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Glycemic behavior of patients in the postoperative period of heart surgery: cohort study

Comportamento glicêmico de pacientes em pós-operatório de cirurgia cardíaca: estudo de coorte

Comportamiento glucémico de pacientes en postoperatorio de cirugía cardíaca: estudio de cohorte

Cíntia Maria Mesquita de Castro[I]; Lílian Moreira do Prado[II]; Renata Flávia Abreu da Silva[I]; Paulo Sérgio Marcellini[I]; Allan Peixoto de Assis[III]; Andrezza Serpa Franco[IV]

[I]Universidade Federal do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brazil; [II]Instituto Nacional de Cardiologia, Rio de Janeiro, RJ, Brazil; [III]Universidade Federal do Rio de Janeiro, Macaé, RJ, Brazil; [IV]Universidade do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

ABSTRACT

Objective: to compare the glycemic behavior of patients in the postoperative period of valve heart surgery and myocardial revascularization, submitted to the same glycemic control protocol and to assess the incidence of hypoglycemia and mortality and in-hospital mortality in this population. **Method:** cohort, retrospective, quantitative study that evaluated 354 medical records of surgeries performed in 2016. **Results:** revascularized patients had higher blood glucose means (149,14±36.03), greater use of insulin and higher coefficient of variation (23.30%). However, the incidence of hypoglycemia was higher (35.32%) valve patients, more affected by acute kidney injury (6.58%), renal replacement therapy (11.97%) and hospital mortality (6.58%). **Conclusion:** a heterogeneous population with clinical outcomes that characterized the valves as more critical, due to a greater number of patients with atrial fibrillation, longer CEC time, and greater use of vasoamines and corticosteroids. It is necessary to know the particularities of each population, in order to manage specific glycemic control protocols for different epidemiological profiles.

Descriptors: Thoracic Surgery; Diabetes Mellitus; Glycemic Control; Hyperglycemia.

RESUMO

Objetivo: comparar o comportamento glicêmico dos pacientes em pós-operatório de cirurgia cardíaca valvar e de revascularização do miocárdio, submetidos ao mesmo protocolo de controle glicêmico, e avaliar a incidência de hipoglicemia e mortalidade intra-hospitalar dessa população. **Método:** estudo de coorte, retrospectivo, quantitativo, que avaliou 354 prontuários de cirurgias realizadas em 2016. **Resultados**: pacientes revascularizados apresentaram maiores médias glicêmicas (149,14±36,03), maior uso de insulina e coeficiente de variação (23,30%). Entretanto, a incidência de hipoglicemia foi maior entre valvares (35,32%), mais acometidos por lesão renal aguda (6,58%), terapia de substituição renal (11,97%) e mortalidade hospitalar (6,58%). **Conclusão:** evidenciou-se uma população heterogênea com desfechos clínicos que caracterizaram os valvares como mais criticos, devido a maior número de portadores de fibrilaçao atrial, maior tempo de CEC, e maior uso de vasoaminas e corticosteroides. Logo, é necessário conhecer as particularidades de cada população, para gerenciar protocolos específicos de controle glicêmico para diferentes perfis epidemiológicos.

Descritores: Cirurgia Cardíaca; Diabetes Mellitus; Controle Glicêmico; Hiperglicemia.

RESUMEN

Objetivo: comparar el comportamiento glucémico de pacientes en postoperatorio de cirugía valvular y revascularización miocárdica, sometidos al mismo protocolo de control glicémico y evaluar la incidencia de hipoglucemia y mortalidad hospitalaria en esta población. **Método:** estudio de cohorte, retrospectivo, cuantitativo que evaluó 354 historias clínicas, entre agosto y octubre de 2020, de cirugías realizadas en 2016. **Resultados:** pacientes revascularizados presentaron mayores medias de glucemia (149,14±36,03), mayor uso de insulina y mayor coeficiente de variación (23,30%). Aunque, la incidencia de hipoglucemia fue mayor (35,32%) entre las válvulas, que se vieron más afectadas por daño renal agudo (6,58%), terapia de reemplazo renal (11,97%) y mortalidad hospitalaria (6,58%). **Conclusión:** el estudio mostró una población heterogénea con resultados clínicos que caracterizaron a las válvulas como más críticas, debido a un mayor número de pacientes con fibrilación auricular, mayor tiempo de CEC y mayor uso de vasoaminas y corticoides. Por tanto, es necesario conocer las particularidades de cada población, para gestionar el control glucémico con protocolos específicos para diferentes perfiles epidemiológicos.

Descriptores: Cirugía Torácica; Diabetes Mellitus; Control Glucémico; Hiperglucemia.

INTRODUCTION

Hospital hyperglycemia is considered to be blood glucose greater than 140 mg/dL, resulting from a known or unknown previous diagnosis of diabetes mellitus (DM) or stress hyperglycemia, the latter being the result of a complex pathophysiology, which includes insulin resistance combined with the suppression of insulin release by pancreatic beta cells[1].

Corresponding author: Cíntia Maria Mesquita de Castro; E-mail: cintiamesquita.cmmc@gmail.com
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In patients undergoing cardiac surgery, this condition may occur more commonly, as pathophysiological changes related to the trauma caused by the surgical approach and the use of extracorporeal circulation (ECC) promote organic retention of sodium and fluids, tachycardia, peripheral vasoconstriction, activation of inflammatory cascades, and coagulation, favoring the emergence of post-operative stress hyperglycemia[2,3].

