Review Article

Patient safety in computed tomography services: an integrative review

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ABSTRACT

The objective was to identify essential elements to offer a safe assistance to patients submitted to computed tomography scan. An integrative literature review on Medline, SCOPUS, Web of Science and CINAHL databases, guided by the question: what are the essential elements to offer a safe assistance to the patient submitted to computed tomography scan? We selected twenty-three articles, from those, 50% addressed optimization, monitoring, quality and protection about radiation dose exposition; 25% focused on the contrast used for tomography; and 25% concentrated on nursing care and management of individual cases. The evidence for safe assistance to the patient submitted to computed tomography points to need to minimize the conduction of unnecessary exams, and consequently exposition to radiation, to guarantee the radiological protection, to provide adequate care for adverse reactions, qualified human resources and trustful quality indicators for assistance.

Descriptors: Diagnostic Imaging; Patient Safety; Tomography.

INTRODUCTION

The science development and the growing use of hard technologies in health, with the use of modern, complex and sophisticated equipment for image exams of high definition for the diagnosis and treatment of diseases, have allowed the early diagnose and the treatment of diseases, contributing to the improvement of the population's quality of life and health[1-3].

This technological advance has been followed by changes in the paradigms of health attention, pointing to a need for safety and reduction of risks to the patient, the establishment and use of quality indicators for assistance, implementation of assistance protocols, prevention, and analysis of adverse events occurrence, grounded in scientific evidence[4-6].

The patient's safety is a critical component for healthcare quality improvement worldwide, once this is a severe global public health issue. Estimates of developed countries indicate that at least one in each ten patients who received hospital care suffered losses denominated adverse events. The consequences of these events can be severe or fatal, and extremely costly for the victims and health care systems[7-9].

As a consequence, there is a growing knowledge of health professionals and managers about the importance of promoting a culture of safety involving health professionals and the organization as a whole. In this context, patient's safety is an important indicator of provided services[10-11].

In Centers of Diagnoses by Image (CDI), professionals should be trained to meet patient's needs in each modality of diagnosing exams, as in the sector of Computed Tomography (CT) [3]. The conduction of quality exams, minimizing the costs and reducing the quantity of radiation exposed to the patient, to the professional and the environment, requires an organized effort intended to guarantee produced diagnostic images with quality to provide adequate information for a safe diagnosis[4].

Thus, when directing the sight to CT services, professionals have an important role in prevention, detection, and treatment of adverse events that can result from the use of iodinated contrast, as well as the provision of necessary information for the adequate conduction of the exam, and the consequent safe diagnosis[3].

A justification for the present study is the lack of studies that gather essential elements to offer a safe assistance to patients submitted to CT scan. Thus, there is a need to search for evidence in the national and international literature about this theme, aiming to qualify nursing assistance intended to guarantee safety to the patient when performing this exam.

Also, the literature reveals gaps related to the lack of well-designed research as systematic reviews, meta-analyses, clinical trials and randomized clinical trials, to provide robust evidence about the essential aids to offer a safe assistance to patients submitted to computed tomography; as well as the impact on the quality of life and safety in the assistance provided to this clientele.

Besides, this study is relevant because it brings information about safety promotion for patients at CDI, where there is an increase of performed image exams, due to the growing evolution of diagnostic resources and, by its high accuracy power[5-7,9-11]. Therefore, this is a new space for risk management, management of the caring process, health investigation, and teaching. In this sense, studies should be increasingly developed, to produce knowledge that will promote sustainability of a positive safety culture in health organizations[10-13].

Thus, this study aimed to identify the essential elements to offer a safe assistance to patients submitted to computed tomography scan, from the literature evidence.

METHODS

We performed an integrative literature review that allows to perform a critical assessment and to synthesize multiple published studies, enabling conclusions related to a determined field of study[14].

To operationalize this study, we followed these steps: to elaborate a research question, to define the objective, to determine the inclusion and exclusion criteria for publications, to set the information to be collected in included studies, analysis, interpretation and synthesis of the review results[14].

We used the following guiding question f this review: Which are the essential elements to offer a safe assistance to patients submitted to the computed tomography scan?

The search for publications occurred between October and November of 2015 in the following databases: Medical Literature Analysis and Retrieval System Online (Medline), SCOPUS, Web of Science, and Cumulative Index to Nursing Allied Health Literature (CINAHL). There was no limitation regarding the year of publication.

