Original Article

TEXTO & CONTEXTO ENFERMAGEM
TEXT & CONTEXT NURSING TEXTO & CONTEXTO ENFERMERÍA

SISPRAD: SOFTWARE FOR RADIOLOGICAL PROTECTION MANAGEMENT IN A HOSPITAL ENVIRONMENT

Andréa Huhn[1]
Mara Ambrosina de Oliveira Vargas[2]
Jorge Lorenzetti[2]
Francine Lima Gelbcke[2]
Luís Lança[3]
Carlos Queiroz[4]

[1]Instituto Federal de Santa Catarina, Programa de Pós-Graduação em Enfermagem. Florianópolis, Santa Catarina, Brasil.
[2]Universidade Federal de Santa Catarina, Programa de Pós-Graduação em Enfermagem. Florianópolis, Santa Catarina, Brasil.
[3]Escola Superior de Tecnologia da Saúde de Lisboa. Lisboa, Portugal.
[4]Clínica de Oncologia São Sebastião. Florianópolis, Santa Catarina, Brasil.

ABSTRACT

Objective: to describe the software for the management of radiological protection, SisPRad, and its construction process, as well as to analyze its implementation and use in a radiodiagnosis service.
Method: a methodological and quasi-experimental research study carried out between November 2016 and October 2019. The study population consisted of the professionals who make up the Radiological Protection Committee of the service. The model chosen for software engineering was the cascade model. In the implementation phase, an evaluation and analysis of the usability of the software was carried out.
Results: the software for radiological protection management presents the structure of the technology and its functionalities. The usability evaluation showed that SisPRad is a tool that will assist the multi-professional and interdisciplinary team of the hospital radiology service in the management of radiological protection. The computerization of the systems and the integration of the sectors that need shared data in the work routines enhance the management of hospital radiological protection for the multi-professional team. The technology was positively evaluated by the multi-professional team working in the hospital radiodiagnosis service. SisPRad generated registration n. 512019002125-8 by the National Institute of Industrial Property.
Conclusion: this tool was developed aiming at the safety of the professionals working in the radiodiagnosis service and of its users, in addition to enabling the constant improvement of the tool, and it can be adapted in other institutions.

DESCRIPTORS: Health management. Medical IT. Radiological protection. Hospital radiology service. Radiological technology.

HOW CITED: Huhn A, Vargas MAO, Lorenzetti J, Gelbcke FL, Lança L, Queiroz C. SisPRad: software for radiological protection management in a hospital environment. Texto Contexto Enferm [Internet]. 2021 [cited YEAR MONTH DAY]; 30:e20200161. Available from: https://doi.org/10.1590/1980-265X-TCE-2020-0161

SISPRAD: SOFTWARE PARA GESTÃO DA PROTEÇÃO RADIOLÓGICA EM AMBIENTE HOSPITALAR

RESUMO

Objetivo: descrever o software para gestão da proteção radiológica, SisPRad, seu processo de construção e analisar sua implantação e utilização em um serviço de radiodiagnóstico.
Método: pesquisa metodológica e quase-experimental realizada entre novembro de 2016 e outubro de 2019. A população do estudo foi constituída pelos profissionais que compõem o Comitê de Proteção Radiológica do serviço. O modelo escolhido para a engenharia do software foi o modelo em cascata. Na fase de implantação foi realizada avaliação e análise da usabilidade do software.
Resultados: o software de gestão para proteção radiológica apresenta a estrutura da tecnologia e suas funcionalidades. A avaliação da usabilidade evidenciou que o SisPRad é uma ferramenta que irá auxiliar a equipe multiprofissional e interdisciplinar do serviço de radiologia hospitalar na gestão da proteção radiológica. A informatização dos sistemas e a integração dos setores que necessitam de dados em comum nas rotinas de trabalho potencializam a gestão da proteção radiológica hospitalar para a equipe multiprofissional. A tecnologia foi avaliada positivamente pela equipe multiprofissional atuante no serviço de radiodiagnóstico hospitalar. O SisPRad gerou o registro 512019002125-8 pelo Instituto Nacional de Propriedade Industrial.
Conclusão: essa ferramenta foi desenvolvida visando a segurança dos profissionais atuantes no serviço de radiodiagnóstico e seus usuários, além de possibilitar a melhora da ferramenta constantemente, podendo ser adaptada em outras instituições.

DESCRITORES: Gestão em saúde. Informática médica. Proteção radiológica. Serviço hospitalar de radiologia. Tecnologia radiológica.

SISPRAD: SOFTWARE PARA GESTIÓN DE PROTECCIÓN RADIOLÓGICA EN ENTORNO HOSPITALARIO

RESUMEN

Objetivo: describir el software para la gestión de protección radiológica, SisPRad, su proceso de construcción y analizar su implementación y uso en un servicio de radiodiagnóstico.
Método: investigación metodológica y cuasiexperimental realizada entre noviembre de 2016 y octubre de 2019. La población de estudio estuvo constituida por los profesionales que integran el Comité de Protección Radiológica del servicio. Para la ingeniería de software, se eligió el modelo en cascada. En la etapa de implementación se realizó la evaluación y el análisis de usabilidad del software.
Resultados: el software de gestión de protección radiológica presenta la estructura de la tecnología y sus funcionalidades. La evaluación de usabilidad mostró que SisPRad es una herramienta que ayudará al equipo multidisciplinario e interdisciplinario del servicio de radiología del hospital en la gestión de la protección radiológica. La informatización de sistemas y la integración de sectores que requieren datos en común en las rutinas de trabajo potencian la gestión de la protección radiológica hospitalaria del equipo multidisciplinario. La tecnología fue valorada positivamente por el equipo multiprofesional que cumple sus funciones en el servicio de radiodiagnóstico del hospital. SisPRad generó el registro 512019002125-8 en el Instituto Nacional de Propiedad Industrial.
Conclusión: esta herramienta fue desarrollada con el objetivo de promover la seguridad de los profesionales que trabajan en el servicio de radiodiagnóstico y de sus usuarios, además de permitir la mejora constante de la herramienta, que puede ser adaptada a otras instituciones.

DESCRIPTORES: Gestión en salud. Informática médica. Protección radiológica. Servicio de radiodiagnóstico. Tecnología radiológica.