Glycemic control is necessary after cardiac surgery, considering that hyperglycemia is associated with prolonged hospitalization, greater demand for human resources and increased hospital costs, besides being an important factor in morbidity and mortality, being directly related to the increase of cardiovascular complications, hemodynamic and hydroelectrolytic disorders, infections, impairment of the healing process, thrombotic phenomena, and recurrent ischemic events. However, the appropriate perioperative blood glucose level needed to achieve the best outcome is still uncertain[1,4].

The recommended therapeutic goal for most critically ill patients is blood glucose values between 140 and 180 mg/dl. Insulin therapy should be initiated to treat persistent hyperglycemia, starting at the threshold ≥180 mg/dl. Once initiated, the glucose target range of 140-180 mg/dl is recommended for most critically ill patients[1,5].

For many years, glycemic monitoring did not receive the necessary attention, which had an impact on increasing complications and mortality in the Intensive Care Unit (ICU). Therefore, keeping the patient on the glycemic target is important, given the endocrine-metabolic response in the face of stress of the postoperative period, trauma, and sepsis, which lead to hyperglycemia[6].

The concern with glycemic control in critically ill patients was highlighted by the publication of a randomized study involving adults admitted to a surgical intensive care unit, including cardiac surgical patients, with strict glycemic control through the implementation of a protocol with intensive intravenous insulin therapy (maintenance of blood glucose at a level between 80 and 110 mg/dl)[2].

The benefit of intensive insulin therapy was attributable to reduced mortality (4.6% versus 8.0%, $p<0.04$) compared to conventional treatment. There was also decreased morbidity related to bloodstream infections, dialysis acute kidney injury, blood transfusions, and critical illness polyneuropathy[2].

However, the NICE-SUGAR randomized trial compared two glycemic control strategies in medical and surgical patients admitted to the ICU. There were 6,104 patients divided into two groups, where severe hypoglycemia (6.8%) was observed in the intensive group (81-108 mg/dl) and 0.5% in the conservative group (<180 mg/dl). In intensive glycemic control, there was also higher mortality associated to cardiovascular causes. Based on the results of this study, the use of lower targets in glycemic control in critically ill adults was not recommended[7].

Insulin administration is an important risk factor for hypoglycemia[8]. A new protocol of the World Health Organization (WHO) report on safe medication processing reports all types of insulin as a high-risk medication that may cause serious harm in case of medication error, requiring additional safety measures[9].

In Brazil, the nurse is responsible for preparing and administering the insulin solution. Thus, to achieve the ideal in the application of a glycemic control protocol, the nursing team must fully understand this instrument, be sure of the aspects involving its management and monitor patients undergoing the protocol to avoid the occurrence of hypoglycemia, in order to offer assistance with quality and safety[10,11].

Surveillance of glycemic levels, although designated as a responsibility of the multidisciplinary team, permeates this scope, and focuses on nursing, which contributes to strict monitoring at the bedside, as well as the management of dysglycemia[6].

Regarding glycemic control, some subpopulations of patients are starting to be better studied, such as diabetics and non-diabetics. Some findings suggest that glycemic levels that may be safe and desirable for some groups of patients may not be for diabetic patients with metabolic control or chronic hyperglycemia[12].

Perioperative glycemic monitoring is essential for satisfactory surgical results, especially in myocardial revascularization[5]. It is noteworthy that most studies on glycemic control deal in general with patients undergoing myocardial revascularization surgery, to the detriment of other cardiac surgeries, such as valvular surgery. In Brazil, 70% of cases of valvular heart disease are caused by rheumatic fever. Thus, attention is needed when applying the results of international studies to this population, considering that rheumatic patients are younger, and have unique immunity and disease evolution[13,14].

Therefore, it is intuitive to think that the consequences of inadequate glycemic control are more common in coronary surgeries. Hence, it is recommended that future studies seek evidence to understand whether glycemic controls have different effects on outcomes, depending on the type of cardiac surgery patients undergo[14].

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Understanding the particularities of the valvular surgery population and the need for studies in scenarios where this population is submitted to glycemic control protocols, it has been defined as objectives of this study to compare the glycemic behavior of patients in the postoperative period of heart valve surgery and myocardial revascularization submitted to same glycemic control protocol as well as to assess the incidence of hypoglycemia and in-hospital mortality in this population.

METHOD

A cohort, retrospective and quantitative study was used, which evaluated the medical records of patients undergoing cardiac surgery (valvular and myocardial revascularization), with or without ECC, who received the same protocol for glycemic control, in the year 2016.

The study setting was a surgical cardio-intensive unit with 20 beds in a Federal Institution, located in Rio de Janeiro, Brazil. The sample was initially composed of 375 medical records of patients over 18 years of age, who were in the unit after undergoing cardiac surgery. Twenty-one medical records were excluded, leaving a final sample of 354 medical records.

Patients below 18 years old have been excluded due to the particular nature of the natural history of the disease and surgeries in adults; who underwent percutaneous, hemodynamic, and arrhythmogenic valve procedures, due to their technical differentiation from conventional heart surgery; death in the first 24h after surgery, due to the lack of minimal time using the protocol recommended for the present study; and medical records not located and with misplaced records of water balance, due to the impossibility of analyzing glycemic values.

Data collection took place between August and October 2020, by analyzing the medical records obtained from the medical file. For the extracted data, the first 48h after surgery were considered. Spreadsheets were built in Microsoft Excel, where the defined variables were recorded for further analysis.