Pairs performed searches, following the order described in these databases, and publications found in more than one database were selected in the first search.

To refine the papers, we established the following inclusion criteria: articles addressing patient's safety when conducting an imaging exam, more specifically, computed tomography; to be fully available in the databases mentioned above; studies referring to adult population; without language restriction. We excluded studies published in an editorial format.

To search studies, we used these controlled descriptors used in health sciences (DeCS) in Portuguese: *Diagnóstico por Imagem; Segurança do paciente; Tomografia.* We also used the controlled descriptors of the Medical Subject Heading (MeSH) vocabulary, in English: Diagnostic Imaging; Patient safety; Tomography. The crossing of these descriptors was done using the Boolean operator AND in all databases, in the order cited above, as follows: Tomography *AND* Patient safety; Diagnostic Imaging *AND* Patient safety; Diagnostic Imaging *AND* tomography *AND* Patient safety.

The crossing allowed us to obtain a total of 14,852 articles, being 7,620 from SCOPUS, 816 from Medline, 6,045 from the Web of Science, and 371 from CINAHL. We present a figure (1) with the general picture of the selected articles.

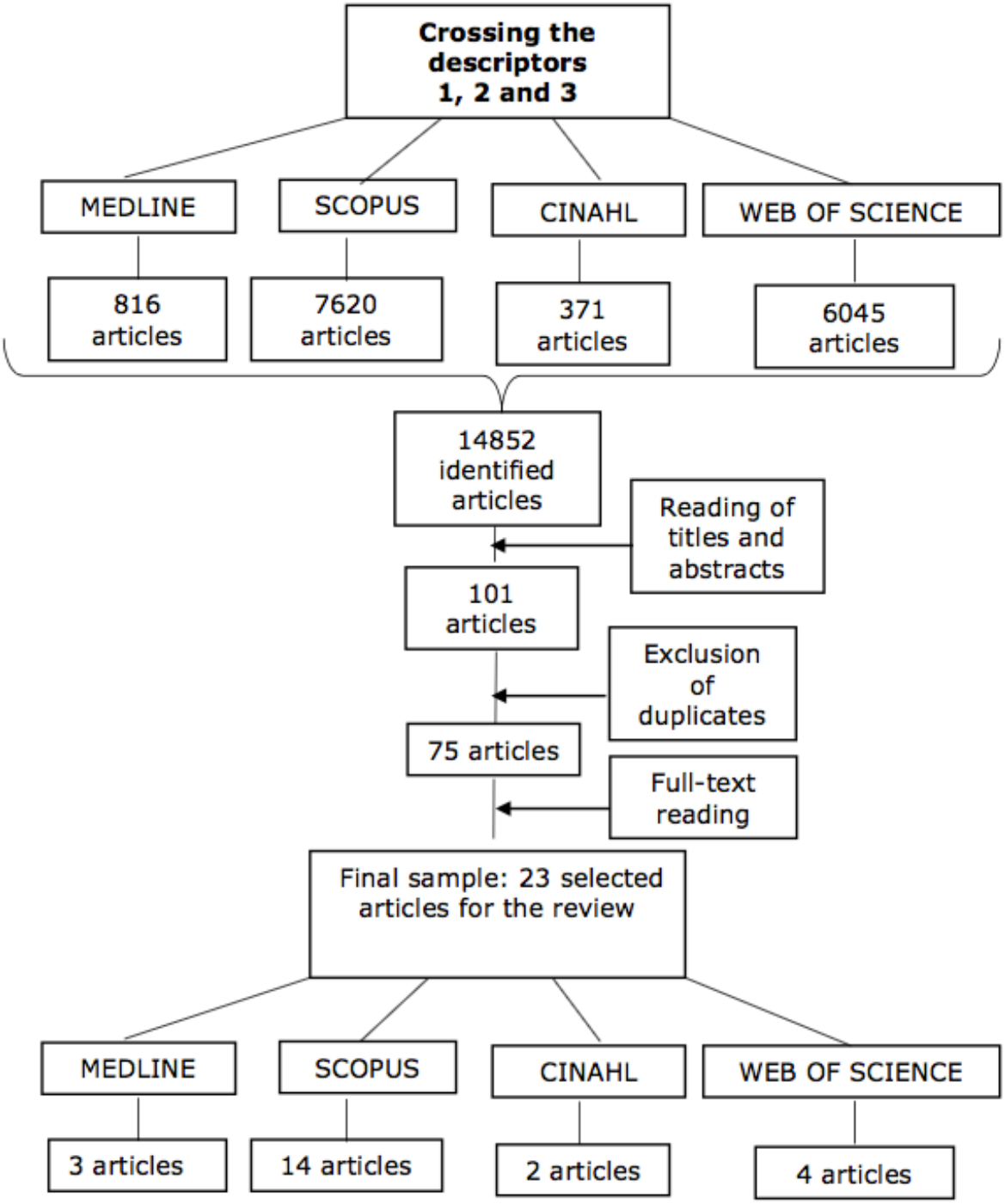

Figure 1: Flow diagram of the selection and inclusion of articles in the integrative literature review.

We pre-selected the found publications from the reading of titles and abstracts. After the full-text reading and analysis of the previously selected articles according to the inclusion criteria, we obtained a final sample of 23 articles.

We used a validated instrument to extract data of articles included in the integrative review. It contained the article identification; the introduction and objectives; methodological characteristics; results and conclusions[15].

The evidence level attributed to articles was based on the following classification: level I – evidence