INTRODUCTION

Information technology is gaining ground in several segments, including health, as it is a way to optimize resources and bring benefits to management and, in turn, to professionals and users.[1] The implementation of computerized systems includes efforts, requires planning, organization, preparation, training, execution and evaluation, in addition to constant improvement. Health information technology is a tool that improves the quality of hospital health services.[2]

In health, Information Technology is a broad term that describes the technology and infrastructure used to record, analyze and share data. Several technologies include health registration systems, including: personal health tools, devices and smart applications; and communities to share and discuss information. Health information technology is defined as the application of information processing involving hardware and software that deal with the storage, retrieval, sharing and use of information, data and knowledge about communication and decision-making.[3]

The development, incorporation and use of new technologies in the health sectors and their sustainability are part of a socioeconomic order that derives from the continuous production and consumption of goods and products. In this case, scientific and technological development has contributed to the economic health complex becoming one of the sectors with the greatest development. At the same time, the health of the individuals, as a right to be preserved, further contributes to the expansion of this sector.[4]

In this sense, it is understood that health information technology presents numerous opportunities to improve and transform health care, which includes reducing human errors, improving clinical results, facilitating coordination of care, improving the efficiency of practices and tracking data over time.[5] Therefore, it is understood that conducting an effective management in the radiodiagnosis service means reducing expenses with supplies, repetition of exams, wear of the equipment, exam execution time and, consequently, reducing the dose of ionizing radiation (IR) emitted during the performance of the radiodiagnosis exams, which is the main focus of the management of Radiological Protection (RP).

Health information technology can help to identify, prevent and avoid the occurrence of events resulting from the improper use of IRs in hospital environments. Therefore, it enables the organization and management of the Radiological Protection Sector (RPS), in order to comply with the precepts of the current legislation regarding RP and to provide adequate support and promote the safe use of IR for professionals and users.

This article presents the software for managing RP in a hospital environment, called SisPRad, configuring the search for solutions to the problem of lack of an automated tool that integrates modules for managing hospital RP. In this sense, it is pertinent to consider the several sectors that need information related to the radiodiagnosis service in order to manage the service with quality, speed and efficiency, in general, such as management of personal dosimetry, equipment, stock of supplies and periodic training. Thus, the objectives were to describe the software for the management of radiological protection, SisPRad, and its construction process, as well as to analyze its implementation and use in a radiodiagnosis service.

METHOD

Production of a technological innovation, whose methodology was constituted by methodological and quasi-experimental research, of the before-and-after type. Methodological studies contribute to increase the rigor in conducting research studies, as they investigate their own methods for collecting or organizing data, developing, validating and evaluating research tools and methods.[2] This research

design was adopted for the development of technological production, which resulted in the final product, that is, an RP manager software program, and was quasi-experimental because it evaluated interventions without using randomization, demonstrating the causality between an intervention and an outcome. It is pointed out that, in health IT, the researchers choose not to randomize the intervention.[6] Therefore, the participants answered two instruments, one before and one after the intervention.

The study was developed at the RPS, from the radiology service of a University Hospital in S outhern Brazil. The hospital's RPS was implemented in July 2009, with the objective of helping to develop RP and adapting to the norms of Ordinance 453/98.[7] In 2015, a Radiological Protection Committee (RPC) was created, made up of members from all sectors of the hospital, including 2 radiologists, 3 nurses, 1 cardiovascular surgeon, 1 occupational physician, 1 occupational safety engineer, 1 clinical engineer, 1 administrator, 2 teaching researchers from the RP area, 1 dentist, 1 radiology technologist, 1 physicist and 1 trainee student. Therefore, the study population was constituted by the professionals who make up the RPC of the radiodiagnosis service of the researched hospital. The participants who were away from the service were excluded from the study due to medical leave, maternity leave or for being on vacation.

The research study covered the period between November 2016 and October 2019. At the monthly meetings, which took place over three months, the proposal for the software development was presented and discussed among the members, to raise suggestions. These meetings started in November 2016, after approval by the Ethics Committee. At a fourth meeting, the first prototype of the software was presented to the RPC with possibilities to raise other suggestions, which were accepted. Then, the individual training of each member of the RPC was carried out, totaling the availability of eight participants. Immediately at this moment, the team's first SisPRad evaluation form was applied, that is, evaluation of version 1.0 in operation at the hospital's RPS, that is, the pre-test. This moment was preceded by a stage in which the participants were asked to use the software. After six months of using SisPRad, the participants completed the post-test, which was the questionnaire to assess user satisfaction in relation to the usability of the software. The stages of development and usability evaluation of SisPRad are explained below.

The software was developed for the web environment and can be used through the Internet Explorer, Mozilla Firefox and Google Chrome browsers in desktops, notebooks and tablets. This technology does not replicate the functions of other software programs for hospital management, electronic medical records and patient flow management but rather interacts with the RPC demands of the radiodiagnosis service. The software reflects a technological innovation, with a request for granting the patent registration made in February 2018, to the National Institute of Industrial Property (*Instituto Nacional de Propriedade Industrial*, INPI). It received registration number 512019002125-8, issued by the INPI in October 2019. The development of the software had the technical participation of a professional who worked as a systems analyst and programmer.

The model chosen for engineering the software was the cascade model,[8] consisting of five stages of the process, namely: Communication, Planning, Modeling, Construction and Implementation. In the communication stage, the necessary requirements for the construction of the software were surveyed, that is, in this phase, all the functionalities that the system should have were collected and cataloged. In the planning phase, the project's execution time was estimated, putting a schedule in place. In the case of SisPRad, after the communication stage, the software execution schedule was drawn in a cascade model, which lasted 6 months, between August 2017 and February 2018.

The modeling phase consisted of product analysis and design. In modeling, all the requirements gathered in the previous phase were analyzed and, based on this information, workflows and descriptors were designed; that is, creating screens, registering and editing information and the relationship between the different interfaces of the software. Diagrams in Unified Modeling Language (UML) and use-case modeling, Eclipse Integrated Development Environment were used, along with the Unified Modeling Language Generator (UMLGEN) plugin. In the construction phase, the results of the modeling stage were transformed into the coded product. Coding started with the definition of technologies and support tools, such as environment and programming language used. For coding the software, the Web 2.0 environment was chosen, and the PHP (Hypertext Preprocessor) programming language, Version 7.0, was used employing the Model View Controller (MVC) Architecture.

In the deployment phase, the software to be used was delivered. In this stage, the pre-test: SisPRad evaluation form by the users, was applied, which were interviews using an instrument that contained: identification data (profession, professional working time in the institution and time working in the RP sector), three open-ended questions (Of the component aspects of SisPRad, which ones do you consider most important?; Based on the aforementioned components, comment on positive and negative aspects of SisPRad and indicate possible weaknesses, gaps or negative points of SisPRad or aspects that should improve) and two multiple choice questions with yes, no, and in part options (Do you consider it necessary and pertinent to create, develop and apply a system like SisPRad?; In your assessment, does SisPRad facilitate the organization of work in the sector and provide bases for improving assistance to the users? and, in this second question, the participant was also asked to assign a score from 0 to 10).