Data were analyzed using descriptive (mean, median and standard deviation) and inferential statistics. The Chi-square association test and Student's t-test were used. The Kolmogorov-Smirnov test was also performed and, as it does not follow the normal distribution, the Mann-Whitney test between independent samples was also used.

The Body Mass Index - BMI (calculated by dividing weight in kg by the height squared in meters, kg/m^2), the following classification was used: thin or low weight BMI < 18.5 kg/m^2; normal or eutrophic, 18-5 – 24.9 kg/m^2; overweight or pre-obese, BMI 25-29.9 kg/m^2; and obesity, BMI ≥ 30 kg/m^2 [16].

For all analyses, p value ≤0.05 was considered statistically significant. Coefficient of variation (CV) = (SD / mean x 100%) was defined[15]. Severe hypoglycemia was considered when the level was ≤40mg/dL; moderate if between 41 to 60mg/dL and mild between 61 to 70mg/dL[10]. However, severe hypoglycemia was considered if <60mg/dL, respecting the protocol in force in the unit.

The body mass index (BMI), calculated by dividing weight in kilograms by height in meters squared (kg/m^2), was used for the following classification: thin or underweight, if BMI <18.5kg/ m^2 normal or eutrophic if 18.5 to 24.9 kg/m^2; overweight or pre-obese if BMI 25 to 29.9kg/m^2 and obesity if BMI ≥30kg/m^2 [16]. In-hospital mortality, considered during the entire stay, whether in the ICU or in the non-ICU hospital environment.

This manuscript was composed from a cut of a Doctoral thesis in Nursing and Biosciences, presented in 2019, approved by the Research Ethics Committee of the institution. As this is a documentary research, with a search for data from medical records, the waiver of the Free and Informed Consent Term (ICF) was requested from the Research Ethics Committees, assuming the commitment to ensure confidentiality and privacy in relation to the information accessed.

RESULTS

The epidemiological and clinical variables of the patient's population are presented in Table 1.

There was a predominance of males in myocardial revascularization surgeries and females in valvular surgery (73.26% versus 57.48%; p<0.001). Regarding the mean age, patients undergoing valvular surgery were younger (52.82 years old), compared to those undergoing revascularization (62.12 years old), with a significant difference (p<0.001).

Regarding BMI overweight was predominant in three patients submitted to myocardial revascularization surgery (MRS) and eutrophic in valvular surgery (48.12% versus 32.93%; p=0,008).

Regarding comorbidities, there were more hypertensive patients (95.72%), dyslipidemic (68.44%) and diabetic patients (78.07%) undergoing myocardial revascularization and more patients with atrial fibrillation (30.53%) in the group of valvular surgery, both groups with significant association (p<0.001).

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In ECC a significant difference was observed in both groups (p<0.001), with the highest means related to the time on ECC (119.63 ± 43.40 min) of valve surgeries, when compared to myocardial revascularization (87.39± 36.98 min).

Table 1: Epidemiological and clinical variables of the analyzed population. Rio de Janeiro, RJ, Brazil, 2020.

Variables	MRS (n=187)	Valvar surgery (n=167)	p-value
Sex			<0.001*
Masculine	137 (73.26%)	71 (42.51%)	
Feminine	50 (26.73%)	96 (57.48%)	
Age (years old)	62.12 ± 8.23	52.82 ± 14.97	<0.001**
BMI			0.008*
Low weight	0 (0%)	06 (3.59%)	
Eutrophic	47 (25.13%)	55 (32.93%)	
Overweight	90 (48.12%)	60 (35.92%)	
Obese	50 (26.73%)	46 (27.54%)	
SAH			<0.001*
Yes	179 (95.72%)	116 (69.46%)	
No	08 (4.27%)	51 (30.53%)	
Atrial fibrillation	08 (4.27%)	51(30.59%)	<0.001*
Yes	179 (95.72%)	116 (69.46%)	
No			
Dyslipidemia			<0.001*
Yes	128 (68.44%)	43 (25.74%)	
No	59 (31.55%)	124 (74.25%)	
Diabetes			<0.001*
Mellitus	146 (78.07%)	32 (19.16%)	
Yes	41 (21.92%)	135 (80.83%)	
No			
Time of ECC (min)			<0.001**
Mean	87.39 ± 36.98	119. 63 ± 43.40	
Median	92	113	
Use of vasoamines		100 (59.88%)	<0.001*
Yes	102 (54.54%)	67 (40.11%)	
No	85 (45.45%)		
Uso of corticosteroids			0.004*
Yes	8 (4.27%)	21 (12.57%)	
No	179 (95.72%)	146 (87.42%)	

Results expressed by n (%) or mean± St. Dev, unless otherwise stated. *Chi-square test **Student's t-test
MRS: Myocardial revascularization surgery; BMI: Body mass index; SAH: Systemic arterial hypertension;
ECC: extracorporeal circulation;

Regarding the use of vasoamines, more valvular surgery patients received these drugs when compared to those undergoing revascularization surgeries (59.88% versus 54.54%; p< 0.001), as well as the use of corticosteroids (12.57% versus 4 .27%; p=0.004), with a statistically significant association.

Table 2 presents data related to behavior and glycemic variation.

A higher mean blood glucose was observed in revascularized patients than in valvular surgery patients (149.14 ± 36.03 mg/dl versus 142.80 ± 31.76 mg/dl, p<0.001), with a statistically significant difference between them (p= 0.001). Regarding the blood glucose variation coefficient, the median was also higher in revascularized patients (23.30% versus 20.91 p=0.01), a statistically significant difference.