from systematic reviews or meta-analysis of clinical trials; level II – evidence from at least one well-designed randomized clinical trial; level III – non-randomized clinical trials; level IV – well-designed cohort and case-control studies; level V – systematic reviews of descriptive and qualitative studies; level VI – evidence from a single descriptive and qualitative study; level VII – evidence based in specialists and committees of experts[16].

The obtained studies were read in full-text to fulfill the completion of the data collection instrument. The collected information was doubled-entered in a Microsoft Excel 2013® spreadsheet to identify inconsistencies and to minimize the risk of errors, allowing a better quality review. Thus, the information from the selected articles was entered and re-entered. In cases of data disagreements, we corrected it by re-reading the article containing discrepancies.

At last, we conducted an exhaustive reading of articles with posterior categorization by thematic content. In this process, we classified the textual information, summarizing it to relevant data in a way to organize and group the categories with similar meanings and meeting the proposed objective. This division was merely didactic to present results and to understand the knowledge synthesis of this review better.

RESULTS

The organization, summarizing, critical and integrative analysis of information from articles suggested to organize the articles in three categories indicating their essential elements; to offer a safe assistance to patients submitted to the computed tomography scan, from the literature evidence as: optimization, monitoring, quality and protection related to doses of exposition to radiation; adverse events and nephropathies related to contrast use; nursing care, management and specific cases. We present below three summary charts illustrating the analysis of the included articles.

Chart 1: Synthesis of articles from the category optimization, monitoring, quality and protection related to doses of exposition to radiation. Natal, RN, Brazil, 2015.