Six months after the deployment and use of the software, the post-test was applied: Questionnaire to evaluate user satisfaction in relation to the usability of the software, which is the System Usability Scale (SUS). This instrument was developed in English, and its cross-cultural validation for Portuguese was carried out. It is a questionnaire composed of a simple ten-item scale. It uses a *Likert* scale with values from1 (strongly disagree) to 5 (strongly agree), where 3 means neutral. To calculate the SUS score, the contributions of each scoring item are added. For items 1,3,5, 7 and 9, the score contribution is the scale position minus 1, for items 4,6, 8 and 10, the contribution is 5 minus the scale position. The counts for the total of the 10 questions are added and multiplied by 2.5 to obtain the overall usability value of the system. The SUS scores range from 0 to 100, where less than 51 is considered bad, more than 71 is good, more than 86 is excellent, and more than 91 is the best achievable usability.[9]

To facilitate the transparency and replication of the method used to develop the software, the source codes and the complete set of product data were made public at: https://doi.org/10.5281/zenodo.3521022.

RESULTS

From the answers of the research participants to the first form, after being introduced to the software, it was possible to improve it with the suggestions received. The following describes the process considering the Application User Interface and the User Experience Assessment. In this sense, Figure 1 refers to access to the software. In sequence, Figure 2 presents the main interface of the software.

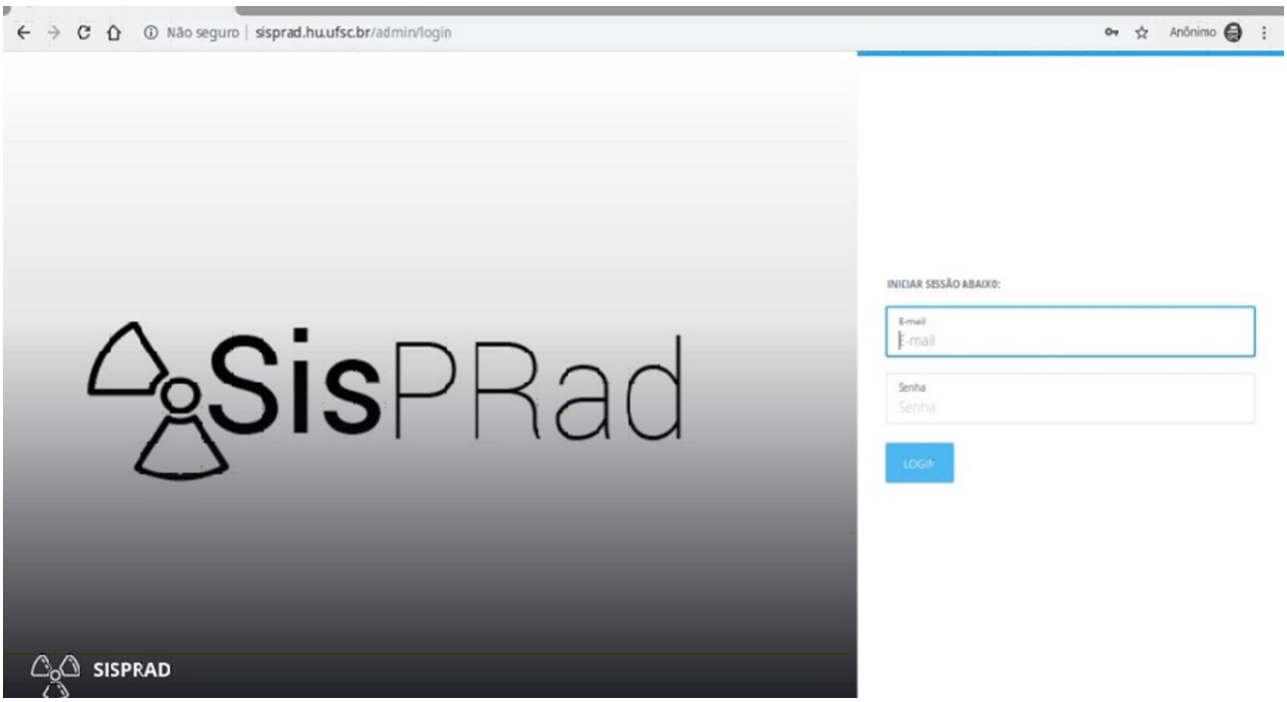

Figure 1 – Login panel. Brazil, 2019.

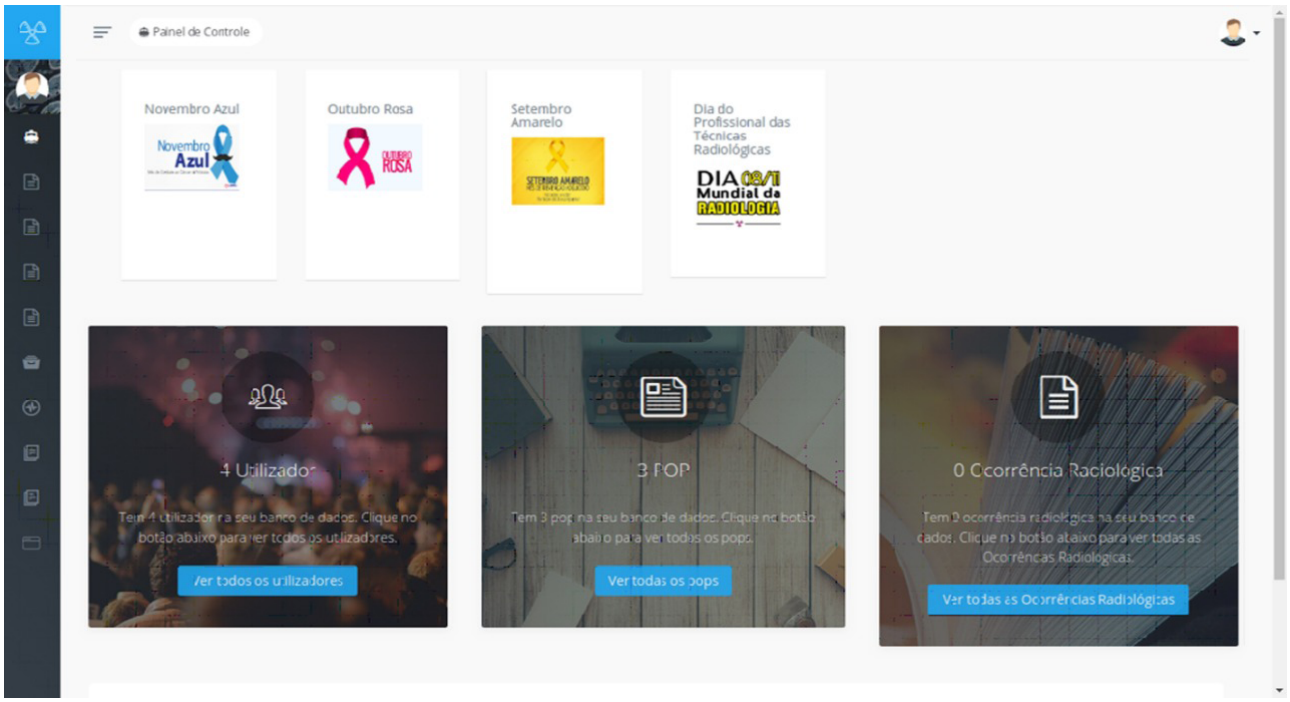

Figure 2 – Initial panel. Brazil, 2019.

