing management is also supposed to make the dose report available so that all staff have access to their dose value and it is also responsible for referring all the professionals that are part of an interventional radiology team to perform a complete blood count on a biannual basis in order to comply with Brazilian labor laws.

## Occupational dose monitoring

Individual monitoring of the radiation dose must be carried out in all health services that use ionizing radiation in their work processes.

All occupationally exposed individuals must use a dosimeter during their working hours and while they remain in a controlled area. This device must be exchanged monthly, and each dosimeter is worn by only one individual. The dosimeters are for the exclusive use of the health service or sector for which they were purchased [9].

Awareness of the importance of dose monitoring by nursing professionals, the fact that the health service is required by law to provide personal dosimeters to all occupationally exposed individuals, as well as surveillance regarding the continuous use of these dosimeters in controlled areas are actions that involve nursing care management in interventional radiology.

An example of a technology for occupational dose control is the use of a smartphone app prototype that made it possible to evaluate the occupational dose of each dosimeter. Using their smartphones, personnel involved in interventional practices were able to review and compare their investigation-level occupational records with dose limits and their departmental colleagues anonymously. The professionals had easy access to their occupational dosimetry records in the environment of their intervention departments, and were actively involved in the radiation protection process [7].

## Personal and collective protective equipment and lead garments

As recommended by Brazilian legislation, all personnel needed in the procedure room must position themselves so that the exposed parts of their bodies are protected by at least 0.5 mm lead –equivalent shielding, and such personal protective equipment must be available in sufficient quantity for all professionals[9].

The protective collective equipment include under-table or lateral lead curtains, lead-lined screens or mobile partitions and barium plaster x-ray protective walls. Regarding radiological protection clothing, they include lead aprons, thyroid shields, lead caps, lead gloves and lead glasses are personal protective equipment. The use of these devices is recommended to reduce occupational doses. Studies reported a reduction of around 50% to 85% in the values of personal doses with the proper use of these devices[10].

New methods have been developed to facilitate the use of lead garments. The use of a lightweight garment was compared to a lead apron. There was a 98.1% reduction in radiation dose. Weight is a factor that makes it difficult for the nursing team to use lead garments. The investigation of new materials is essential to optimize nursing management in radiological protection in this regard[11].

A major concern is related to exposure of the lensto ionizing radiation. According to the literature, dose limits for this body structure are exceeded in some services [12]. The dose limit for the lens has been recently reduced from 150 mSv to 20 mSv by international organizations after recent findings of radiation-induced cataract in individuals exposed to doses lower than the previous established limit[12].

Regarding the exposure of the lens, nurses should advise professionals on the importance of using a dosimeter on the apron at the level of the collar, so that the occupational dose of the lens can be estimated. Nursing management must also work towards the development of new equipment and types of monitors to keep track of eye lens exposure.

Care management actions in radiological protection should aim to raise the nursing team's awareness of the importance of the use of personal and collective protective equipment, as well as radiological protection garments, as a practice that guarantees the care of each one regarding the risks of exposure to ionizing radiation. Care management must implement actions that ensure that these devices are available in an amount that allows each staff member to use them during interventional procedures, as well as ensure that these devices are in good condition in order to promote effective protection. Nursing care management is also responsible for devising better ways to measure the dose of commonly unmonitored structures such as the lens and extremities.

## Patient safety in the face of exposure to ionizing radiation

Lack of knowledge about the principles of radiation protection can result in deleterious biological effects for patients. The most common effects include erythema, tissue necrosis, alopecia and cataract. Although rare, these injuries are the result of poor knowledge about the principles of radiation protection and the biological effects of ionizing radiation, and usually occur after an interval of days or weeks after the procedure[13].

Skin injuries are biological effects arising from exposure to ionizing radiation in interventional procedures that can occur in patients. These injuries can be classified into immediate, acute, subacute, and chronic injuries. It is recommended that the free and informed consent of the patient be obtained before the procedure. The risks of interventional procedures and radiation exposure must be explained in detail and discussed with patients in these consent forms[13].

Substantial knowledge of radiation protection results in better patient care as well as a safe working environment. A study demonstrates that proper knowledge of radiological protection by the nursing team results in lower dose exposure for patients, since nursing professionals use available resources more frequently to reduce radiation exposure in their work process[13].