Although the group of revascularized patients were more likely to use intravenous insulin (82.35% versus 73.05%; p=0.03), valvular surgery patients had a higher incidence of hypoglycemia (35.32% versus 30.48%; p=0.33), but the difference was not statistically significant. Glycemic support was received by both groups, almost entirely (97.86%

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versus 97.60%).

Table 2: Glycemic behavior and variation. Rio de Janeiro, RJ, Brazil, 2020.

Variables	MRS (n= 187)	Valvular surgery (n=167)	*p* value
Mean of glycemia (mg/dl)	149.14 ± 36.03	142.80 ± 31.76	<0.001**
CV (%)			0.01***
Mean	23.76 ± 8.76	21.77 ± 8.94	
Median	23.30	20.91	
Intravenous insulin			0.03*
Yes	154 (82.35%)	122 (73.05%)	
No	33 (17.64%)	45 (26.94%)	
Hypoglycemia			0.33*
Yes	57 (30.48%)	59 (35.32%)	
No	130 (69.51%)	108 (64.67%)	
Glycemic support with GS 10%			0.87*
Yes	183 (97.86%)	163 (97.60%)	
No	04 (2.13%)	04 (2.39%)	

Results expressed by n (%) or mean± St. Dev, unless otherwise stated. *Chi-square test **Student's t-test; ***Mann-Whitney's test.
MRS: Myocardial revascularization surgery; CV: Coefficient of variation; GS: Glucose solution;

Table 3 presents the analysis of the clinical outcomes observed.

Table 3: Clinical outcomes observed. Rio de Janeiro, RJ, Brazil, 2020.

Variables	MRS (n= 187)	Valvar surgery (n=167)	p value
Transfusions			
Yes	53 (28.34%)	49 (29.34%)	0.83*
No	134 (71.65%)	118 (70.65%)	
Bleeding			
Yes	18 (9.62%)	16 (9.58%)	1.00*
No	169 (90.37%)	151 (90.41%)	
Length of hospital stay (days)			
Mean	33.72 ±19.16	35.43 ± 23.59	0.45**
Median	28	28	
Length of ICU stay (days)			
Mean	6.03 ± 9.78	7.70 ± 9.50	0.10**
Median	4	5	
Length of mechanical ventilation (h)			
Mean	1.31 ± 5.34	2.05 ± 7.07	0.26**
Median	0	0	
Acute kidney injury (AKI)			
Yes	03 (1.60%)	11 (6.58%)	0.016*
No	184 (98.39%)	156 (93.41%)	
Renal replacement therapy in AKI			
Yes	07 (3.74%)	20 (11.97%)	0.003*
No	180 (96.25%)	147 (88.02%)	
In-hospital death			
Yes	03 (1.60%)	11 (6.58%)	0.016*
No	184 (98.39%)	156 (93.41%)	

Results expressed by n (%), unless otherwise stated.
*Chi-square test **Student's t-test
MRS: Myocardial revascularization surgery; ICU: Intensive care unit; AKI: Acute kidney injury.

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It has been observed that more valvar surgery patients underwent blood component transfusions (29.34% versus 28.34%; p=0,83), however, more revascularized patients presented bleeding (9.62% versus 9.58%; p=1). The length of hospital stay was the same in both groups (28 days versus 28 days; p=0.45), as was the time on mechanical ventilation (0 versus 0; p=0.26). The length of stay in the ICU was longer in the valve surgery group (5 versus 4 days; p=0.1).

The incidence of acute kidney injury (AKI) and the need for renal replacement therapy were higher among valvular surgery patients (6.58% versus 1.60%; p=0.016) and (11.97% versus 3.74%; p=0.003), respectively, with a significant association in both outcomes. Regarding in-hospital mortality, more valve surgery patients did not survive (6.58% versus 1.60%; p=0.016) compared to revascularized patients, a statistically significant difference.

DISCUSSION

The practice of intensive care nurses in the cardiovascular context involves, among other technical procedures, handling medications, managing their administration, and monitoring their effects, according to the therapeutic goal for the patient guided by the institutional protocol. Specifically in relation to intravenous insulin therapy and its denomination as a potentially dangerous drug, it is necessary to adopt an adequate monitoring of its effects, either therapeutic or not. It should be considered, as well, the predisposing factors to adverse events, such as hypoglycemia, with a view to ensuring safe care for patients using this drug[10]. Therefore, monitoring the clinical outcomes of patients under their care brings to the cardiovascular nurse the necessity to monitor glycemic variability, with a view to anticipating possible situations of hypoglycemia and, for that, monitoring the variables that are related to it.

In the population studied in this article, there was a predominance of male patients in the revascularized group, and of female among valvular surgery patients. It is known that males are more afflicted by cardiovascular diseases, however, the incidence is increasing among women, especially in the post-menopausal period[17]. In relation to valvular surgeries, in general, among rheumatic patients there is a greater predominance of females[18,19].

Regarding age, revascularized patients are in a higher age group than valvular surgery patients. More and more studies point out that more elderly people undergo heart surgery. This is due to technological and drug advances that increase life expectancy[20,21].

Regarding BMI, obesity is associated with lower risks after heart surgery, a concept known as the “obesity paradox”. Underweight and morbidly obese individuals are more susceptible to worse outcomes[22,23].