The features of the software are called People Management of the Radiological Protection Team (*Gestão de Pessoas da Equipe de Proteção Radiológica*, GPEPRa), Management of Radiological Protection Materials (*Gestão de Materiais da Proteção Radiológica*, GMaPRa), Occupationally Exposed Team Monthly Dosimetry System (*Sistema Mensal de Dosimetria da Equipe Ocupacionalmente Exposta*, SMDE), Patient Dose Management (*Gestão de Dose dos Pacientes*, GDPa), Management of Quality in Radiological Protection (*Gestão de Qualidade em Proteção Radiológica*, GQuaPRa) and Collegiate Manager of Radiological Protection (*Colegiado Gestor da Proteção Radiológica*, CoGEPro). Specifically, GPEPra focuses on the preparation and management of the monthly work schedule of the multi-professional team working in the radiodiagnosis service and in the activities of permanent education and performance evaluation of team members, especially with regard to RP.

In turn, SMDE makes it possible to identify and classify the occupationally exposed team, or rather, each individual occupationally exposed (IOE) to IR, in each sector that uses it to generate diagnostic images (Figure 3). It is a resource for the management of RP because it provides, permanently, a chart of the estimate of exposure to radiation of the IOEs, and for being a basic indicator for the planning and provision of RP measures for each professional subjected to dosimetry. SMDE is fed with data from the monthly dose report of each IOE, issued by an accredited laboratory, by the National Nuclear Energy Commission (*Comissão Nacional de Energia Nuclear*, CNEN), for dosimetric reading, as recommended by the legislation.[10]

The GMaPRa module allows monitoring data related to infrastructure conditions, equipment management, management of the installation rooms, the need to purchase supplies for the radio diagnosis service and supply management, approved by the RPC. In this case, in SisPRad, materials management is concentrated in the registration of the monthly reports on the purchase of these supplies, as a verification of the need to replace RP clothing in environments that have IR emitting equipment. In addition, the GMaPRa monthly report is part of the RPS's periodic performance report.

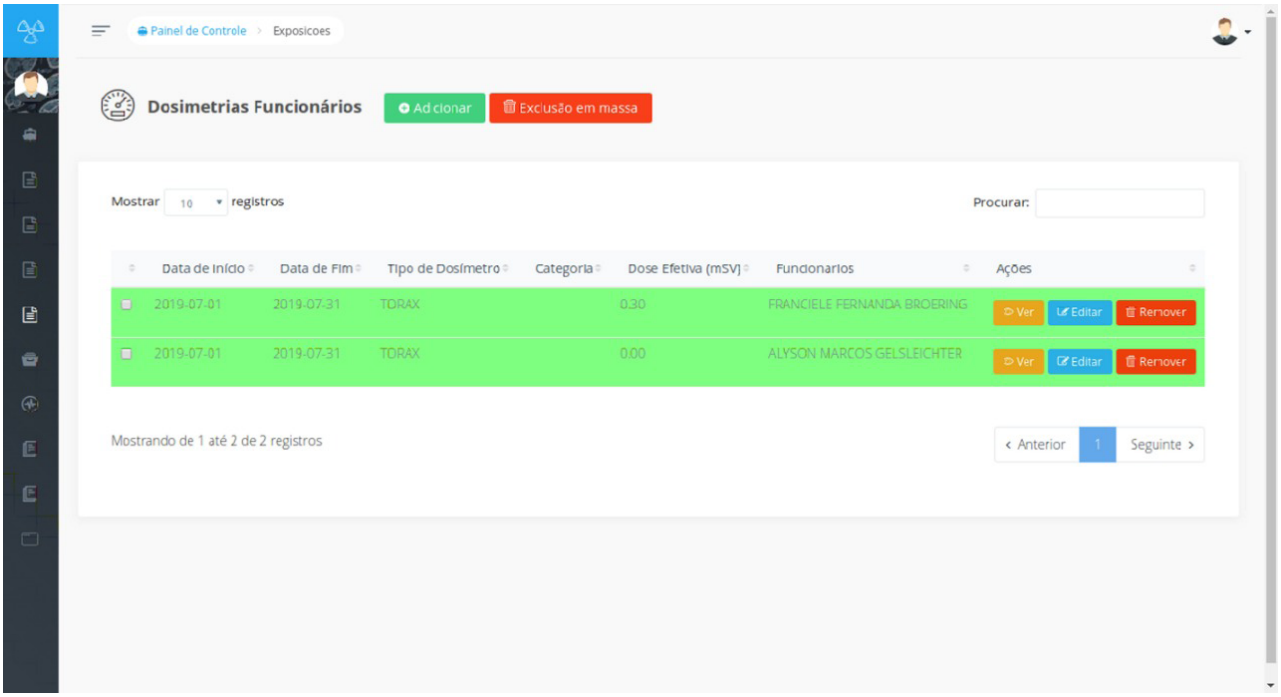

Figure 3 – ETMDS List of the Occupational Doses Received. Brazil, 2019.

GquaPRa is concerned with the quality of care and the safety of patients and professionals, a relevant aspect of the management of health services that also includes the management of RP. In this sense, SisPRad incorporates some assessment and quality instruments and indicators as a module for managing Memoranda; Operational Procedures; Complications; Audits and Quality Controls for IR emitting equipment (Figure 4). In order to assist the RPS, the system will alert, six months in advance, about the expiration of the equipment quality control, among others. This monitoring makes it possible to carry out specific tests for each equipment in a timely manner, so as to keep the data up to date and in accordance with the legislation. The alert is green in the first two months, changing to yellow in the next two months, and ending with red in the last two months. The alert only disappears from the screen when the new tests are attached (Figure 5). Finally, the GQuaPRa monthly report is part of the RPS's periodic performance report.