The nursing team should advise patients about the possibility of biological effects caused by radiation, which is an important link for the prevention and diagnosis of these injuries in interventional radiology procedures. Nursing workers must ensure safe care for patients who undergo interventional procedures that use ionizing radiation. Nursing systematization must be implemented to guarantee safe care and it should be based on advanced care practices. Nursing professionals should also know which procedures have longer durability, as this results in greater exposure to x-radiation. Dose data should be recorded in the patients' charts for follow-ups by the multidisciplinary team.

## Education in radiological protection

It is known that education in radiation protection, whether formative or continuing, is incipient in the context of nursing work worldwide. Professionals assigned to work in the radiology department usually do not have specific training, nor do they receive initial training to work in this area. Studies with nurses revealed a lack of training in radiation protection and a low level of knowledge on this topic. Moreover, radiation protection is not addressed in training courses in the field of nursing[14].

Continuing education programs must include initial and periodic training and preparation, at least once a year, practical training whenever new processes, techniques or technologies are implemented or when new staff are integrated into the work process. All continuing education methods applied must include an evaluation methodology in order to demonstrate the effectiveness of training actions[9].

Continuing training of interventional radiology nursing professionals must be ensured, addressing the issues of radiological protection, the biological effects of radiation, occupational and patient dose reduction techniques, in order to eliminate training deficits on the subject of radiological protection among these professionals, in the admission of new employees and at least once a year as recommended by the current legislation.

### Quality assurance program

This program must be implemented in health services and must include the management of technologies, processes and risks inherent to the interventional radiology service[9].

The service must establish and implement image quality standards and ensure equipment maintenance. It must also perform acceptance tests. Whenever an adjustment or alteration is made to the radiation emitting equipment, new tests must be carried out to verify the new parameters established[9].

Standards, routines, protocols and standard operating procedures must be implemented in the work process in interventional radiology[9].

The management of technologies used in the work environment in interventional radiology permeates the management of nursing care in radiological protection in interventional radiology. Nursing management is responsible for verifying the implementation of preventive and periodic maintenance of the equipment, acquiring supplies compatible with the operating equipment, filing the records of preventive and periodic maintenance, participating jointly with the medical physics and clinical engineering team to improve the parameters of image quality.

In a Postgraduate Program in Nursing in Brazil, a technology was developed, which consisted in the development of a software for the management of radiological protection and that integrates several instruments for computerization of data related to radiological protection. This software is a tool that helps the multidisciplinary and interdisciplinary teams of the radiodiagnostic service in the management of radiation protection. The idea is that computerization of systems and integration of sectors that need common data in work routines are essential for the management of radiation protection, both for the multidisciplinary team and for users. Finally, the technology aims at the safety of the interventional radiology services staff, in addition to mitigate repetitive activities, at the management level, and can be adapted for use in other institutions[15].

## CONCLUSION

The management of care in radiological protection in interventional radiology can be defined as all care aimed at reducing the occupational dose to ionizing radiation, for workers or patients. In the dimension of public policy implementation, nurses are responsible for promoting actions aimed at the compliance with national and international standards on the use of ionizing radiation in the health area. In this regard, we highlight RDC 330/2019 standards and the guidelines of the International Commission on Radiological Protection and CNEN 3.01 standard on basic guidelines for Radiological Protection.

Regarding the management of human and material resources, interventional radiology nurses must ensure a sufficient number of professionals, as well as foresee and provide material resources, in order to guarantee the quality of care. They must also ensure the availability of personal and collective protective equipment, as well as personal protective garments in sufficient quantity and in good condition. They are also responsible for implementing quality assurance programs in order to promote the correct functioning of the radiological technologies used in the nursing work process in interventional radiology.

Regarding professional training, it is known that training courses do not include the theme of radiation protection in their curricula. This reality must be changed. Continuing education is also deficient in radiological nursing and, therefore, nurses must implement educational activities that promote knowledge about radiological protection, based on dialogical activities, in order to promote the training of critical-reflective workers.

The lack of knowledge about radiological protection measures and the biological effects of radiation can result in an unsafe care practice, exposing staff and patients to the physical risk of ionizing radiation. Therefore, it is essential that the care provided to individuals is based on scientific evidence and that the planning and evaluation of the care provided are based on the systematization of nursing care, actions that include the management of care in radiological protection in interventional radiology services.

Nursing researchers should also carry out studies on the topic of radiation protection in interventional radiology, in order to promote the implementation of effective care management in this little addressed area.

We stress the need for studies and the promotion of actions that result in greater recognition, understanding and characterization of nursing care management in radiological protection in these services.

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