



Extracorporeal circulation and complications during the immediate postoperative period for cardiac surgery*

Circulação extracorpórea e complicações no período pós-operatório imediato de cirurgias cardíacas

Circulación extracorpórea y complicaciones en el período post-operatorio inmediato de cirugías cardíacas

Fernanda Gaspar Torрати¹, Rosana Ap. Spadoti Dantas²

ABSTRACT

Objectives: To compare the frequency of complications presented by patients during the immediate postoperative period (IPP) for cardiac surgery, based on the time of extracorporeal circulation (ECC). **Methods:** A quantitative, descriptive and correlational study with 83 adult patients, divided into two groups according to the time of ECC. **Results:** Of the total patients, 44 (53%) had an ECC duration of up to 85 minutes, and 39 (47%) had a time of over 85 minutes. Complications were common in both groups, with the most frequent being pain and oliguria. However, hemothorax, pneumothorax, and acute myocardial infarction occurred only in the group with the longer duration of ECC. **Conclusion:** The majority of IPP complications presented in similar frequency for patients, independent of ECC time.

Keywords: Nursing care; Thoracic surgery; Postoperative care

RESUMO

Objetivos: Comparar a frequência de complicações apresentadas pelos pacientes, durante o pós-operatório imediato (POI), de cirurgias cardíacas de acordo com o tempo de circulação extra-corpórea (CEC). **Métodos:** Estudo de natureza quantitativa, descritivo e correlacional com 83 pacientes adultos divididos em dois grupos de acordo com o tempo de CEC. **Resultados:** Do total de pacientes, 44 (53%) tiveram o tempo de duração da CEC de até 85 minutos e 39 (47%) tiveram o tempo acima de 85 minutos. As complicações foram comuns para ambos os grupos, sendo as mais frequentes dor e oligúria. No entanto, hemotórax, pneumotórax e infarto agudo do miocárdio ocorreram apenas no grupo com maior tempo de CEC. **Conclusão:** A maioria das complicações ocorridas no POI apresentou frequência semelhante para os pacientes, independente do tempo de CEC.

Descritores: Cuidados de enfermagem; Cirurgia torácica; Cuidados pós-operatórios

RESUMEN

Objetivos: Comparar la frecuencia de complicaciones presentadas por los pacientes, durante el post-operatorio inmediato (POI), de cirugías cardíacas de acuerdo con el tiempo de circulación extra-corpórea (CEC). **Métodos:** Estudio de naturaleza cuantitativa, descriptiva y correlacional realizado con 83 pacientes adultos divididos en dos grupos de acuerdo con el tiempo de CEC. **Resultados:** Del total de pacientes, 44 (53%) tuvieron el tiempo de duración de la CEC de hasta 85 minutos y 39 (47%) tuvieron el tiempo encima de 85 minutos. Las complicaciones fueron comunes para ambos grupos, siendo las más frecuentes dolor y oliguria. Entre tanto, hemotórax, pneumotórax e infarto agudo del miocardio ocurrieron en el grupo con mayor tiempo de CEC. **Conclusión:** La mayoría de las complicaciones ocurridas en el POI presentó frecuencia semejante para los pacientes, independiente del tiempo de CEC.

Palabras clave: Cuidados de enfermería; Cirugía torácica; Cuidados postoperatorios

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¹ M.Sc. in Nursing. Nurse at the University of São Paulo at Ribeirão Preto Medical School Hospital das Clínicas – USP – Ribeirão Preto (SP), Brazil.

² Ph.D. in Nursing. Professor, General and Specialized Nursing Department, University of São Paulo at Ribeirão Preto College of Nursing – USP – Ribeirão Preto (SP), Brazil.

INTRODUCTION

Although clinical treatment of cardiac diseases has been progressing from year to year and the least invasive approach is rapidly expanding, cardiac surgery is the preferred intervention in some cases of heart diseases.

To accomplish different kinds of cardiac surgeries, cardiopulmonary bypass (CBP) remains a frequent procedure, aimed at providing a clean surgical field, preserve the functional characteristics of the heart and offer security to the surgical team⁽¹⁾.

