



ORIGINALES

Contrast-induced nephropathy: identification of risks to promote good practices

Nefropatia induzida por contraste: identificação de riscos para promoção de boas práticas

Nefropatía inducida por contraste: identificación de riesgos para promoción de buenas prácticas

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ABSTRACT:

Objective: To identify the risk factors for contrast-induced nephropathy (CIN) in patients who underwent percutaneous transluminal coronary angioplasty (PTCA) and discuss the nursing care from the perspective of good practices in order to minimize it.

Method: Cross-sectional, retrospective, quantitative study carried out from January to December 2015, using documentary analysis through medical records.

Results: Eighty-seven medical records were selected. The male sex prevailed with 67.8% (59), with a mean age of 58.8 ± 10.4 . It was seen that 6 patients (6.8%) used contrast injections between 100 ml or

more and 32 (36.8%) presented alterations in hematocrit values. Concerning the risk for nephropathy, 24 (27.6%) presented moderate to very high risk.

Conclusion: Risk factors for CIN are common in patients who undergo PTCA. Thus, discussing nursing care that can collaborate in the identification and prevention of kidney injury is strategic and contributes to good practices.

Key words: Acute Kidney Injury; Cardiovascular Nursing; Patient Care Planning; Contrast Media.

RESUMO:

Objetivo: Identificar os fatores de risco para nefropatia induzida por contraste (NIC) nos pacientes que se submeteram ao procedimento de angioplastia coronária transluminal percutânea (ACTP) e discutir os cuidados de enfermagem na perspectiva das boas práticas para minimizá-la.

Método: Estudo transversal, retrospectivo, quantitativo, realizado de janeiro a dezembro de 2015, que utilizou análise documental através de prontuários.

Resultados: foram selecionados 87 prontuários. O sexo masculino prevaleceu com 67,8% (59), com uma média de idade de 58,8 ±10,4. Verificou-se que 6 pacientes (6,8%) utilizaram injeções de contraste entre 100 ml ou mais e 32 (36,8%) apresentaram alterações nos valores de hematócrito. Quanto ao risco para nefropatia, 24 (27,6%) apresentaram de moderado a altíssimo.

Conclusão: Fatores de risco para NIC são frequentes nos pacientes que realizam ACTP. Assim, discutir cuidados de enfermagem que possam colaborar na identificação e prevenção da injúria renal é estratégico e contribui para boas práticas.

Palavras-chave: Lesão Renal Aguda; Enfermagem Cardiovascular; Planejamento de Assistência ao Paciente; Meios de Contraste.

RESUMEN:

Objetivo: Identificar factores de riesgo para nefropatía inducida por contraste (NIC) en pacientes sometidos al procedimiento de angioplastia coronaria transluminal percutánea (ACTP) y discutir los cuidados de enfermería en la perspectiva de las buenas prácticas para minimizarla.

Método: Estudio transversal, retrospectivo, cuantitativo, realizado de enero a diciembre de 2015, utilizando análisis documental mediante registros médicos.

Resultados: Se seleccionaron 87 registros. El sexo masculino prevaleció con el 67,8% (59), con un promedio de edad de 58,8 ± 10,4. Se notó que 6 (6,8%) utilizaron inyecciones de contraste entre 100 ml o más y 32 (36,8%) presentaron cambios en los valores de hematocrito. Sobre el riesgo para nefropatía, 24 (27,6%) presentaron de moderado a altísimo.

Conclusión: Factores de riesgo para NIC son frecuentes en pacientes que realizan ACTP. Así, discutir cuidados de enfermería que puedan colaborar en la identificación y prevención del problema renal es estratégico y contribuye a buenas prácticas.

Palabras clave: Lesión Renal Aguda; Enfermería Cardiovascular; Planificación de Atención al Paciente; Medios de Contraste.

