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Risk factors for prolonged hospital stay after isolated coronary artery bypass grafting

Fatores de risco para tempo de internação prolongada após revascularização isolada do miocárdio

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Abstract

Introduction: **Characteristics of the patient and the coronary artery bypass grafting may predispose individuals to prolonged hospitalization, increasing costs and morbidity and mortality.**

Objective: **The objective of this study was to evaluate individual and perioperative risk factors of prolonged hospitalization in intensive care units and wards.**

Methods: **We conducted a case-control study of 104 patients undergoing isolated coronary artery bypass grafting with cardiopulmonary bypass. Patients hospitalized >3 days in the intensive care unit or >7 days in the ward were considered for the study. The association between variables was estimated by the chi-square test, odds ratio and logistic regression; *P* ≤0.05 was considered statistically significant.**

Results: **Hospital stay >3 days in the intensive care unit occurred for 22.1% of patients and >7 days in the ward for 27.9%. Among preoperative factors, diabetes (OR=3.17) and smoking (OR=4.07) were predictors of prolonged intensive care unit stay. Combining the pre-, intra-and postoperative variables, only mechanical ventilation for more than 24 hours (OR=6.10) was predictive of intensive care unit outcome. For the ward outcome, the preoperative predictor was left ventricular ejection fraction <50% (OR=3.04). Combining pre- and intraoperative factors, diabetes (OR=2.81), and including postoperative factors, presence of infection (OR=4.54) were predictors of prolonged hospitalization in the ward.**

Conclusion: **Diabetes and smoking were predictors of intensive care unit outcome, and ejection fraction <50% of ward outcome. For the set of perioperative factors, prolonged hospitalization after isolated coronary artery bypass grafting was associated with mechanical ventilation >24 hours for the intensive care unit and presence of infection for the ward.**

Descriptors: **Risk factors. Myocardial revascularization. Hospitalization.**

Resumo

Introdução: **Características do paciente e da cirurgia de revascularização do miocárdio podem predispor à internação prolongada, aumentando custos e a morbimortalidade.**

Objetivo: **Avaliar fatores de risco individuais e transoperatórios para internação prolongada na unidade de terapia intensiva e na enfermaria.**

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Abbreviations, acronyms & symbols	
BMI	Body mass index
CABG	Coronary artery bypass grafting
CCIH	Commission for hospital infection control
CPB	Cardiopulmonary bypass
ICU	Intensive Care Unit
LVEF	Left ventricular ejection fraction
MV	Mechanical ventilation
OI	Oxygenation index
PNMV	Pneumonia associated with mechanical ventilation
RF	Renal failure
SAH	Systemic arterial hypertension
SC	Surgical center
SUS	Unified Health System

Métodos: **Realizou-se estudo de caso-controle com 104 pacientes submetidos à revascularização do miocárdio isolada sob circulação extracorpórea. Consideraram-se casos os pacientes com internação >3 para terapia intensiva ou >7 dias para enfermaria. A associação entre variáveis foi estimada pelo teste do qui-quadrado e pela razão de chances (odds ratio-OR) empregando-se a regressão logística, ao nível de *P*≤0,05.**

Resultados: **A permanência >3 dias na terapia intensiva ocorreu em 22,1% dos pacientes e >7 dias na enfermaria em 27,9%. Entre os fatores pré-operatórios, o diabetes (OR=3,17) e o tabagismo (OR=4,07) foram os preditores para permanência prolongada na terapia intensiva. Combinando-se as variáveis pré-, intra- e pós-operatórias, somente a ventilação mecânica por mais que 24 horas (OR=6,10) foi preditora para o desfecho na terapia intensiva. Para o desfecho na enfermaria, o preditor pré-operatório foi a fração de ejeção ventricular esquerda <50% (OR=3,04). Combinando os fatores pré- e intraoperatórios, o diabetes (OR=2,81) e, somando-se os pós-operatórios, a presença de infecção (OR=4,54), foram os preditores para internação prolongada na enfermaria.**

Conclusão: **Diabetes e tabagismo foram os preditores para o desfecho na terapia intensiva, e a fração de ejeção <50% para a enfermaria. Para o conjunto dos fatores transoperatórios, internação prolongada após revascularização do miocárdio isolada associou-se à ventilação mecânica >24 horas para terapia intensiva e à presença de infecção para a enfermaria.**