On the other hand, CBP produces a systemic inflammatory response, including the release of substances that impair coagulation and patients' immune response; increase the venous tonus; produce a great release of catecholamines, altered blood fluids and electrolyte status; myocardial dysfunction, lesion or cell necrosis and a mild pulmonary dysfunction. This inflammatory response leads to a movement of fluids from the intravascular to the interstitial space, due to changes in vascular permeability and decrease oncotic pressure⁽¹⁾, which entails some complications in the immediate postoperative period⁽²⁻⁴⁾. Several of these can also be identified in the form of nursing diagnoses in patients during the immediate postoperative period after cardiac surgeries. In a study developed at a hospital in Southern Brazil, the authors identified 15 nursing diagnoses according to the taxonomy of the North American Nursing Diagnosis Association (NANDA), including acute pain, impaired gas exchange, hypothermia, decreased cardiac output and risk for imbalanced fluid volume⁽⁵⁾.

The harmful effects of CBP are widely known and can result in edema, respiratory complications, leukocyte agglutination with deposit in the microcirculation, neurological disorders, acute renal failure, arrhythmias, low output syndrome, postoperative bleeding, infections and glucose control difficulties, among others. The longer the duration of the CBP, the more severe the patient's physiological imbalance will be⁽¹⁾ and the complications this procedure can provoke⁽²⁻⁴⁾. Various researchers have attempted to demonstrate the advantages of cardiac surgery without CBP in comparison with conventional cardiac surgery⁽⁶⁻⁹⁾.

Patients with longer CBP presented more neurological deficits, including excessive sleepiness, cognitive and intellectual function alterations in comparison with patients who spent less time in CBP⁽¹⁰⁾. It is highlighted that the incidence of cognitive dysfunction has been higher among patients after cardiac surgeries than among patients submitted to other surgical procedures. This incidence is even higher among more elderly patients⁽¹¹⁾.

Some authors have demonstrated that postoperative complications after cardiac surgeries with CBP, like coronary artery bypass graft surgeries for example, are also related with the cardiac patients' risk level⁽¹¹⁻¹²⁾, and not only with CBP use.

In view of the consulted literature and the authors' clinical experience at a service where care is delivered to patients in the immediate postoperative period after cardiac surgeries, we established the following guiding questions for this study: Which are the most common complications, in the first 24 immediate postoperative (IPO) hours, adult patients present who were submitted to coronary artery bypass graft and/or valve replacement or valvuloplasty with CBP? Is the frequency of complications related with the duration of CBP? To answer these questions, the goal of this study was to compare the frequency of complications patients present during IPO according to the duration of CBP.

METHOD

A descriptive and correlational quantitative research was developed at the Postoperative Unit for Thoracic and Cardiovascular Surgery of the University of São Paulo at Ribeirão Preto Medical School *Hospital das Clínicas* (HCFMRP-USP). Based on the clinical characteristics of patients attended at this unit, it is considered an intensive care unit (ICU).

Approval for the project was obtained from the Research Ethics Committee at HCFMRP-USP (Process No. 13521/2006). Patients were invited to participate in the research during their preoperative hospitalization at the surgical wards. The study aims were presented to the patients and, if they agreed to participate in the study, they signed the informed consent term.

The potential study population included male and female patients, submitted to elective coronary artery bypass graft surgery and/or valve replacement or valvuloplasty and who complied with the following inclusion criteria: agreeing to participate in the study, being over 18 years of age, being physically and psychologically apt to answer the sociodemographic and clinical questionnaire and awaiting coronary artery bypass graft surgery and/or valve replacement or valvuloplasty. Previous submission to a cardiac surgery served as an exclusion criterion. During the study period, 225 patients were submitted to cardiac surgery at HCFMRP-USP. In this group, 108 (48.0%) were invited to participate during preoperative hospitalization. Only 83 (77.7%) out of 108 potential participants took part though, as the remainder was not submitted to cardiopulmonary bypass.

Thus, these 83 patients who complied with the inclusion criteria constituted a non-probabilistic sample, between May 2007 and November 2008. Patients who were operated on without CBP use, only identified in the immediate postoperative period, were excluded from the study. The presented data were collected during the IPO period, considered as the first 24 hours after the surgery. As data were collected through the consultation of patients' files, patients' clinical conditions during hospitalization at the postoperative unit were not considered an exclusion criterion, as they were not interviewed.