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INTRODUCTION

The current scenario shows a variety of approaches for individuals with endovascular pathologies and in many of these treatments the use of iodinated contrast is necessary to improve the visualization of certain structures. However, the risk of contrast-induced nephropathy (CIN), which is a frequent and worrying event, may be directly related to its systemic use, which favors the reduction of renal perfusion, tubular toxicity, and oxidative stress^(1,2).

This complication is responsible for increased morbidity, mortality and length of hospital stay. However, CIN is still an under diagnosed condition, because many patients undergo procedures in which contrast is used and return to their homes without evaluation by the health team after this⁽³⁾.

CIN can be defined as the acute reduction of kidney function over a period of hours or days after systemic administration of a contrast medium, with no other apparent causes.

It mainly refers to the reduction of glomerular filtration rate and/or urinary volume, but also to disturbances in the control of hydroelectrolytic and basic acid balance ⁽⁴⁾. The diagnosis is established when the serum creatinine is increased by 25% or in greater than 0.5 mg/dl in relation to baseline values, or when there is a drop in glomerular filtration rate (GFR) of more than 25%, generally observed after a period 24 to 48 hours from the contrast medium administration, with a peak between 3 and 5 days and a return of renal function to basal levels between 7 and 21 days⁽³⁾.

Chronic renal failure (CRF), diabetes mellitus (DM), advanced age (> 75 years), hypotension, anemia, dehydration, hepatic cirrhosis, hyperosmolar states, heart failure functional class III or IV are considered risk factors by the *New York Heart Association* (NYHA), as well as smoking, dyslipidemia, and recent use of non-steroidal anti-inflammatory drugs. In individuals with risk factors, the incidence of CIN may reach 50%⁽⁴⁾.

In parallel, cardiovascular diseases (CVD) account for about 20% of all deaths in individuals over 30 years of age, with CVD of ischemic origin being the most frequent ^(5,6). Due to the high incidence and high mortality of coronary artery disease (CAD), early diagnosis and rapid treatment become essential tools for a good prognosis⁽³⁻⁶⁾.

The growing increase of minimally invasive diagnostic and interventional procedures in this population has raised the incidence of acute kidney injury after exposure to contrast medium and may lead to the development of CIN⁽⁷⁾. In view of the high mortality associated with the presence of CIN, the possibility of detection of risk factors and the implementation of preventive measures, it is essential that health professionals act in the identification of individuals at risk and follow-up strategies after the procedure ⁽⁸⁾.

In this sense, Mehran et al. developed and validated a CIN risk stratification score for patients submitted to PTCA based on eight variables, demonstrating a directly proportional relationship between the increase in the score and the risk of developing CIN. After the sum of these variables, it is possible to assess with greater accuracy and stratify individuals into low, medium, high, and very high risk of developing CIN and of need for renal replacement therapy. Values less than or equal to 5 points are considered to indicate low risk, and values above 16 points, high risk⁹. This information is described in Figure 1.

Figure 1. Risk Stratification Score for Contrast-Induced Nephropathy after PTCA, according to Mehran

Multivariate predictors	Points
Hypotension (SBP < 80mmHg)	5
Use of intra-aortic balloon (IAB)	5
Heart Failure Functional Class III or IV (NYHA)	5
Age > 75 years	4
Anemia Women: Hematocrit < 36% Men: Hematocrit <39%	4

Diabetes Mellitus		3
Contrast volume		1pt/100ml
Serum creatinine > 1.5mg/dL		4
<i>Creatinine</i> clearance	40-60 ml/min/1.73m ²	2
	20-39 ml/min/1.73m ²	4
	< 20 ml/min/1.73m ²	6
TOTAL		

In this perspective, it is of great importance that nurses working with this population guide their practice through care focused on attention to risk factors for CIN and its early diagnosis. Therefore, it is necessary to plan the care process, whether in the hospital or in the outpatient setting, focusing on the safe performance of procedures and on the management of these individuals after the referred procedure, in order to monitor the undesirable effects that exposure to the venous contrast can cause⁽⁹⁾.