Descritores: **Fatores de risco. Revascularização miocárdica. Hospitalização.**

INTRODUCTION

Despite advances in preventative and curative approaches to cardiovascular disease, data from the American Heart Association [1] indicate that the incidence and prevalence of these diseases remain high, although with reduced mortality. In the surgical treatment of coronary artery disease, coronary artery bypass grafting (CABG) is one of the most common therapeutic choices [1,2]. The benefits of CABG are identified as contributing factors for reduced fatal outcomes in many cases of associated cardiovascular diseases [1,2]. However, this surgery, besides being expensive, can result in reduced functional capacity due to morbidities acquired postoperatively or risks associated with the procedure [3,4].

In the Brazilian Unified Health System (SUS), over R$ 400 million have been spent to perform 32,809 isolated CABG surgeries between January-2011 and March 2012, with an average hospital stay of 12.8 days [5]. This spending comes from the costs of the operation and hospitalization in the ward and/or in the Intensive Care Unit (ICU) [6]. According to Haddad et al. [3], 66.2% of the expenses are associated with the surgery, 17.5% with the postoperative period in the ICU and 12% with the postoperative period in the ward. It is estimated that the longer the postoperative hospital stay is, the higher the costs are. Bashour et al. [7] observed that 5.4% of the 142 patients who stayed more than 10 days in the ICU were responsible for 48% of the total expenses of 2,618 patients.

Postoperative hospital stay may also contribute to increased severity, reduced functional capacity and loss of professional productivity [4,8], affecting family budgets, quality of life and increasing costs [1]. Bashour et al. [7] showed that, after cardiac surgery, many patients with prolonged hospital stay died soon after discharge and that the functional status of those who survived for a longer period was worse when compared with those who recovered faster.

In this context, the objective of this study was to identify pre-, intra- and postoperative risk factors for long hospitalizations in the ICU or the ward, of patients undergoing isolated CABG surgery with cardiopulmonary bypass (CPB) in a specialized service of the Federal District - Brazil.

METHODS

We conducted a case-control study of adults of both sexes, with coronary artery disease, admitted in 2007 at the Instituto de Cardiologia do Distrito Federal hospital (IC-DF) who had undergone coronary artery bypass grafting via median sternotomy with CPB. This study was approved by the Hospital Research Ethics Committee (IC-DF n° 038/2009).

Of the 153 patients who underwent the procedure in the period, we excluded 34 due to associated surgical procedures, 10 who did not undergo CPB, 2 that re-operated and three that died. The anthropometric and clinical data were retrospectively collected from medical records and electronic records of the hospital. The information was categorized and organized according to the pre-, intra-and postoperative periods.

The final sample consisted of 104 patients who underwent isolated CABG with median age (extremes) of 60 (37-82) years, 50 (48.1%) over 60 years and 72 (69.2%) male. Body mass index (BMI) before surgery was 27 (17.8 to 41) kg/m². In this group, in a combined or isolated manner and prior to surgery, 24 (23.1%) patients had left ventricular ejection fraction (LVEF) <50%, 5 (4.8%) presented renal failure (RF), 87 (83.7%) had systemic arterial hypertension (SAH), 42 (40.4%) had diabetes mellitus type II, 12 (11.5%) were smokers and 43 (41.3%) were former smokers.

Study design

The length of stay in the ICU after surgery was considered to be the number of days spent at the hospital immediately after surgery, and hospitalization in the ward as the days following transfer from the ICU until discharge. Periods of time shorter than 24 hours in the ICU or in the ward were considered as one day. For the patient who was eventually readmitted to the ICU, the total number of days (first admission and readmission) was considered. We considered a prolonged stay in the ICU to be >3 days, in accordance with the study by Janssen et al. [6], and >7 days for the ward, according to Atoui et al. [8], which corresponded to the values of the 70th percentile of the sample in both cases. The cases were considered were those in which the patient spent more than 3 days in the ICU and more than 7 days in the ward, and controls those with ≤ 3 and ≤ 7 days of hospitalization, respectively.

Predictors of risk

The preoperative variables evaluated as possible predictors of risk for the outcomes studied were: sex [8], age [8,9], BMI [10], LVEF [8,10], hypertension [9], diabetes [6,7,9], RF [8,11,12], smoking [7,8] and former smoking (>2 months without tobacco). The continuous preoperative variables, besides being evaluated as such, were categorized to form subgroups based on cuttoff points: older and younger than age 60 [9,12], LVEF higher and lower than 50% [9,12], creatinine levels higher and lower than 1.5 mg/dl for renal failure (RF) [13] and BMI between 18.5 and 24.9 (normal) and <18.5 or> 24.9 kg/m² (outside the normal range).