As this is an exploratory research on the theme, the sample size was not calculated, as confirming any hypothesis on the relation between the variables of interest went beyond the goals of the study at this moment.

To collect the data, an instrument was elaborated that contained socio-demographic and clinical information and the main complications that can affect patients submitted to cardiac surgery with CBP. The instrument was developed based on the consulted literature and the authors' clinical experience. Before its use, an expert group of five cardiology nurses who worked with this population analyzed this instrument's face and content validity.

The collected data were processed and analyzed in *Statistical Package for the Social Sciences (SPSS) software*, version 15.0. For descriptive analysis of the numerical, discrete and continuous variables, position (mean, median) and variability (standard deviation) measures were used for numerical variables, and simple frequency measures for categorical variables. To answer the study goals, patients were divided in two groups according to the duration of CBP: one group with CBP duration of up to 85 minutes (44 patients) and one group with duration of more than 85 minutes (39 patients). This point to divide the groups was adopted because it was the median duration of CBP in the surgical procedures under analysis, considering that previous studies provide no reference for CBP duration to be used for these purposes. Chi-square or Fisher's Exact Test were used to analyze the association between each of the detected complications and the duration of CBP variable (≤ 85 min and > 85 min). Significance was set at 5%.

RESULTS

The sociodemographic and clinical characteristics of the 83 research participants, according to the duration of CBP they were submitted to during the cardiac surgery, are displayed in Table 1.

Table 1. Distribution of sociodemographic and clinical characteristics of 83 subjects according to duration of cardiopulmonary bypass (CBP). Ribeirão Preto, 2007-2008

Variables	CBP duration ≤ 85 min(N=44) %	CBP duration > 85 min(N=39) %
Gender		
Female	61.5	48.7
Male	38.6	51.3
Age		
Younger than 60 years	50.0	59.0
60 years or older	50.0	41.0
Presence of comorbidities		
Hypertension	75.0	69.2
Coronary artery disease	63.6	46.4
Dyslipidemia	45.5	41.0
Valvular heart diseases	38.6	74.4
Diabetes mellitus	29.5	38.5
Obesity	22.7	25.6
Hypothyroidism	11.4	12.8
Chronic renal failure	11.4	12.8
Neurological diseases	6.8	7.7
Surgery done		
Coronary artery bypass	61.4	28.2
Valve replacement	27.3	48.7
Valvuloplasty	6.8	7.7
Coronary artery bypass with valve replacement	2.3	10.3
Replacement with valvuloplasty	2.3	0
Coronary artery bypass with valvuloplasty	0	5.1

In the group with the shortest CBP duration, higher frequencies were found for female patients, equal proportions of patients younger and older than 60 years and prevalence levels of more than 50% for arterial hypertension and coronary artery diseases. In the second group (more than 85 minutes of CBP), a slight increase was observed in the presence of male patients, younger than 60 years and the most prevalent diseases were hypertension and heart valve diseases (Table 1).

According to surgical treatment, coronary artery bypass graft surgery was more frequent in the group with the shortest CBP duration (61.4%) than in the group with longer CBP duration (28.2%). The opposite was observed for valve replacement surgery (27.3%) in the group with the shortest and in that with the longest CBP duration (48.7%) (Table 1). It should be highlighted

that the mean duration of the surgical procedure was 4.9 hours (SD=1.3 hours, range from 3 to 9.5 hours).

During the immediate postoperative period, the difference in complication frequencies between both groups was small. In the group with CBP duration of less than 85 minutes, the complications ascertained in at least 50% of patients were pain, oliguria, hyperglycemia and arterial hypertension or hypotension. In the group with longer CBP duration, the same complications were observed, except for hyperglycemia. Less frequent complications (present in less than half of patients in both groups) can be observed in data in Table 2.