OBJECTIVE

Identify the risk factors for contrast-induced nephropathy (CIN) in patients who underwent percutaneous transluminal coronary angioplasty (PTCA) and discuss the nursing care from the perspective of good practices in order to minimize CIN.

METHOD

Ethical aspects

According to the formal procedures that rule the research, the study was submitted to the Brazil platform and the authorization of the sector was released for its realization, as recommended by Resolution 466/2012 of the National Health Council, through opinion obtained from the Committee of the Pedro Ernesto University Hospital.

Study design, place and period

Cross-sectional research, with a quantitative approach, that used the analysis of medical records between January and December 2015. The study scenario was a cardiac intensive care unit of a university hospital in the state of Rio de Janeiro.

Population, inclusion and exclusion criteria

Eigthy-seven medical records were selected from the patient handbook of this unit, having as inclusion criteria all medical records of patients who underwent PTCA, who had complete records available at the time of the evaluation. Medical records of patients already affected by chronic kidney disease; medical records of critically ill patients, such as those with respiratory insufficiency and with artificial support for any vital function, such as mechanical ventilation - because, ususally, these patients already have some damage in vital organs which may confuse the sample -, and medical records of patients who died were excluded from the study.

Study protocol

The instrument used for extraction of data had variables related to sociodemographic and clinical characteristics (gender, ethnicity, underlying disease, age, cardiovascular risk factors, and schooling) and risk factors for the development of nephropathy after the procedure, based on the Mehran diagram for NIC identification: hypotension (SBP < 80mmHg), heart failure functional class III or IV (NYHA), age > 75 years, anemia, diabetes mellitus, introduced contrast volume, serum creatinine > 1.5mg/dL and/or creatinine *clearance*⁽¹⁰⁾.

Analysis of results and statistics

The collected data were inserted into a *Microsoft Office Excel 2010*[®] worksheet and analyzed through descriptive statistics, with description of absolute and relative frequencies, measures of central tendency, means, medians, and standard deviations.

RESULTS

In the 87 medical records analyzed, the mean age was 58.8 ± 10.4 , with a minimum of 29 and a maximum of 82 years. Elderly people represented 36 cases (41.4%). There was a predominance of males 59 (67.8%) and a higher prevalence of brown skinned people 33 (37.9%).

Table 1 - Sociodemographic and clinical characteristics of patients submitted to the percutaneous transluminal coronary angioplasty in the cardiac intensive care unit of a university hospital - Rio de Janeiro, 2015.

Characteristics	N	%
Age Group		
Adults (18 to 59 years)	51	58.6
Elderly (60 years and over)	36	41.4
Sex		
Male	59	67.8
Female	28	32.2
Ethnic group		
White	32	36.8
Black	17	19.5
Brown	33	37.9
Not stated	5	5.7
Main Diagnosis		
Stable angina	11	12.6
Unstable angina	28	32.2
STEMI	23	26.4
NSTEMI	25	28.7

*STEMI = ST segment elevation myocardial infarction

**NSTEMI = Non-ST segment elevation myocardial infarction

The main cardiovascular risk factors and comorbidities were systemic arterial hypertension (SAH), 77 (88.5%); dyslipidemia, 46 (52.9%); diabetes, 33 (37.9%); and smoking, 33 (37.9%), as shown in Table 2.

Table 2 - Risk factors for cardiovascular disease and comorbidities of patients submitted to the percutaneous transluminal coronary angioplasty in the cardiac intensive care unit of a university hospital - Rio de Janeiro, 2015.