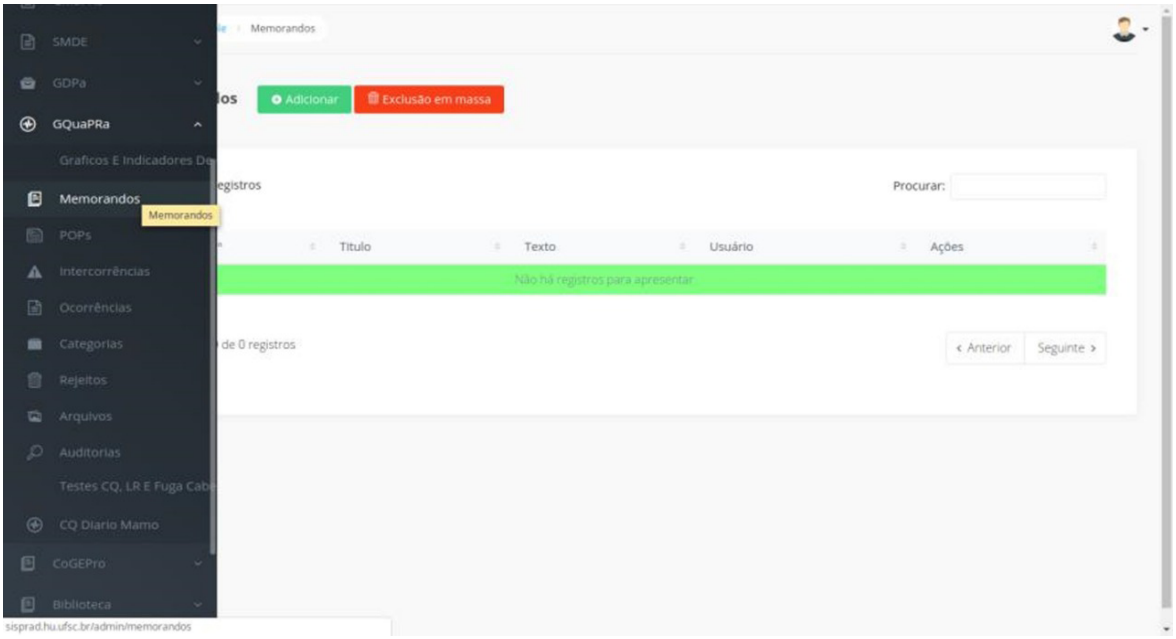

Figure 4 – Module: List of Memoranda; Operational Procedures and Complications. Brazil, 2019.

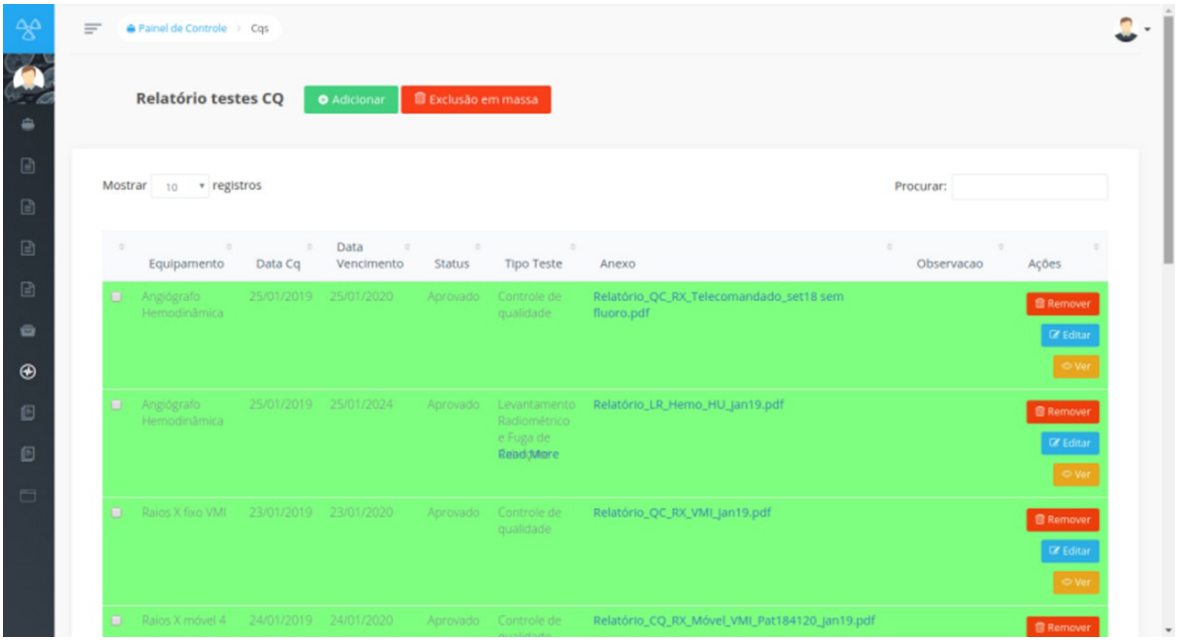

Figure 5 – List of Quality Controls. Brazil, 2019.

The COGEPro module is used to record meeting minutes of the Collegiate Manager of RP, which is composed of the medical physicist, a technologist in radiology and an intern in the undergraduate course in Technology in Radiology, who also make up the RPS. At the Collegiate meetings, the PPR is systematically reviewed to ensure that the quality control equipment and the procedures performed are used properly, observing the current RP regulations. In addition, measures are reinforced to ensure the safe use of the radiation emitting equipment existing in the institution. In this way, the system is responsible for storing meeting information in an organized manner. All occurrences and detected faults are discussed in the RPC and recorded in the minutes contained in the respective module, since the modules are independent

User experience assessment

Six months after the implementation of SisPRad, the SUS form was applied to assess users' satisfaction. Eight professionals answered: 1 administrative assistant, 1 administrator, 1 physicist, 1 professor at the IFSC (the other professor is a researcher in the present study; therefore, he did not participate in data collection), 1 clinical engineer, 1 radiology technician, 1 occupational safety engineer and 1 RPC intern, linked to the Higher Course in Technology in Radiology. Of the eight participants, three have worked for less than 6 months in the institution and five have worked in the institution for more than 60 months.

All the participants stated that the creation, development and practical application of a system like SisPRad is necessary and pertinent, as the software facilitates work organization in the sector and provides bases for improving assistance to the users through RP management. They also agree that the system is intuitive and easy to navigate. However, five participants are not satisfied with the acronyms used to identify the modules in the menus, although this aspect is not preventing the proper use of SisPRad. To overcome this difficulty, the researchers suggested creating a new tab next to each acronym, to insert the respective full name.

Four participants fully agree when the question asks whether the several functions of the system are well integrated, one participant disagrees and three participants signaled the "Neutral" option, which makes it possible to infer the need to improve the integration of the several functions of the system, as an example, integrating the work engineering sector with the medical physics sector, which would minimize double work. Finally, a participant is afraid of experiencing rework in the registration of some information, considering that the system does not integrate with third party software programs and legacy systems. The mean score received by SisPRad is 95 out of 100 points, in terms of usability.