Author/periodic/year/level of evidence	Study objective	Research method	Summary of the article's evidence
Reiner BI, American College of Radiology/2009/IV	To quantify the risk of radiation, to develop patterns and guidelines based on radiation "best practice," and to develop new technologies to minimize radiation doses.	Cohort study.	To keep the image quality including questions related to patient's safety.
MacGregor K, Li I, Dowdell T, Gray BG/ Radiology/2015/IV	To assess efforts of radiation optimization protocols for computed tomography (CT) and to determine the levels of radiation doses using a monitoring software of automized radiation dose level.	Retrospective observational study.	Reduction and tracking radiation doses.
Gervaisea A; Esperabe-Vignaub F.; Pernina M et al**./** Journal de Radiology/2011/IV	To assess the knowledge of physicians who prescribe TC scans about the protection against patient's radiation.	Cohort study	To improve knowledge about radiation protection.
Holmberg O; Malone J; Rehani M et al./ European Journal of Radiology/ 2010/IV	To associate ionizing radiation with risks due to undetermined effects and to consider the protection of patients against potential harms.	Cohort study	Development of new technologies for safety.
Siegelman JRPW; Gress DA/ Journal of American College Radiology/ 2013/IV	To assess the efficacy of a multidisciplinary commission to estimate dose and cost to perform a CT scan and to describe an initiative to improve the quality of radiation.	Case-control study.	Protocols to reduce radiation doses improve the quality of assistance to patients, develop a safety culture and reduce costs.
Fletcher JG; Kofler JM; Coburn, JA et al./ Abdominal Imaging Journal/ 2013/V	To reflect about awareness and communication about questions related to radiation dose.	Systematic review of descriptive studies.	To individualize tomographies according to patient's characteristics and the indication of diagnosis without compromising a precise diagnosis.
Tsivian M; Abern MR; Yoo JJ et al./ Journal of Endourology/2013/IV	To quantify the effective dose associated to CT and to determine how patient's factors affect the exposition to radiation.	Retrospective observational study.	Management strategies should be developed to reduce the exposition to ionizing radiation.
Talati RK; Dunkin J; Parikhb S; Moore WH/ Journal of American College Radiology/ 2013/V	To describe components from the nucleus of a monitoring strategy of the universal dose and details of available commercial platforms.	Systematic review of descriptive studies	Monitoring, registry and communication of cumulative doses for patients and professionals result in the higher fidelity of patients, physician's satisfaction and opportunity for new business.
Raman SP; Mahesh M; Blasko, RV et al./ Journal of American College Radiology/ 2013/IV	To guide radiologists to reduce the patient's radiation dose.	Case-control study.	To better understand the technology is essential to produce diagnostic images with lower doses and a safer image.
Birnbaum, S./ Seminars Ultrasound CT MRI/2010/V	To minimize the radiation dose for patients doing a computed tomography scan.	Systematic review of descriptive studies	Professionals should have a political, social and economic power to manage dose reduction.
Qiao, Y.; Wang N.; Chen, R. et al. / American College of Radiology/ 2014/ IV	To propitiate new evidence for the establishment of a radiological protection policy for patients.	Cohort study	The comprehension of the role of social factors for radiological protection. A gap between the conscience and behavior for radiation safety.

Author/periodic/year/level of evidence	Study objective	Research method	Summary of the article's evidence
Yu JPJ, Kansagra AP; Mongan J/ American College of Radiology/ 2014/IV	To determine the experience of radiologists, analyzing the absolute time and frequency that they spend on the phone to better understand this phenomenon and its potential implications.	Case-control study.	Effects of frequent interruptions about the performance of radiologists on call at academic institutions.

Chart 2: Synthesis of articles from the category adverse reactions and nephropathies related to the contrast used in computed tomography. Natal, RN, Brazil, 2015.

Author/periodic/year/level of evidence	Study objective	Research method	Summary of the article's evidence
Kobayashi D; Takahashi O; Ueda T et al. / BioMedCentral Medical Informatics and Decision Making/ 2013/IV	To create a scoring rule to predict adverse reactions caused by types of contrasts used in computed tomography	Cohort study	Those were significant predictors of an acute adverse reaction: previous adverse reaction to types of contrast, hives, history of allergy to other contrast agents, high concentration contrast agent, to be older than 50 years, and total contrast agent higher than 65g.
Piechowiak EI; Peter JF; Kleb B; Klose KJ; Heverhagen JT/ Radiology/2015/IV	To determine the effect of the use of iodized contrast agents in the formation of double-stranded DNA during thorax CT scan.	Cohort study	The application of iodized contrast agents during the x-ray diagnostic processes, as the computed tomography, leads to an increase of DNA harm induced by radiation.
Acauan LV; Rodrigues, MCS/ Texto Contexto Enfermagem/ 2014/ VI	To comprehend the nursing team perception about elderly safety when administering iodized contrast.	Descriptive qualitative study	The nursing team understands that elderly safety during the exam is associated with their capacity to assess risks for the occurrence of adverse reactions related to the radio-pharmacological administration, where processes, technologies, and human interactions are tangled and, it results in safe practices.
Kidoh, M; Nakaura, T; Awai K et al./ Journal Computer Assisted Tomography /2014/II	To assess the safety of a low dose protocol for CT in patients with kidney failure by contrast-induced nephropathy.	Randomized controlled trial	The existence of protocols for low dose contrast allows performing tomography with contrast in patients with kidney failure without major harms.
Velázquez MT, Albarrán A, Hernández F, García Tejada J, Zueco J, Andreu J, et al./ Acta Cardiologica/21010/II	To analyze the diagnostic efficacy and tolerability of the iobitridol use as intravascular contrast agent by image, and it shortly reviews its pharmacological properties.	Multicentric double blinded clinical trial	Iobitridol is an effective intravascular agent to use in image diagnosis.
Traub, SJ; Mitchell, AM; Jones, AE et al./ Annals of Emergency Medicine/ 2013/II	To test the hypothesis that the N-acetylcysteine and saline solution is more effective than the normal saline solution only for the prevention of nephropathy per contrast.	Double blinded randomized clinical trial	There is no beneficial evidence to administer N-acetylcysteine to patients submitted to TC with contrast. However, there is a significative association between the administered intravenous fluid volume and the reduction of induced nephropathy per contrast.