Table 2. Frequency of immediate postoperative complications for 83 participants according to duration of cardiopulmonary bypass (CBP). Ribeirão Preto, 2007 – 2008

Variables	CBP duration ≤ 85 min (N=44) %	CBP duration > 85 min (N=39) %
Pain	39 (88.6)	32 (82.1)
Oliguria	28 (63.6)	24 (61.5)
Hyperglycemia	26 (59.1)	17 (43.6)
Hypotension	23 (52.3)	20 (51.3)
Hypertension	22 (50)	20 (51.3)
Arrhythmias	20 (45.5)	19 (48.7)
Nausea	18 (40.9)	14 (35.9)
Vomiting	16 (36.4)	9 (23.1)
Agitation	15 (34.1)	12 (30.8)
Below-normal hemoglobin	15 (34.1)	16 (41)
Fever	11 (25.0)	6 (15.4)
Other complications	10 (22.7)	9 (23.1)
Neurosensory deficit	9 (20.5)	10 (25.6)
Bleeding	8 (18.2)	12 (30.8)
Need for new surgery	3 (6.8)	1 (2.6)
Hemothorax	0	1 (2.6)
Pneumothorax	0	1 (2.6)
Myocardial infarction	0	2 (5.1)

DISCUSSION

This study was aimed at detecting the most common complications patients present during the first 24 postoperative hours after cardiac surgeries in view of CBP duration, aiming to support nursing in care planning for these clients.

Patients' assessment in the postoperative period after large surgeries is an important aspect of nursing care, aiming for the identification of clinical conditions and monitoring for possible complications, mainly during the first 24 hours. Nurses' clinical skills and competences in

this period are extremely important, as they are directly oriented towards the establishment of the hemodynamic balance, pain relief and complication prevention⁽¹³⁾.

CBP is common and used in cardiac surgeries for most patients⁽¹⁴⁾. It has been appointed one of the causes of postoperative pulmonary dysfunction, due to increased airway resistance and a possible diaphragm dysfunction increase⁽¹³⁾.

Literature on the main possible complications after a cardiac surgery involving CBP use is still scarce⁽¹³⁻¹⁶⁾, which made it difficult to compare the results in this study.

Patients were divided in two groups, based on a statistical criterion, which was the median duration of CBP, as no clinical criterion was found in the literature, like the time considered ideal for the duration of CBP in each type of cardiac surgery for example. In general, it is known that the duration of surgery is directly connected with the duration of CBP⁽¹⁷⁾.

As for complication, pain was the most frequent in both groups under analysis, which can be explained by the extent of the tissue trauma patients were submitted to during cardiac surgeries. Acute pain, common after cardiac surgeries, is related to other complications, mainly respiratory problems^(13,15), and also with the triggering of arrhythmias⁽¹⁵⁾. Pain levels tend to be higher on the first and second postoperative day⁽¹⁶⁾. Acute pain was also the nursing diagnosis identified among postoperative patients after cardiac surgeries at a hospital in Southern Brazil, although without any distinction of whether they were submitted to CBP or not⁽⁵⁾.

Oliguria was the second most frequent complication in both groups. Increased creatinine levels are more common in patients going through coronary artery bypass graft surgery with CBP than in those subject to the same surgery without CBP⁽⁸⁾. A study involving patients submitted to cardiac surgeries ascertained that the development of acute kidney injury, characterized by decreased diuresis volume (< 20 ml/h) and increased creatinine, affected patients submitted to a longer duration of CBP⁽¹⁸⁾.

In the group with up to 85 minutes of CBP, the third most frequent complication was hyperglycemia, and it ranked sixth in the other group. In another study, the authors found that blood glucose levels in patients submitted to coronary artery bypass graft surgery with and without CBP were similar⁽⁷⁾. The authors ascertained that the surgery without CBP lowered the need for exogenous insulin to keep up the same glucose homeostasis levels during the first 24 hours. In another study, which compared glucose control in patients submitted to coronary artery bypass graft, the researchers observed that glucose control was worse in those patients who had gone through CBP, including a patient group without diabetes⁽¹⁹⁾.

Patients with blood pressure alterations corresponded to 50% or more in both groups. These alterations may be related to the patient's illness but, in this study, the relation between the baseline diseases and immediate postoperative complications was not established. In another study with a sample of 47 patients, 4.2% experienced hypertensive crises during the postoperative period after aortic arch surgery, but the authors did not establish any relation with the duration of CBP⁽²⁰⁾.