Another important aspect to be considered, even though it goes beyond the data collection instrument, as it portrays aspects experienced among researchers and users of SisPRad, deals with the greater and better use of some of the functionalities to the detriment of other functionalities. That is, in SisPRad, the most used functionalities are GMaPRa and GQuaPRa, and the functionality that users signal that they would most need to use is SMDE.

However, some aspects, addressed by the participants, were not addressed due to the unfeasibility of performing the service, including demands for: Integration between SisPRad and the State Ionizing Radiation Information System (*Sistema de Informação Estadual de Radiação Ionizante*, SIERI) of the State Health Surveillance, allowing for the export of information such as occupational dosimetric data, which would avoid double work; indication of pending release from work by Occupational Medicine and alert of the dates of the new exams; visual monitoring of the worker working in the radiation area during the radiological procedure; indication of administrative pending issues, which would allow socialization of the respective pending issue with the other users of the system; indication of the type of equipment and the time that each worker operates each equipment that emits IR.

DISCUSSION

In this research, RP management is involved with the integration needs of the different services that would need to dialog for management to occur effectively. For this to become possible, the first option is the use of information technology, achieved through the production of a software program. However, currently, there is an aggravating fact that several hospitals have financial difficulties, deficient physical and technological structures and lack of qualified professionals. In addition, the scarcity of reliable indicators and information in the hospital itself has impacted on the lack of adequate subsidies for the decision-making of the administrators.[11]

Concomitant to this situation, it is clear that when the theme is RP, some software programs are available that address the issue of optimizing doses *versus* image quality, to the detriment of software programs related to RP management. For example, there are studies whose results assess that images optimized by software show significantly better image quality than those with a software configuration of clinical routine , which is now considered for use in the clinical practice.[12]

In this sense, the focus is more on exams than on the organization/management of radiodiagnosis services as a whole. And, for the procedure to take place with the safety recommended by the current legislation, it is necessary to implement management targeted at RP, which approves tests of quality control of the equipment, in order to ensure that they are emitting a dose as low as reasonably possible to generate images, following the principle of ALARA (*As Low As Reasonably Achievable*), paying special attention to each medical exposure and, consequently, to the dose control of each IOE.[13] It is also necessary to prove, through specific tests, that the shielding of the rooms adequately bar IR, so as to ensure the safety of everyone who circulates in that environment.

Thus, the creation of a software program, such as SisPRad, that assists in the management of RP is relevant, since hospital radiodiagnosis services need to be in accordance with numerous standards and current ordinances to prove the quality assurance of equipment emitting IR, as well as the RP of everyone. This requires complex management, ranging from the quality control of equipment within the deadlines provided by law to the safety of the multi-professional team working in these environments, as well as the safety of patients and their companions.

Reinforcing the need for effective management, it should be noted that most radiodiagnosis services have difficulty in maintaining the documents required by the Health Surveillance up-to-date, in order to keep the services in question operational, such as, for example, the MDPR of the service.[14]

It is also possible to analyze aspects pertinent to the need and importance of a qualified multi-professional team to properly use the IR emitting equipment present, constantly, in these environments. Therefore, knowing the possible harms resulting from the inappropriate use of IR is essential to ensure the RP of everyone who circulates in these environments.[14] Thus, the need to perform an accurate, quality and safe examination involves knowledge and reflection about radiological protection by the entire team.[15]

In addition, the importance of dialog between the hospital sectors is essential, precisely to update and optimize the work system with regard to RP management. One of the sectors that requires effective communication is the occupational health sector, which needs access to the doses received by the workers to correlate with the periodic examinations that must be performed to monitor the health of the worker.[16] In this sense, SisPRad allows access to the different areas that are directly or indirectly linked to the hospital radiodiagnosis service. The expectation is that there will be exchange and dialog between specialists from different areas of knowledge. These characteristics of exchange, dialog between specialists and integration of the disciplines in a common project, characterize inter-disciplinarity.[17] Therefore, it is a process built in the community, which provides exchanges and

integration, as well as it signals paths of unity, with the transition from subjectivity to intersubjectivity taking place.[18]

Another emerging issue in this study deals with the fact that the training of professionals in the health field, whether from higher education, technical or high school courses, rarely contemplates the need for education in RP. When there is this approach, they favor individual protection and neglect protection for the users, family members and other people present in the hospital or health care environment.[19] However, all hospitals must understand the functions and importance of the radiation protection monitoring equipment and need committees with computerized RP systems to monitor the practices performed in radiodiagnosis, so that any undesirable effects can be minimized.[16]

A dosimetry of the team working in the hospital radiodiagnosis service can be obtained by means of a dosimeter, the most common being the lapel dosimeter, which has its dose reading performed by specialized laboratories and accredited by the National Nuclear Energy Commission (CNEN), with each occupationally exposed worker having their own individual dosimeter. These laboratories have the obligation to send a general report of all professionals subjected to dosimetry, which can be transcribed and/or attached to the software, avoiding the loss of this important document and providing the comparison of doses on necessary occasions.

The registration of the dose received by the patient, on the other hand, is more complex, due to the fact that in Latin America, unlike other countries such as the United States and European countries, there is no adequate legal framework to control the safe use of IR in health. Therefore, in these countries, it is not allowed to sell angiography equipment, for example, without the kerma-area product meter, which indicates the radiation dose that the patient receives. That is, it is essential to estimate the dose received by the patient during the exam, thus optimizing the safety of the procedure.[20]

Even so, in the reality of our services, there would be a logistical difficulty, since the professional who performs the exam would have to add the dose of each radiographic shot taken on the patient, write it down or launch it in a specific system for this end, which is not feasible in the practice due to the demand for exams. In addition to that, in order to have the approximate dose that the patient receives, the professional would have to compute the dose that can possibly be received by a repetition of the exam, which perhaps would not be computed in order not to compromise the conduct of the professional himself, which makes obtaining the exact dose received by the patient for each exam performed complex.

The *DoseCal* software, developed at the Radiological Protection Center of the Saint George's Hospital, measures the dose entry into the skin by an estimate, even though it is not applied for all types of exam. To do so, it uses IR exposure parameters, patient characteristics and X-ray tube performance.[21] The requirements for a reliable estimate for dose calculation are not easily achieved in IR emitting equipment, which complicates this data collection practice. In Brazil, no radiodiagnosis service is able to collect it. In addition to that, the legislation provides for the principle of dose justification, by emphasizing that medical exposure to IR that results in a benefit to the individual's health, in terms of diagnosis or therapy, should be prioritized over radiation to the individual.[7]

Anyway, although it is not yet possible to calculate the dose received by the patient, in SisPRad there is a specific tab for filling in these data, considering that it is necessary to disclose the need for adequate practice in the services. The success of the practices in the use of new health technologies is only possible when the creation of an organizational culture that encourages interpersonal relationships[22] and responsible behavior is allowed.