Chart 3: Synthesis of articles from the category Nursing care and management of special cases. Natal, RN, Brazil, 2015.

Author/periodic/year/level of evidence	Study objective	Research method	Summary of the article's evidence
Hussein AA; Abutaleb A; Jeudy, J et al./ Journal of the American College of Cardiology/2014/IV	To assess the safety of CT in patients with equipment to manage cardiac rhythm.	Cohort study	There was no change in the battery voltage or parameters of the equipment to manage cardiac rhythm exposed to radiation.
Litmanovich DE; Tack D; Lee KS et al./ Journal Thoracic Imaging/ 2014/V	To revise the actual evidence-based recommendations for radiology themes to pregnant and lactating patients; to provide efficient algorithms to minimize the risk and to increase safety for the pregnant and the fetus.	Systematic review of descriptive studies	Image radiation should be applied in the lowerest possible levels, to keep high levels of safety for pregnant patients.
Miguel C; Barros F S; Tilly JGJ; Fontoura LD; Sowek LF; Saskoski GVR/ Colégio Brasileiro de Radiologia e diagnóstico por imagem/ 2013/V	To provide an aid about the essential elements of patient's position for radiology procedures.	Systematic review of descriptive studies	The adequate patient's positioning should be included in the guidance for nurses who work with radiology because patient's safety is the final objective of caring for all patients.
Campbell, KL; Hud, LM; Adams S et al./ The American Journal of Medicine/ 2012/ IV	To assess the adverse results after contrast administration in a cohort of patients with the falciform disease.	Cohort study	Adverse events related to intravenous contrast occur in patients with a disease similar to falciform, with a rate similar to the general population.
Brask KB; Birkelund RP/ Journal Radiology Nursing/ 2014/V	To investigate how the team with care experience expresses themselves during the little contact with patients in a department of image diagnosis.	Systematic review of descriptive qualitative studies.	Care comprehends the preliminary phases until the image is electronically forwarded.
Santosa AM; Martín JMA/ Radiología/ 2011/V	To reflect about the emergency radiology demand that involves more than 50% of the global activity of radiology services.	Systematic review of descriptive studies	Hospitals should have a specific emergency radiology unit, equipped with aids to meet this task.

DISCUSSION

The majority of selected articles were identified on SCOPUS, followed by the Web of Science, PUBMED, and CINAHL. We noted a growing distribution of publications between the years 2013 and 2014, probably because this is a subject that has been broadly discussed over the past years.

Regarding the language of publication, English prevailed, and regarding the professional category, the medical was most frequent. These professionals are involved in the whole CT scan path, starting at the indication/request, its execution, until the emission of evaluation reports. The evidence found was in its majority classified as level four and five, and we understand that there is a need to improve studies.

We organized the primary results in three categories, as described below. The first has half of the included studies: Optimizing, monitoring, quality and protection about doses of radiation exposition[11-13;17-19]. We equally divided the other half of studies between the following categories: Contrast used in computed tomography, about adverse reactions and nephropathies[20-25] and Nursing care, management, and specific cases, as the conduction of exams with pregnants, patients with falciform anemia and patients using peacemakers[26-31].

Optimization, monitoring, quality, and protection related to doses of exposition to radiation

The analyzed studies allowed us to identify that besides the significant medical advances, although there are image diagnoses to determine with better accuracy and to treat diseases in its initial phase, on the other hand, there is the possibility of errors with harmful consequences for the patient's life. These can relate to flaws in the interpretation of exams or the extreme confidence in the image leaving on the side the clinical aspect and the client's subjectivity. Studies points to the existence of a growing evidence of higher serious risk to solid organs and the blood system with the increment of radiation exposition, even in lower doses, which would be a negative aspect of the rapid growth of the use of computed tomography[17-19,32].