The intraoperative variables considered were number of grafts, duration of CPB [10], aortic clamping time [8,10] and oxygenation index (OI) in the surgical center (SC). In the postoperative phase, we analyzed acute RI [12], mechanical ventilation (MV) [9,14], IO at ICU admission (IO-ICU) occurrence of pneumonia associated with MV (PNMV) [12] and the presence of other infections [14]. Intra- and postoperative categories to form subgroups were CPB time longer and shorter than 120 minutes [15], SC-IO and IO-ICU higher and lower than 300 [15]. The occurrence of infection and PNMV was characterized based on the records of the Commission for Hospital Infection Control (CCIH) of the institution, categorized as presence or absence of PNMV, upper, lower, and deep surgical site infection, infection in the bloodstream, urinary tract infection, pneumonia, endocarditis, mediastinitis, and empyema.

Statistical Analysis

Taking into consideration the non-normal distribution of most variables (Shapiro-Wilk test), we used non-parametric statistics. In order to analyze the association between categorical variables we used the chi-square or Fisher's exact test when indicated.

We proceeded to the bivariate analysis to verify the strength of association between the variables tested groups of smaller and longer hospitalization. We also calculated the odds ratio (odds ratio, OR) and the 95% confidence intervals. To compare the values of continuous variables we used the Mann-Whitney test, and these variables expressed as median and extremes. Sequentially, we proceeded to the multivariate analysis of the variables that had a significance level $P \leq 0.20$ in the previous analysis, using logistic regression to calculate the adjusted OR. To avoid duplication, when a continuous variable showed good conditions of to join the multivariate model and its corresponding categorical variable too, only the last one entered the model.

The multivariate logistic regressions of the stepwise [6,11] backward likelihood ratio method [10] were performed with the length of stay in ICU and in the ward as a binomial outcome variable (≤ 3 *versus* >3 days and ≤ 7 *versus* >7 days, respectively). Variables were included in the equation in three blocks: the preoperative ones in the first block, these variables plus intraoperative ones in the second, and postoperative variables over the previous two were the third block. The probability *(P* value) Hosmer-Lemshow was calculated to estimate how much the logistic regression model is adapted to the data [10].

The differences were considered statistically significant when the two-tailed probability of their occurrence due to chance (type I error) were less than or equal to 5% ($P \leq 0.05$). Data were analyzed using SPSS v.13.0 for *Windows* (SPSS Inc., Chicago, IL).

RESULTS

The median total length of postoperative hospital stay was 8 (5-53) days: 3 (2-36) days in the ICU and 5 (1-36) days in the ward. Of the 104 patients, 23 (22.1%) remained for more than three days in the ICU, and 29 (27.9%) for more than seven days in the ward.

ICU satay during the postoperative period

Table 1 presents the frequencies and bivariate analysis of risk factors associated with prolonged ICU stay (> 3 days).

Table 2 shows the comparisons between medians (extreme) of the continuous predictor variables of those who remained for less and for more than 3 days in the ICU. In the case of variable time of VM, its categorical discrimination in greater and less than 24 hours was significantly associated with length of ICU stay (Table 1), so that this discrimination was only considered for logistic regression analysis.

Table 1. Absolute frequencies (relative) and bivariate analysis of risk factors associated with ICU for more and less than 3 days (n = 104).