Risk factors and comorbidities	n	%
Systemic Arterial Hypertension	77	88.5
Dyslipidemia	46	52.9
Diabetes	33	37.9
Smoking	33	37.9
Alcohol consumption	6	6.9
Obesity	2	2.3
Heart Failure	9	10.3
Chronic Obstructive Pulmonary Disease	4	4.6
HIV	2	2.3
Peripheral Vascular Disease	1	1.1

Regarding the presence of risk factors for the development of CIN according to the Mehran diagram, 6 (6.8%) of the analyzed medical records showed the registry of contrast injections of 100 ml or more, 32 (36.8%) had changes in hematocrit values, and 7 (8.0%) had registry of functional class III or IV (NYHA). Also, 6 (6.9%) presented creatinine values above 1.5 mg/dL, 2 (2.3%) reported hypotension, and 2 (2.3%) showed creatinine *clearance* values between 40-60 ml/min/1.73m², as listed in Table 3:

Table 3 - Variables for contrast-induced nephropathy after PTCA according to Mehran's diagram of patients submitted to PTCA admitted to the cardiac intensive care unit of a university hospital - Rio de Janeiro, 2015.

Variables for contrast-induced nephropathy after the second PTCA Mehran's diagram	n	%
Contrast volume		
< 100 ml	81	93.1
100-200 ml	4	4.6
300 ml	2	2.3
Diabetes Mellitus	33	37.9
Hematocrit changed		
Women: Hto < 36%	19	21.8
Men: Hto < 39%	13	14.9
Heart Failure Functional Class III or IV (NYHA)	7	8.0
Hypotension (SBP < 80mmHg)	2	2.3
Age > 75 years	1	1.1
Serum creatinine > 1.5mg/dL	6	6.9
<i>Creatinine clearance</i>		
40-60 ml/min/1.73m ²	2	2.3
20-39 ml/min/1.73m ²	0	0.0
< 20 ml/min/1.73m ²	0	0.0

By analyzing the variables involved in contrast-induced nephropathy after PTCA, a moderate, high and very high risk of developing nephropathy was identified in 24 (27.6%) of the medical records studied, as shown in Table 4.

Table 4 - Number of patients in relation to the risk for development of nephropathy after PTCA of patients hospitalized in the cardiac intensive care unit of a university hospital - Rio de Janeiro, 2015.

Risk for development of CIN after PTCA	N	%
Low (< 5)	63	72.4
Medium (6-10)	17	19.5
High (11-15)	6	6.9
Very high (> 15)	1	1.1
Total		

DISCUSSION

Regarding the sociodemographic and clinical characteristics, it was observed that there was a predominance of males, with a mean age beyond the fourth decade (58.8 years), associated with risk factors for cardiovascular disease such as: SAH, 77 (88.5 %); dyslipidemia, 46 (52.9%); diabetes, 33 (37.9%); and smoking, 33 (37.9%). These elements are responsible for the progression of the cardiovascular disease and of other non-communicable chronic diseases, especially ischemic heart disease, which often require invasive percutaneous interventions with contrast. The sociodemographic and clinical data found in this study resemble those of other national studies^(5,8).

Non-communicable chronic diseases (NCDs) have increased in Brazil due to the increase in life expectancy. Cardiovascular diseases, cancer, chronic respiratory diseases and diabetes stand out in this group of diseases, corresponding to 38 million deaths each year.^(3,6) In Brazil, these set of diseases account for 70% of the causes of death and imply a large-scale health problem, with cardiovascular disease being even more frequent.

Data point to the change in the age profile of the Brazilian population and its direct relationship with the increase in NCCD, corroborating with the findings of the present research, which identified that the majority of cases presented age close to 60 years. Each year, 650 thousand new elderly people become part of the Brazilian society, corresponding to an increase of almost 700%. Technological advances and the improvement of the quality of life are the main factors contributing to this transformation⁽¹¹⁾.

Regarding the predominance of males, studies confirm that there is a greater risk for cardiovascular event in men, while women are protected until the menopause period, due to estrogenic hormones. Moreover, one-third of men do not have the habit of seeking health care services, smoke more frequently, eat less vegetables, and consume more alcoholic beverages than women⁽¹²⁾.