In this context, it also important to note that the lack of safety to radiation among professionals working in the hospital environment is common, caused by unsafe actions or working conditions. Existing studies demonstrate a lack of knowledge about the dose, exposition and radiation risk between many health professionals[19,33].

With this reality, the government of the United States of America and other countries have demonstrated a growing desire to intervene in health care on the past years, mainly related to the safety of patients receiving radiation during CT scans. For that, they provide regulatory safety norms to implement health care for professionals and institutions that work with image[34].

With the use of these regulation norms, it is possible to implement the strategy to reduce the radiation dose, allowing an approach more patient-centered. The Registry of these levels of radiation doses in patients also allows institutions to make detailed comparisons of their levels of radiation, intended to determine if institutions are keeping the reduction in practice, according to safety norms[35].

Most protocols require lower doses in comparison with the technique used in practice for obtaining

sufficient image quality to allow a precise diagnosis[18,36].

The CT scanners manufacturers, in answer to safety issues, to the growing exam demand and, to medical-legal concerns; developed multiple strategies to decrease the radiation during the exam, such as standardized protocols, automatic modulation of doses and algorithms for interactive reconstruction. Radiologists should train their specialists, radiology technicians and biomedical professionals to become more than just button-pressers[37].

Still in this context, with the increase of the media attention for errors during the exam and the frequency increase of medical requests of this exam for diagnoses, there is an increase in the quantity of publications suggesting CT dose reduction, which allows a tendency to decrease used doses in practice. But, regardless of these efforts taken in some countries, they might not apply to all patients in need of a CT scan, due to the most various clinical conditions[38].

Thus, although radiation dose reduction in patients propitiates valuable contributions for the improvement of the exam quality, some care should be taken to avoid its misuse by physicians in the decision-making when requesting image exams for patients. Health professionals should be carefully informed about the history of these users and to dominate such procedures using this technology, before its application[35].

Adverse reactions and nephropathies related to the contrast used in computed tomography

Nowadays, a new organizational philosophy grounded in the patient's safety has involved health institutions around the world. Analyzed studies where patient's safety is a crucial aspect of health assistance, should anticipate the occurrence of mistakes before they cause harms to patients[20-25,31].

In this context, we should be attentive for the incidence of acute adverse reactions to contrast agents used in CT, which is approximately 2 to 3%, with contrasts of low osmolarity. The symptoms are diverse, varying from more simple reactions as blushing, itching, urticaria, and angioedema, up to more severe effects related to severe hypertension, loss of conscience, bronchospasm and life threat by obstruction of airways[20].

A study conducted in Germany with 9,515 patients demonstrated that adverse reactions to medications were reported by 70 patients (0.74%), including hypersensitivity reactions in 55 of them. Only 30 presented immediate reactions and, 40 had delayed reactions. Severe adverse reactions were identified in five patients (0.05%). Still, in this study, patients with allergy history appeared to be at greater risk of presenting immediate and late adverse reactions. But, the discomfort was mild and reported by 72% of patients[39].

Also, in another study, adverse reactions as nausea and vomits were only observed in one of 108 patients (0.93%) with the use of low-osmolarity contrast, in comparison with a previous study that estimated an occurrence of 5.1%[21].

Thus, according to the articles, some factors can predict adverse reactions, being those: history of allergies to contrast agents, urticarial, history of previous allergy to other drugs, agent concentration of the

contrast higher than 70%, to be younger than 50 years and, total agent dose of the contrast superior than 65g. The use of this information can facilitate referrals to a better assistance propitiated by the multi-professional team, as well as the accompaniment of high-risk patients by radiologist physicians[20].

Regarding the contrast-induced nephropathy (CIN), it is a potential complication of its intravenous administration. In the general population, the incidence of CIN is estimated as 1 to 6%. However, the risk can be higher, reaching 50% in some subgroups of patients, as those with myasthenia gravis[40].

But, some studies demonstrate that there is no significant difference in the incidence of acute kidney lesion when a lower contrast dose is used, once no patients with kidney dysfunction needed to have a dialysis after the procedure. Thus, a protocol using low contrast doses could allow conducting the exam in this population without major concerns with its safety. Therefore, the frequency of acute kidney dysfunction by CIN should be considered rare[21].