The frequency of arrhythmias, including atrial fibrillation and bradycardias, corresponded to 45.5% in the group with shorter CBP duration and 48.7% in the group with CBP time over 85 minutes, without a difference between the two groups. A study in 2009 demonstrated that atrial fibrillation percentages were lower for postoperative patients after coronary artery bypass graft with CBP (21%)⁽²¹⁾, which does not confirm the results the present authors obtained. In previously presented results, the percentage of patients who developed atrial fibrillation, tachycardia or ventricular fibrillation and bradycardias were higher in patients who had gone through coronary artery bypass graft with the use of CBP than in patients who had not used this procedure⁽⁷⁾. In another research, the authors observed a frequency level of 78% of these arrhythmias during the postoperative period of cardiac surgeries, however, without establishing any association with CBP use⁽¹⁵⁾.

In the groups with longer and shorter CBP duration, 77.3% and 59.0% presented nausea and vomiting, respectively. Some authors found that these complications are associated with the anesthesia type and time of surgery⁽²²⁾. No studies were found that related these variables with CBP duration.

The percentage of neuro-sensory alterations, characterized by agitation, cognitive deficit or convulsive crises corresponded to 43.2% and 43.6%, respectively, in the groups with longer and shorter CBP time, showing minimal differences between the two groups.

Neurosensory alterations in the postoperative period can occur because, during the intraoperative phase, small clots can be released and nest into small arteries and cerebral capillary vessels⁽²³⁾. Cognitive decline has been associated with vascular disease, chronic neurological disease and solitude, but some researchers found that this decline was inversely proportional to the duration of CBP, as well as to the patients' years of education⁽²⁴⁾.

The drop in hemoglobin levels was another complication the participants in this study presented in both groups (34.1% and 41%, respectively). According to some researchers, the borderline blood hemoglobin level is 7g/dl⁽²⁵⁾. In this study, the participants' blood hemoglobin level was not described.

Among the study participants, 40.4% presented fever in the immediate postoperative period. The group with

CBP duration of up to 85 minutes presented a higher percentage for this complication (25%). A recent research on the epidemiology of CBP fluid and blood sample cultures demonstrated that 5.7% of the patients presented fever of unknown origin during the postoperative period, without any significant difference between patients with positive or negative cultures, and no association was established with CBP duration either⁽²⁶⁾.

Some complications, like bleeding, hemothorax and pneumothorax, only appeared in the group with CBP duration of more than 85 minutes. According to some authors, postoperative hemorrhage was associated with complications like cerebrovascular accident, low cardiac output, pleural effusion, cardiac tamponade and coagulopathy⁽²⁾. In another study, the frequency of pneumothorax as a respiratory complication after coronary artery bypass graft corresponded to 5.3%⁽²⁷⁾, higher than what the authors found (2.6%).

The need for early reoperation of a patient in the postoperative period after cardiac surgeries is not uncommon, as shown in the presented results (9.4%) and can be due to different motives, like thrombosis or graft failure for example, leading to a sudden hemodynamic collapse⁽²⁸⁾. No studies were found, however, which linked this complication with CBP duration.

Acute myocardial infarction was identified in 5.1% of patients during the postoperative period, in the group with longer CBP duration. These results exceed the levels other authors presented, who found an acute myocardial infarction rate of 1.25% in patients who died in the early or late phase after heart valve surgery, but without establishing a relation with CBP duration⁽²⁹⁾.

CONCLUSION

Similar frequencies were found for most complications during the IPO period, independently of CBP duration. The most common complications the participants presented were pain, oliguria and hyperglycemia. Percentages for some complications were higher in patients with shorter CBP duration, without any relation between the duration of CBP and the frequency of postoperative complications.

Many of the complications observed may be related with the risk factors in the patient's history, but these data were not related in our study, which represents a study limitation.

This study is relevant for nursing practice, as knowledge on the possible complications that occur in the immediate postoperative period of cardiac surgeries permits adequate nursing care planning, minimizing problems. A positive trust bond between nurse and patient during the first 24 hours of hospitalization at a postoperative unit after cardiac surgery can influence the determination of surgical patients' positive experience.

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