Regarding cardiovascular risk factors, the most prevalent factor was hypertension, present in 88.5% (77). SAH is known to be one of the most important risk factors for the occurrence of coronary diseases, heart failure, cerebrovascular diseases, atrial fibrillation, and chronic renal failure. Therefore, the relevance of screening blood

pressure levels is a preventive measure in asymptomatic patients and hypertensive patients⁽⁵⁾ in treatment.

The second most prevalent risk factor was dyslipidemia. This is considered the main modifiable risk factor for coronary artery disease, since its control results in great reductions of cardiovascular events such as heart attack and death. Smoking and diabetes appeared with the same frequency (33-37.9%). Smoking causes a five-fold higher risk for myocardial infarction in individuals under 50 years. Diabetes mellitus is a cardiovascular risk factor and an important risk factor for CIN, and has grown in the Brazilian adult population, reaching percentages in the range of 13% in some municipalities. It is directly related to the increasing indices of population aging, urbanization, sedentary lifestyle, and obesity⁽¹³⁾.

With regard to risk factors for CIN, the most prevalent were diabetes mellitus (37.9%) and anemia (36.8%). CIN is directly associated with chronic diseases that damage the oxygenation of the renal medulla, such as DM. In addition to this impairment caused by the pathophysiological process of the disease, the medications most commonly used in the treatment of DM cause acidity in the renal environment, requiring previous suspension in case of imminent use of contrast medium⁽¹⁴⁾. In this sense, it is important to make sure that the use of these medications was discontinued before referring the patient to procedures that use contrast medium. Good practices should be guided by prior nursing consultation, not only with the objective of seeking risk factors and comorbidities, but also to guide the interruption of hypoglycemic agents in the 48 hours before PTCA.

The kidneys are responsible for the production of erythropoietin, which is a hormone responsible for the control of erythropoiesis and which actively participates in the production of blood cells. Since the contrast medium is a nephrotoxic substance, its passage through the renal medulla can lead to a decrease in the production of erythropoietin due to acute kidney injury. Therefore, monitoring the hematocrit and hemoglobin of patients before the procedure represents a safe and cautious care measure. If the patient already has altered hematocrit, it is worth talking with the medical team about the volume of the contrast medium and the time of administration. In this perspective, it is emphasized that the volume is an important predictor to demarcate the risk of kidney injury. The greater the volume infused, the greater is the risk to the patient, due to the nephrotoxic activity. The indispensable use of contrast in the procedure may contraindicate the performance, if the patient's renal residues are altered. In this study, it was identified that almost 7% of patients who underwent PTCA were exposed to more than 100 ml of contrast medium during the procedure. Because CIN may develop within hours or days after exposure to the contrast medium, monitoring of these patients after the procedure and after hospital discharge is necessary to identify early signs of kidney injury and also translates into a good practice.

The screening of medications in use is another safe care measure to avoid CIN, since it makes it possible to identify nephrotoxic substances or those substances that are metabolized in the kidneys, such as nonsteroidal anti-inflammatory agents, diuretics, and angiotensin-converting enzyme inhibitors, which can cause interstitial nephritis, renal papillary necrosis, and toxic effects on the kidneys⁽¹⁵⁾. Some antibiotics can cause kidney damage because they contribute to the development of interstitial nephritis, nephrotic syndrome, and acute tubular dysfunction, with potassium loss, acidosis, and renal failure. These drugs associated with the use of venous contrast

medium can increase the likelihood of kidney injury and indicate that greater monitoring of these patients is fundamental^(16,17).

The evaluation of the patient's hydration status before the procedure is another care measure for good practice in patients undergoing PTCA, because dehydration activates the renin-angiotensin system (leading to vasoconstriction and the use of contrast media through the parenteral via), increases blood viscosity and retards the filtration of proteins and molecules through the nephrons^(1,16). Thus, an effective protection measure is hydration before and after the procedure with 0.45% saline, administered at 1 ml/kg/h for 12 hours, and adjustments should be made for patients with a low ventricular ejection fraction and history of congestive heart failure^(18, 19).