Regarding the use of contrast in the CT scan, another important factor to be discussed is the protocol for kidney protection. The analyzed investigations did not demonstrate beneficial evidence for the administration of N-Acetylcysteine to patients submitted to CT scan with contrast. However, there was a significant association between the volume of intravenous fluids administered and the reduction of contrast-induced nephropathy[23].

Nursing care and management of exam cases in specific populations as pregnants, patients with falciform anemia, severe myasthenia, and peacemakers

Radiology stopped being purely a diagnostic specialty to invasive, processual and curative medicine. As an answer, the nursing role in radiology evolved. Today, the radiology nurse is an integrated element of assistance to patients submitted to radiological procedures[22].

In this sense, is fundamental for nurses to have technical skills as the safe positioning of the patient, critical care skills, critical thinking and clinical assessment skills, handling of material and equipment, skills in urgency and emergency situations and, of ambulatorial care. It is also necessary to have adequate human resources, permanent education, and reliable quality indicators to assess assistance[22,28,41].

In this context, the Food and Drug Administration (FDA) have been requiring better management and organization, where information for users are broader, with a particular focus in guaranteeing quality. It still institutes that image exam installations should follow the regulating norms to avoid adverse events and avoidable risks[30-31]. The following three areas of safety focus were also highlighted for computed tomography: medical error, correct CT use, and dose optimization[33].

With regards to image exams in pregnant patients, it requires familiarity with important themes, as the risk of exposition to radiation for the mother, the risk of indirect exposition to radiation for the fetus, fetal and maternal domisetry. Safety when administering the iodized contrast during pregnancy and breastfeeding are also essential. It is fundamental to understand that during pregnancy, two individuals are simultaneously exposed, and the intensity of the exposition consequences can vary substantially between

them. The American Colege of Radiology and the American Congress of Obstetrics and Gynecologists agree that the imaging exam should be conducted after a risk/benefit clinical assessment and, the level of radiation should be kept as lower as possible[27].

In what refers to patients with the falciform disease, adverse events related to intravenous contrast can occur at a similar rate to the general population, without CIN increment. However, the use of image diagnosis can be conducted without increasing the risk of severe complication in this population[29].

Regarding the patients with managed cardiac rhythm, many were submitted to this exam, and there were no cases of adverse events in practice, neither described for authorities or published in articles, making the CT scan safe for patients with these devices[26,42].

Another study demonstrated that there is no immediate increase in exacerbation risk of the myasthenic weakness with the use of low-osmolarity contrast, which is opposed when compared with previous studies that used ionic type contrasts and showed an increment of weakness between 2.1 to 3.4% of patients. Thus, although this study suggests no increase of the immediate risk of worsening of myasthenic symptoms in this population, precaution should be taken when administering contrast in patients with Myasthenia Gravis[40].

CONCLUSION

This study allowed us to synthesize findings related to essential elements to offer a safe assistance to patients submitted to computed tomography, which evidence was distributed in categories, demonstrating its impact in the clinical practice.

The category “optimization, monitoring, quality and protection about doses of exposition to radiation” showed that evidence for this assistance comes from the need to minimize the indication of exams and the unnecessary exposition to radiation. It guarantees the radiological protection of patients, professionals, and the environment, as well as, the development of new safety technologies, without interfering with the image quality.

In what regards to the category “adverse reactions and nephropathies related to the contrast used in computed tomography”, there is a need to use protocols for CT scans with low radiation doses, on the other hand, we identified gaps related to lack of studies exploring the significant predictors of risk assessments for the occurrence of an acute adverse reaction associated with the administration and contrast concentration.

Also, the category “nursing care and management of exam cases in specific populations as: pregnants, patients with falciform disease, severe myasthenia and peacemakers”, it was seen a need of changes in tomography services, through the implementation of indicators to assess the assistance quality and the development of educational initiatives that establishes programs that not only organize the service, but also qualify professionals through permanent educational process in the radiology field.

At last, when identifying essential elements to offer a safe assistance to patients submitted to computed tomography scan, based on the best scientific evidence, the study will contribute as theoretical

subside to formulate assistance protocols for patients attended in computed tomography services.

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