This research prioritized quality in RP, by identifying the problems in the hospital radiology sector and the daily situations that compromise the sector's management and the quality of the services provided. In this sense, a number of studies signal the importance of a project that aims to improve the infrastructure of the facilities, the training of employees, and the communication between the radiodiagnosis sector and the other sectors.[23–24]

Valuing work begins with actions that prioritize occupational safety, preventing harms and promoting worker health.[25] In Brazil, there is evidence of weaknesses regarding RP. A study carried out in Paraíba showed that the professionals of the radiological techniques work under inadequate safety conditions, evidenced by the lack of signs to indicate the use of radiation, lead glass, insufficient PPE and inattention to standard precautions. Therefore, predictive aspects of health problems for workers are signaled.[26] Another study[14] also showed, through documentary analysis and observation of the daily lives of the professionals, that not all the items required by law were recorded and that some professionals did not use RP clothing properly in themselves and in service users.

Finally, when evaluating the SisPRad by users of the software, the relevance of studies that evaluate usability was considered, as it involves the participation of the user to browse and make comments or complete some tasks according to the request of the original document. Thus, it is possible to verify the user's ease of use and acceptance, before and after implementation. And, in addition to being considered a low-cost method, training the user enables greater use of the Information System.[27–28]

Thus, SisPRad was conceived and tested, through the usability scale, in order to fit in the context of evaluating a quality service, in terms of hospital RP management that involves: planning and organizing the service according to the current legislation and preparing for regular audits, considering the responsibility of the professionals for themselves and the users and the transparency and accountability updated.[13] However, it is worth remembering that the consolidation of a new technology and a comprehensive assessment of its impacts takes time and a maturation process.[11]

As a limitation of the study, the lack of integration of SisPRad with other systems of the hospital and of Health Surveillance is evidenced, which requests data from the radiodiagnosis service. However, there was a need to implement and use a system like this, in order to automate management processes. New versions of SisPRad should improve the software, as well as meet and improve the users' needs.

CONCLUSIONS

Information technology is important for health institutions. Among these, there is a great and growing demand in hospitals, as it is a way to optimize their resources, bringing benefits to both the patients and the professionals involved, even though it needs improvements and maturation.

The analysis and development of SisPRad resulted in a tool that will assist the multi-professional and interdisciplinary team of the hospital radiology service in RP management. The computerization of systems and the integration of sectors that need data in common in work routines are essential for the management of RP, both for the multi-professional team and for users, not preventing it from being used and adapted for other institutions that have equipment IR emitters.

The results obtained suggest that the SisPRad software was developed in order to integrate the RP management process. Therefore, it is a tool that can mitigate repetitions of activities, which usually occur in manual processes, as well as alert those responsible for the quality control of the service. In addition to this, the usability test showed that the system has the best possible usability.

REFERENCES

1. Santana R, Silva L, Cruz IM, Lemos G, Perini E, Lopes CR. SECH: Software de Gerenciamento Farmacêutico e Prescrição Eletrônica. Saúde.com [Internet]. 2017 [acesso 2018 Nov 25]; 12(4):680-7. Available from: http://periodicos2.uesb.br/index.php/rsc/article/view/430
2. Santos TO, Pereira LP, Silveira DT. Implantação de sistemas informatizados na saúde: uma revisão sistemática. RECIIS [Internet]. 2017 [acesso 2018 Nov 13];11(3):1-11. Available from: http://hdl.handle.net/10183/178198
3. Thompson TG, Brailer DJ. The decade of health information technology: delivering consumer-centric and information-rich health care. Framework for strategic action [Internet]. 2004 [cited 2018 Aug 14]. Available from: http://www.hhs.gov/healthit/documents/hitframework.pdf
4. Gadelha CAG. Desenvolvimento, Inovação e Saúde: a perspectiva teórica e política do Complexo Econômico-Industrial. Cien Saude Colet [Internet]. 2018 [acesso 2019 Apr 25];23(6):1891-902. Available from: https://doi.org/10.1590/1413-81232018236.06482018
5. Pinochet LHC, Lopes AS, Silva JS. Inovações e Tendências Aplicadas nas Tecnologias de Informação e Comunicação na Gestão da Saúde. Rev Gest Sist Saude [Internet]. 2014 [acesso 2019 May 28];3(2):11-29. Available from: https://doi.org/10.5585/rgss.v3i2.88
6. Harris AD, McGregor JC, Perencevich EN, Furuno JP, Zhu J, Peterson DE, et al. The use and interpretation of quasi-experimental studies in medical informatics. J Am Med Inform Assoc 2006 [acesso 2019 Aug 28];13:16-23. Available from: https://academic.oup.com/jamia/article-abstract/13/1/16/780729
7. Brasil. Secretaria de Vigilância Sanitária do Ministério da Saúde. Portaria nº 453 de 1º de junho de 1998. Diretrizes de proteção radiológica em radiodiagnóstico médico e odontológico. Diário Oficial da União, 1998 [acesso 2019 May 12]; Available from: http://www.conter.gov.br/uploads/legislativo/portaria_453.pdf
8. Pressman RS. Software engineering: a practitioner's approach. 8th ed. Nova York (US): McGraw-Hill Higher Education; 2015.
9. Bangor A, Kortum PT, MIller JT. An empirical evaluation of the system usability scale. International J Hum Comp Int [Internet]. 2008 [cited 2018 Apr 10];24(6):574-94. Available from: https://doi.org/10.1080/10447310802205776
10. Huhn A, Vargas MAO. Plano de proteção radiológica e responsabilidade ética. Braz J Rad Sci [Internet]. 2016 [cited 2018 Apr 10];3(2a):1-7. Available from: https://doi.org/10.15392/bjrs.v3i2A.184
11. Lorenzetti J, Gelbcke FL, Vandresen L. Management technology for hospital inpatient care units. Texto Contexto Enferm [Internet]. 2016 [cited 2016 Aug 18];25(2):e1770015. Available from: https://doi.org/10.1590/0104-07072016001770015
12. Precht H, Gerke O, Rosendahl K, Tingberg A, Waale D. Large dose reduction by optimization of multifrequency processing software in digital radiography at follow-up examinations of the pediatric femur. Ped Rad [Internet]. 2018 [cited 2016 Aug 18];44(2):239-40. Available from: https://doi.org/10.1007/s00247-013-2854-3
13. Melo JAC, Gelbcke FL, Huhn A, Vargas MAO. The work process in radiological nursing: invisibility of ionizing radiation. Texto Contexto Enferm [Internet]. 2015 [cited 2016 Apr 10];24(3):801-8. Available from https://doi.org/10.1590/0104-07072015003130014
14. Huhn A, de Oliveira Vargas MA, de Melo JAC. D, Gelbcke FL, Ferreira M, Lança L. Implementation of a radiation protection program: opinion of the health team working in a radiology service. Texto Contexto Enferm [Internet]. 2017 [cited 2018 Apr 10];26(1):e5370015. Available from: https://doi.org/10.1590/0104-07072017005370015