The importance of prior evaluation of the patient and identification of risk for CIN are essential practices to minimize acute kidney injury. In this sense, this study identified that 27.6% of patients who underwent PTCA presented from medium to very high risk for the event. Thus, planning care focused on identifying comorbidities and stratifying risk factors for CIN appears to be a good strategy for safe care.

In the care process for this clientele, another strategy of extreme importance is the implementation of nursing consultations before PTCA. Nursing consultations are an exclusive activity of nurses. In Brazil, nursing consultations were established by the Federal Council of Nursing through Resolution 159/93. Nursing consultations represent a method that enables nurses to identify health/disease situations, prescribe and implement nursing measures that contribute to the promotion, prevention, protection of health, and recovery and rehabilitation of individuals, families and community.⁽²⁰⁾

Thus, nursing consultations before the PTCA allow nurses to provide necessary information to the patients, clarify doubts, and obtain relevant information about their condition before the procedure. This facilitates the identification and stratification of risk factors for contrast-induced nephropathy as well as the prescription of care measures for renal protection of patients at risk, contributing to good nursing practices.^(20,21)

Study limitations

As limitations of the study, we can consider the fact that it was conducted in only one center, which leads to sample limitation. Because it was a retrospective study that used the analysis of medical records, there is loss of records, few records or incomplete records, and this may interfere with data quality. Thus, prospective and interventional studies would be useful to evaluate the nursing care in the prevention and early detection of CIN.

Contributions to the nursing, health or public policy area

This research has the goal to contribute to a reflection on how we need to manage the care directed to patients who will undergo PTCA in order to achieve the best possible practice. Through management of care, it is possible to know the risk for CIN in these patients and implement measures that can minimize the events resulting from the use of venous contrast agents. When patient safety is a primary goal, focus on prevention and reduction of adverse events is necessary. It is also intended, in the future, to

prepare a script of pre-, trans- and post-PTCA nursing actions that will subsidize the process of caring for this population in the public and private spheres.

CONCLUSION

In the studied population, there was a predominance of males, with a mean age of 58.8 years, with systemic arterial hypertension, dyslipidemia, diabetes and smoking, which translated into patients at greater risk for cardiovascular events and need for PTCA.

Higher occurrence of CIN is natural with the increase of percutaneous interventions. Although CIN still has a non-defined etiology, some of the risk factors are known. Acute kidney injury increases the risks of morbidity and mortality and contributes to the development of chronic renal failure. Therefore, it is necessary to disseminate this theme among professionals of the health teams, so as they may detect the risk factors and the first signs and symptoms presented.

The data obtained in this research demonstrated that a considerable number of individuals who underwent the PTCA had some risk factor for CIN. Thus, discussing nursing care plans that can collaborate to the identification and prevention of kidney injury is strategic and contributes to good practices in this specific scenario.

Finally, the study stimulates a reflection on the need for thorough evaluation of patients by us, nurses (before the procedure), which is essential to know our clientele and to receive help in the planning of our actions with a focus on patient safety and quality of care. Follow-up measures are also necessary after the procedure and after hospital discharge, as CIN may develop within hours or days after exposure to the contrast agent.

It is imperative to plan nursing interventions focused on the recognition of risk factors for nephrotoxicity before and after the procedure in question. For this, prior nursing consultations are extremely important, because through history, anamnesis and evaluation of laboratory values make it possible to identify indicators that may potentiate nephrotoxicity, and thus guide appropriate measures to minimize the event. The study led to the conclusion that, in the planning of the care process directed to patients that undergo PTCA, it is necessary to devise strategies of evaluation, stratification, early detection and interventions focused on good practices for prevention of kidney injury.

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