A study showed that patients with a BMI <24 undergoing aortic valve replacement have an increased risk of mortality. In extreme situations, for example, after cardiac surgery, patients with a lower BMI and lower percentage of body fat may have less reserves. Consequently, they cannot deal with complications, and this can result in higher mortality, as occurred in our population of valvular surgery patients[24].

Regarding comorbidities, systemic arterial hypertension, dyslipidemia, and DM were predominant occurrences, mainly among patients who underwent myocardial revascularization, corroborating other studies in the country of patients undergoing cardiac surgery[25-28].

However, more valve surgery patients presented atrial fibrillation, as in the REMEDY study[19]. Atrial fibrillation cause a reduction in cardiac output and predisposes patients to thromboembolic events, in addition to being an independent predictor of death risk in the postoperative period of cardiac surgeries[18].

Regarding ECC time, patients undergoing valve surgery remained on circulatory support for a longer time than those undergoing revascularization. The ECC time ≥ 180 minutes increases the chance of death by 80% in one year, in addition to readmissions within 30 days, prolonged stay in the ICU and hospital on mechanical ventilation and reoperation[29]. Although ECC time in this study did not reach the mentioned cutoff point, patients with longer ECC time, here specifically valvular surgery patients, are believed to be more prone to complications and negative outcomes.

The use of vasoamines in this patient population was higher among valvular surgery patients when compared to revascularized patients. Hemodynamic conditions with reduced systemic vascular resistance are commonly observed in patients undergoing cardiac surgery, such as vasoplegic shock. The long duration of ECC is one of the factors that increase the risk of this condition and therapy with vasopressors is a pillar in the treatment of this condition[30].

However, high doses of catecholamines can lead to significant adverse effects, such as arrhythmias, hyperglycemia, myocardial and tissue ischemia, and increased mortality. Among the arrhythmias, atrial fibrillation stands out, which not only frequently prolongs ICU and hospital stays, but can also be associated with increased

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morbidity and mortality[30]. In this study, more valvular surgery patients received corticosteroids, which are used in cardiac surgery to attenuate the inflammatory response resulting from ECC[31].

Regarding glycemic behavior, the revascularized patients presented with a higher mean blood glucose and used more insulin. DM, predominant in the revascularized group, is believed to contributed to the glycemic elevation, as well as the higher insulin consumption; corroborating a study that evaluated the glycemic pattern of a retrospective cohort of diabetic and non-diabetic critically ill patients. However, even in this study, diabetics were also more prone to hypoglycemia, in contrast to our population where more valvular patients had this event[15].

In addition to the presence of diabetes mellitus, other risk factors for hypoglycemia are the severity of critical illness, sepsis, kidney injury or liver dysfunction, requirement for vasoactive drugs, insulin therapy, lower BMI, intraoperative transfusion of blood products, hemodialysis, and previous brain stroke[10,12,32-34].

Thus, it is believed that the criticality of valvular patients, the lower BMI and the higher consumption of vasoamines have contributed to the advance of hypoglycemia in this group. Recent studies have reported that the increased mortality associated with hypoglycemia in the hospital setting may not be caused directly by this event, but may be due to its association with more severe disease [35].

The glycemic variability translated by the metric of the coefficient of variation is characterized by the change in amplitude, frequency, and duration of the glucose fluctuation throughout the day. Its increase is associated with mortality, and in the ICU, it is a predictor of hypoglycemia[1].

A multicenter study with critical surgical and non-surgical patients showed that the coefficient of variation was higher among diabetics, however, mortality was significantly higher in non-diabetic patients[15]. In this study's population, glycemic variability was greater in the group of revascularized patients, who in turn had more patients with diabetes. However, this group had a lower incidence of hypoglycemia compared to the group of valvular surgery patients.

High glucose variability in ICU patients with DM appears to be less harmful than in patients without DM. Adaptation to hyperglycemia may be a key mechanism. Acute hyperglycemia and inflammation induce oxidative stress, which causes endothelial damage. In patients without DM, cellular adaptation mechanisms will be activated for the first time in the acute care setting, while patients with DM could already have adapted to these insults during their DM years and therefore better tolerate episodes of hyperglycemia in this environment of acute treatment[36].

Metrics of variability are also proposed to be of greater importance than actual blood glucose levels. Growing evidence suggests that the reduction in variability, rather than absolute levels, is the main determinant of the beneficial effects of insulin therapy[14].

Regarding clinical outcomes, valvular surgery patients were more prone to blood component transfusions and longer ICU stays. This group also showed a greater predominance of patients who developed AKI requiring renal replacement therapy and a higher in-hospital mortality, with statistical significance. Among revascularized patients, there was a higher incidence of bleeding.

Regarding transfusion, a study analyzed the impact on the incidence of clinical outcomes in the postoperative period of cardiac surgeries and showed that patients who received blood transfusions had significantly more infectious episodes such as: mediastinitis, respiratory infection, sepsis, more episodes of atrial fibrillation, acute renal failure and cerebrovascular accident, and longer hospital stay in the postoperative period[37].

The long duration of ECC is an operative factor that increases the risk of respiratory compromise in the postoperative period, as it can cause microemboli, activation of inflammatory cascades and alveolar hypoperfusion. Some patients are not able to follow an early extubation protocol and will be supported with ventilatory weaning, often with a tracheostomy, which consequently increases the length of ICU stay[21,38,39].

Acute kidney injury (AKI) is one of the main complications after cardiac surgery, with an incidence between 20% and 40%, and represents an independent risk factor for increased morbidity and mortality. The causes of AKI are multifactorial, but include the use of nephrotoxic drugs, hypoperfusion and the inflammatory cascade resulting from a longer duration of ECC. About 1% of patients will require renal replacement therapy and, in this group, morbidity and mortality significantly increase[38,40].