15. Kim H, Park M, Park S, Jeong H, Kim J, Kim Y. Estimation of absorbed organ doses and effective dose based on body mass index in digital radiography. Radiat Prot Dosimetry [Internet]. 2013 [cited 2019 Apr 25];153(1):92-9. Available from: https://doi.org/10.1093/rpd/ncs

16. Huhn A, de Oliveira Vargas MA, Lorenzetti J, Neves F, Dorow PF, Medeiros L, Lança L, Queiroz C. Evaluation of the management of hospital radiological protection. Int Jol A R [Internet]. 2019 [cited 2019 Nov 12];7(5)630-6. Available from: http://doi.org/10.5281/zenodo.3271240

17. Velloso MP, Guimarães MBL, Cruz CRR, Neves TCC. Interdisciplinaridade e formação na área de saúde coletiva. Trab Educ Saúde [Internet]. 2016 [cited 2016 May 10];14(1):257-71. Available from: http://www.scielo.br/pdf/tes/v14n1/1981-7746-tes-14-01-0256.pdf

18. Anjos MB. Interdisciplinaridade na condução docente: Impressões a partir da vivência. In*:* Pinho MJ, Susanno MVR, Susanno JR, Ferraz EPN, et al., eds. Complexidade, interdisciplinaridade e transdisciplinaridade na educação superior. Goiânia, GO(BR): Editora Espaço Acadêmico; 2015.

19. Batista VMD, Bernardo MO, Morgado F, Almeida FA. Radiological protection in the perspective of health professionals exposed to radiation. Rev Bras Enferm [Internet]. 2019 [cited 2020 Apr 28];72(Suppl 1):9-16. Available from: https://doi.org/10.1590/0034-7167-2017-0545

20. Leyton F, Canavaro L, Dourado A, Castelo H, Barcelar A, Navarro MT et al. Risco da radiação X e a importância da proteção radiológica na cardiologia intervencionista: uma revisão sistemática. Rev Bras Cardiol Invasiva [Internet]. 2014 [cited 2016 May 18];22(1):87-98. Available from: http://www.scielo.br/pdf/rbci/v22n1/0104-1843-rbci-22-01-0087.pdf

21. Azevedo ACP, Mohamadain KEM, Osibote AO, Cunha ALL, Pires Filho A. Estudo comparativo das técnicas radiográficas e doses entre o Brasil e a Austrália. Radiol Bras [Internet]. 2005 [cited 2020 Apr 28];38(5):343-6. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-39842005000500007&lng=en

22. Dorow P, Silva C, Huhn A, Borges LM, Nóbrega J, Andrade MAB, et al. Practices of knowledge management in health organizations. Espacios [Internet]. 2019 [cited 2020 Apr 28];40(24). Available from: https://www.revistaespacios.com/a19v40n24/in194024.html

23. Queiroz JV, Rosa JRC, Queiroz FCBP, Hékis HR, Pereira FB. Gestão da qualidade em um setor de radiologia hospitalar: um estudo no centro de diagnóstico por imagem (Santa Catarina). R-BITS [Internet]. 2011 [acesso 2012 Sept 22];4(4):1-13. Available from: http://ufrn.emnuvens.com.br/reb/article/view/1492

24. Singh TD, Jayaraman T, Arunkumar Sharma B. Assessment of radiological protection systems among diagnostic radiology facilities in North East India. J Radiol Prot [Internet]. 2016 [cited 2019 Apr 28];37(1):68-83. Available from: https://iopscience.iop.org/article/10.1088/1361-6498/37/1/68

25. Brand CI, Fontana RT, Santos AV. A saúde do trabalhador em radiologia: algumas considerações. Texto Contexto Enferm [Internet]. 2011 [cited 2014 Aug 10];20(1):68-75. Available from: https://doi.org/10.1590/S0104-07072011000100008

26. Diniz DN, Bento PM, Pereira MSV, Pereira JV, Silva DF, Costa MRM. Avaliação do conhecimento sobre biossegurança em radiologia pelos alunos do curso de Odontologia da Universidade Estadual da Paraíba. Arq Ciênc Saúde [Internet]. 2009 [cited 2020 Apr 20];16(4):166-9. Available from: http://repositorio-racs.famerp.br/racs_ol/vol-16-4/IDK4_out-dez_2010.pdf

27. Cintho LM. Métodos para avaliação de sistema de informação em saúde. J. Health Inform [Internet]. 2016 [cited 2019 Apr 28];8(2):41-8. Available from: http://www.jhi-sbis.saude.ws/ojs-jhi/index.php/jhi-sbis/article/view/346/259

28. Hoyt R, Adler K, Ziesemer B, Palombo G. Evaluating the usability of a free electronic health record for training. Perspect Health Inf Manag [Internet]. 2013 [cited 2020 Apr 28];10:1-14. Available from: https://pubmed.ncbi.nlm.nih.gov/23805062/

NOTES

ORIGIN OF THE ARTICLE

Article extracted from the thesis - SisPRad: Software for Radiological Protection Management, presented to the Postgraduate Program in Nursing, *Universidade Federal de Santa Catarina*, in 2019.

CONTRIBUTION OF AUTHORITY

Study design: Huhn A, Vargas MAO, Lorenzetti J, Queiroz C.
Data collection: Huhn A, Queiroz C.
Data analysis and interpretation: Huhn A, Vargas MAO, Lorenzetti J, Lança L, Queiroz C.
Discussion of the results: Huhn A, Vargas MAO, Lorenzetti J, Lança L, Gelbcke FL, Queiroz C.
Writing and/or critical review of content: Huhn A, Vargas MAO, Lorenzetti J, Lança L, Gelbcke FL, Queiroz C.
Review and final approval of the final version: Huhn A, Vargas MAO, Lorenzetti J, Lança L, Gelbcke FL, Queiroz C.

APPROVAL OF ETHICS COMMITTEE IN RESEARCH

Approved by the Research Ethics Committee of the *Universidade Federal de Santa Catarina*, opinion No.1,939,144/2019, Certificate of Presentation for Ethical Appreciation 63196616.3.0000.0121.

CONFLICT OF INTEREST

There is no conflict of interest.

EDITORS

HISTORICAL

Received: May 18, 2020.
Approved: September 14, 2020.

CORRESPONDING AUTHOR

Andrea Huhn
andrea.huhn@ifsc.edu.br