In this population, valvular surgery patients underwent a longer period of ECC and presented a higher incidence of acute kidney injury and renal replacement therapy, with a consequent increase of in-hospital mortality.

Bleeding was the complication that was slightly higher among revascularized patients. It is possible that diabetes mellitus, predominant in the revascularized group, has contributed to its increase, which corroborates the outcomes of

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a review paper on predictors of excessive bleeding after cardiac surgery in adults, where DM is evidenced as a preoperative risk factor (not modifiable)[41].

Based on the results, the present study concludes that it is imperative for cardiovascular nurses to be aware of this important drug therapy and its impacts on the clinical outcomes of patients undergoing valvular surgery. Raising awareness of safe practices, participating in, and requesting training and updates regarding the management of insulin therapy, and clinically monitoring the patients under their care, and anticipating complications arising from glycemic variability, may contribute to changes in this context[10].

Study limitations

A limitation of this study is the retrospective analysis of medical records as a source of data, since of the data depends on the quality of the records. Furthermore, we point out the use of a single health center as a data source for such a complex topic is another limitation.

CONCLUSION

This paper has studied a heterogeneous population composed of revascularized and valvular surgery patients submitted to the same glycemic control protocol in the postoperative environment of cardiac surgery.

Glycemic behavior showed a higher consumption of intravenous insulin among the revascularized group, where diabetic patients predominated. However, there was a higher incidence of hypoglycemia among valvular surgery patients. Blood glucose variability was greater among revascularized patients and seems to be an interesting metric to guide glycemic control using intravenous insulin in the ICU, in addition to the clinical outcomes that characterized valvular surgery patients as being more critical.

Therefore, it is imperative to know the particularities of the populations in this study, specifically valvular and revascularized patients. This can help in the identification of the most vulnerable groups and seek strategies that help in a safe glycemic monitoring performed by the nurse and his team, in the scenario of intensive cardiac care.

Therefore, it is imperative to know the particularities of the populations. In this study, specifically valvular and revascularized patients, to understand which groups are most vulnerable and seek strategies that help perform a safe glycemic monitoring by nurses and their team in the cardiology intensive care setting.

REFERENCES

1. Sociedade Brasileira De Diabetes. Diretrizes 2019-2020. [cited 2020 Oct 15]. Available from: http://www.saude.ba.gov.br/wp-content/uploads/2020/02/Diretrizes-Sociedade-Brasileira-de-Diabetes-2019-2020.pdf.
2. Van Den Berghe G, Schetz M, Vlasselaers D, Ferdinande P, Lauwers P, Bouillon R. Intensive Insulin Therapy in Critically Ill Patients. N Eng J Med [Internet]. 2001 [cited 2020 Sep 6]; 345:1359-67. DOI: https://doi.org/10.1056/nejmoa011300.
3. Gallindo, MAC, Guimarães HP, Negri AJA, Réa-Neto A. Cardiointensivismo. 1. ed. Rio de Janeiro: Atheneu, 2022.
4. Siddiqui KM, Asghar MA, Khan MF. Perioperative glycemic control and its outcome in patients following open heart surgery. Ann Card Anaesth [Internet]. 2019 [cited 2020 Sep 16]; 22:260-4. DOI: https://doi.org/10.4103%2Faca.ACA_82_18.
5. American Diabetes Association. Diabetes Care in the Hospital: Standards of Medical Care in Diabetes 2021. Diabetes Care 2021; 44 (Suppl. 1): S211–S220 [cited 2021 Jun 20]. DOI: https://doi.org/10.2337/dc21-s015.
6. Viana, RAPP, Ramalho Neto, JM. Enfermagem em terapia intensiva: práticas baseadas em evidências. 2° ed.-Rio de Janeiro: Atheneu, 2021.
7. Finfer S, Chittock DR, Su SY, Blair D, Foster D, Dhingra V, et al. Intensive versus conventional glucose control in critically ill patients. N Eng J Med [Internet]. 2009 [cited 2022 Mar 22]; 360:1283-97. DOI: https://doi.org/10.1056/NEJMoa0810625.
8. Egi M, Krinsley J. S, Maurer P, Amin DN, Kanazawa T, Ghandi S, et al. Pre-morbid glycemic control modifies the interaction between acute hypoglycemia and mortality. Intensive Care Med [Internet]. 2016 [cited 2021 Mar 10]; 42(4):562-71. DOI: https://doi.org/10.1007/s00134-016-4216-8.
9. World Health Organization. Medication Safety in High-risk Situations. Geneva: World Health Organization; 2019 (WHO/UHC/SDS/2019.10), [cited 2021 Nov 30]. Licence: CC BY-NC-SA 3.0 IGO. Available from: https://www.who.int/publications/i/item/medication-safety-in-high-risk-situations.
10. Paixão CT, Nepomuceno RM, Santos MM, Silva LD. Predisposing factors for hypoglycemia: security measures for critical patients on intravenous insulin. Rev enferm UERJ [Internet]. 2015 [cited 2020 Sep 16]; 23(1):e15098. DOI: http://dx.doi.org/10.12957/reuerj.2015.15098.
11. Sousa, TL, Matos E, Salum NC. Indicators for best practices in glycemic control in the intensive care unit. Esc. Anna Nery [Internet]. 2018 [cited 2021 Nov 30]; 22(2):e20170200. DOI: https://doi.org/10.1590/2177-9465-EAN-2017-0200.

DOI: http://dx.doi.org/10.12957/reuerj.2022.64079

12. Aramendi I, Burghi G, Manzanares W. Dysglycemia in the critically ill patient: current evidence and future perspectives. Rev Bras Ter Intensiva [Internet]. 2017 [cited 2020 Oct 15]; 29(3):364-72. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5632980/?report=classic.
13. Sociedade Brasileira de Cardiologia. Diretriz Brasileira de Valvopatias / I Diretriz Interamericana de Valvopatias - SIAC 2011 [cited 2021 Feb 20]. Arq. Bras. Cardiol. 2011; 97(5 supl. 1): 1-67. Available from: http://publicacoes.cardiol.br/consenso/2011/Diretriz%20Valvopatias%20-%202011.pdf.
14. Navaratnarajah M, Rea R, Evans R, Gibson F, Antoniades C, Keiralla A, et al. Effect of glycaemic control on complications following cardiac surgery: literature review. J Cardiothoriac Surg [Internet]. 2018 [cited 2020 Oct 15]; 13:10. DOI: https://doi.org/10.1186%2Fs13019-018-0700-2.
15. Lanspa MJ, Dickerson J, Morris AH, Orme JF, Holmen J, Hirshberg EL. Coefficient of glucose variation is independently associated with mortality in critically ill patients receiving intravenous insulin. Crit Care [Internet]. 2014 [cited 2020 Oct 15]; 18(2):R86. DOI: https://doi.org/10.1186/cc13851.
16. Associação Brasileira para o Estudo da Obesidade e da Síndrome Metabólica Diretrizes brasileiras de obesidade 2016 / ABESO - Associação Brasileira para o Estudo da Obesidade e da Síndrome Metabólica. – 4.ed. - São Paulo, SP. [cited 2020 Oct 15]. Available from: https://abeso.org.br/wp-content/uploads/2019/12/Diretrizes-Download-Diretrizes-Brasileiras-de Obesidade-2016.pdf.
17. Gardone, DS, Correa MM, Salaroli LB. Association of cardiovascular risk factors and nutritional status in the postoperative complications in cardiac surgery. Rev. Bras. Pesq. Saúde [Internet]. 2012 [cited 2021 Nov 21]; 14(4):50-60. Available from: https://periodicos.ufes.br/rbps/article/view/5119/3845.
18. Moraes RCS, Katz M, Tarasoutch F. Clinical and epidemiological profile of patients with valvular heart disease admitted to the emergency department. Einstein (São Paulo) [Internet]. 2014 [cited 2021 Nov 21]; 12(2):154-8. DOI: http://dx.doi.org/10.1590/S1679-45082014AO3025.
19. Zuhlke L, Engel ME, Karthikeyan G, Rangarajan S, Mackie P, Cupido B, et al. Characteristics, complications, and gaps in evidence-based interventions in rheumatic heart disease: the Global Rheumatic Heart Disease Registry (the REMEDY study). Eur Heart J [Internet]. 2015 [cited 2021 Jan 10]; 36(18):1115-22a. DOI: https://doi.org/10.1093/eurheartj/ehu449.
20. Atalay Hh, Atalay Bg. Cardiac surgery clinical outcomes in 70 years and over patients. J Pak Med Assoc [Internet]. 2019 [cited 2021 Mar 10]; 69(11):1677-81. DOI: https://doi.org/10.5455/jpma.301659.
21. Cordeiro AL, Guimarães AR, Pontes SS, Jesus L, Lima C, Coutinho V. Clinical and surgical characteristics of the elderly submitted to cardiac surgery. Revista Pesquisa em Fisioterapia [Internet]. 2016 [cited 2021 Mar 10]; 7(1):30-5. DOI: https://doi.org/10.17267/2238-2704rpf.v7i1.1184.
22. Mariscalco G, Wozniak MJ, Dawson AG, Serraino GF, Porter R, Nath M, et al. Body mass index and mortality among adults undergoing cardiac surgery: a nationwide study with a systematic review and meta-analysis. Circulation [Internet]. 2017 [cited 2020 Nov 10]; 135(9):850-63. DOI: https://doi.org/10.1161/circulationaha.116.022840.
23. Nakadate Y, Sato H, Sato T, Codere-Maruyama T, Matsukawa T, Schricker T. Body mass index predicts insulin sensitivity during cardiac surgery: a prospective observational study. Can J Anesth [Internet]. 2018 [cited 2021 Mar 10]; 65(5):551–9. DOI: https://doi.org/10.1007/s12630-018-1081-7.
24. Florath I. Body mass index: a risk factor for 30-day or six-month mortality in patients undergoing aortic valve replacement? J Heart Valve Dis [Internet]. 2006 [cited 2021 Feb 20]; 15(3):336-44. Available from: https://www.ncbi.nlm.nih.gov/pubmed/16784069.
25. Kaufman R, et al. Perfil epidemiológico na cirurgia de revascularização miocárdica. Rev Bras Cardiol [Internet]. 2011 [cited 2021 Jan 10]; 24(6):369-76. Available from: http://www.onlineijcs.org/english/sumario/24/pdf/v24n6a05.pdf.
26. Tonial R, Moreira DM. Clinical, epidemiological and surgical profile of patients undergoing coronary artery bypass grafting at instituto de cardiologia de Santa Catarina, São José - SC. Arquivos Catarinenses de Medicina [Internet]. 2011 [cited 2020 Oct 15]; 40(4):42-6. Available from: http://www.acm.org.br/acm/revista/pdf/artigos/894.pdf.
27. Jansen MAS, Azevedo PR, Silva LDC, Dias RS. Sociodemographic and clinical profile of patients submitted to the myocardial revascularization surgery. Rev Pesq Saúde [Internet]. 2015 [cited 2021 Nov 21]; 16(1):29-33. Available from: https://periodicoseletronicos.ufma.br/index.php/revistahuufma/article/view/4073.
28. Vieira CAC, Soares AJC. Clinical and epidemiological profile of patients who underwent cardiac surgery in Rio de Janeiro south hospital - HUSF. Revista de Saúde [Internet]. 2017 [cited 2021 Jan 10]; 8(1):3-7. DOI: https://doi.org/10.21727/rs.v8i1.607.
29. Madhavan S, Chan S, Tan W, Eng J, Li B, Luo H, et al. Cardiopulmonary bypass time: every minute counts. J Cardiovasc Surg (Torino) [Internet]. 2018 [cited 2021 Mar 05]; 59(2):274-81. DOI: https://doi.org/10.23736/s0021-9509.17.09864-0.
30. Guarracino F, Habicher M, Treskatsch S, Kettner S, Groesdonk H, Heringlake, et al. Vasopressor therapy in cardiac surgery: an experts' consensus statement. J Cardiothorac Vasc Anesth [Internet]. 2021 [cited 2021 Nov 30]; 35(4):1018-29. DOI: https://doi.org/10.1053/j.jvca.2020.11.032.
31. Patvardhan C, Vuylsteke A. Corticosteroids in adult cardiac surgery-yet another paper. J Cardiothorac Vasc Anesth [Internet]. 2018 [cited 2021 Nov 29]; 32(5):2261-2. DOI: https://doi.org/10.1053/j.jvca.2018.05.009.
32. Lowden E, Schmidt K, Mulla I, Andrei A, Cashy J, Oakes DJ, et al. Evaluation of outcomes and complications in patients who experience hypoglycemia after cardiac surgery. Postoperative Hypoglycemia, Endocr Pract [Internet]. 2017 [cited 2020 Oct 30]; 23(1):46-55. DOI: https://doi.org/10.4158/EP161427.OR.
33. Mahmoodpoor A, Hamishehkar H, Beigmohammadi M, Sanaie S, Shadvar K, Soleimanpour h, et al. Predisposing factors for hypoglycemia and its relation with mortality in critically ill patients undergoing insulin therapy in an intensive care unit. Anesth Pain Med [Internet]. 2016 [cited 2021 Jan 21]. 6(1):e33849. DOI: https://doi.org/10.5812%2Faapm.33849.

DOI: http://dx.doi.org/10.12957/reuerj.2022.64079

34. Stamou SC, Nussbaum M, Carew JD, Dunn K, Skipper E, Robicsek F, et al. Hypoglycemia with intensive insulin therapy after cardiac surgery: Predisposing factors and association with mortality. J Thorac Cardiovasc Surg [Internet]. 2011 [cited 2020 Nov 26]; 142(1):166-73. DOI: https://doi.org/10.1016/j.jtcvs.2010.09.064.
35. Umpierrez GE, Pasquel FJ. Management of inpatient hyperglycemia and diabetes in older adults. Diabetes Care [Internet]. 2017 [cited 2020 Nov 26]; 40(4):509–17. DOI: https://doi.org/10.2337/dc16-0989.
36. Sechterberger MK, Bosman RJ, Straaten HMO, Siegelaar SE, Hermanides J, Hoekstra JG, et al. The effect of diabetes mellitus on the association between measures of glycaemiccontrol and ICU mortality: a retrospective cohort study. Crit Care [Internet]. 2013 [cited 2021 Nov 29]; 17(2):R52. DOI: https://doi.org/10.1186/cc12572.
37. Dorneles CC at al. O impacto da hemotransfusão na morbimortalidade pós-operatória de cirurgias cardíacas. Rev Bras Cir Cardiovasc [cited 2020 Nov 26] 2011;26(2):222-9. DOI: https://doi.org/10.1590/S0102-76382011000200012.
38. Libertini R, Evans B. Looking after the cardiac surgery patient: pitfalls and strategies. Surgery (Oxford) [Internet]. 2021 [cited 2021 Nov 30]; 39(3):164-70. DOI: https://doi.org/10.1016/j.mpsur.2021.01.007.
39. Fonseca L, Vieira FN, Azzolinc KO. Factors associated to the length of time on mechanical ventilation in the postoperative period of cardiac surgery. Rev Gaúcha Enferm [Internet]. 2014 [cited 2021 Nov 30]; 35(2):67-72. DOI: https://doi.org/10.1590/1983-1447.2014.02.44697.
40. Mackie S, Saravanan P. Postoperative care of the adult cardiac surgical patient. Cardiac Anaesthesia [Internet]. 2021 [cited 2021 Nov 30]; 22(5):279-85. DOI: https://doi.org/10.1016/j.mpaic.2021.03.006.
41. Lopes CT, Santos TR, Brunori EHFR, Moorhead SA, Lopes JL, Barros ALBL. Excessive bleeding predictors after cardiac surgery in adults: integrative review. Journal of Clinical Nursing, 2015 [cited 2020 Sep 15], 24, 3046–3062. DOI: https://doi.org/10.1111/jocn.12936.