	Variables	ICU > 3 days n = 23	ICU ≤ 3 days n = 81	*P*	OR (CI 95%)
Preoperative	Gender				
	Woman	10 (31%)	22 (69%)	0.135*	2.06 (0.79-5.38)
	Man	13 (18%)	59 (82%)		
	Age (years)				
	> 60	13 (26%)	37 (74%)	0.358*	1.55 (0.61-3.93)
	< 60	10 (19%)	44 (81%)		
	BMI (kg/m^2)				
	<18.5 ou ≥ 24.9	19 (24%)	61 (76%)	0.463*	1.56 (0.47-5.12)
	18.5-24.9	4 (17%)	20 (83%)		
	Renal failure				
	Yes	2 (40%)	3 (60%)	0.305†	2.48 (0.39-15.80)
	No	21 (21%)	78 (79%)		
	EF (%)				
	< 50	8 (33%)	16 (67%)	0.102*	2.32 (0.83-6.48)
	≥ 50	14 (18%)	65 (82%)		
	Diabetes				
	Yes	14 (33%)	28 (67%)	0.023*	2.94 (1.13-7.65)
	No	9 (15%)	53 (85%)		
	Hypertension				
	Yes	22 (25%)	65 (75%)	0.111†	5.42 (0.68-43.23)
	No	1 (6%)	16 (94%)		
	Smoke				
	Yes	5 (42%)	7 (58%)	0.134†	2.90 (0.82-10.19)
	No	18 (20%)	73 (80%)		
	Former smoker				
	Yes	9 (21%)	34 (79%)	0.807*	0.89 (0.35-2.29)
	No	14 (23%)	47 (77%)		
Intraoperative	On-pump time (min)				
	≥ 120’	10 (23%)	34 (77%)	0.898*	1.89 (0.70-4.10)
	< 120’	13 (22%)	47 (78%)		
	Number of bypasses				
	≥ 4	8 (21%)	30 (79%)	0.843*	0.91 (0.34-2.39)
	< 4	15 (23%)	51 (77%)		
	OI-SC				
	≤ 300	20 (23%)	68 (77%)	0.516†	1.90 (0.40-9.20)
	>300	2 (13%)	13 (87%)		
Postoperative	OI-UTI				
	≤ 300	19 (22%)	66 (78%)	1.000†	1.08 (0.32-3.64)
	> 300	4 (21%)	15 (79%)		
	MV (h)				
	> 24	8 (57%)	6 (43%)	0.002†	6.58 (1.99-21.73)
	≤ 24	15 (17%)	74 (83%)		
	Infection				
	Yes	6 (33%)	12 (67%)	0.221†	2.03 (0.67-6.19)
	No	17 (20%)	69 (80%)		
	PNMV				
	Yes	3 (75%)	1 (25%)	0.033†	12.00 (1.18-121.57)
	No	20 (20%)	80 (80%)		
	Renal failure				
	Yes	3 (50%)	3 (50%)	0.120†	3.90 (0.73-20.80)
	No	20 (20%)	78 (80%)		

OR – Odds ratio; CI – Confidence Intervals; ICU – Intensive Care Unit; BMI – Body Mass Index; EF – Ejection Fraction; OI-SC – oxygenation index leaving surgical center; OI-UCI – oxygenation index ; MV - Mechanical ventilation; PNMV – pneumonia associated with MV; (*) Chi-square; (†) Fisher’s exact test.
Note: the situations in groups "cases" with 22 and "controls" with 80 individuals indicate lack of data on one of the individuals

Table 2. Comparative analysis of the median values (extremes) of continuous predictor variables presented by patients according to duration of prolonged ICU stay (n = 104).

	ICU length of stay (days)		
Variables	≤ 3	> 3	*P*
BMI (kg/m²)	26.0 (17.8 - 35.0)	27.8 (18.0 - 41.0)	0.53
EF (%)	64.0 (31.0 - 79.0)	56.5 (26.0 - 76.0)	0.35
On-pump (min)	110.0 (45.0 - 200.0)	110.0 (55.0 - 200.0)	0.81
Time of anoxia (min)	90.0 (0.0 - 170.0)	100.0 (40 - 150)	0.57
OI-SC	195.0 (86.8 - 574.0)	200.5 (98.0 - 342.0)	0.66
OI-UCI	229.0 (101.0 - 500.0)	196.0 (66.0 - 360.0)	0.45
MV (hours)	10.0 (3.0 - 47.0)	18.0 (4.0 - 598.0)	0.001

ICU – Intensive Care Unit; BMI – Body Mass Index; EF – Ejection Fraction; OI-SC – oxygenation index leaving surgical center; OI-UCI – oxygenation index ; MV - Mechanical ventilation. Statistics analyses: Mann-Whitney Test

Table 3. Multivariate logistic regression of factors associated with $P \leq 0.20$ for prolonged length of stay in the ICU (n = 104).

		1st Block		2nd Block		3rd Block	
	Variables	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)
Preoperative	Female gender						
	EF < 50%						
	Diabetes	0.027	3.17 (1.34-8.85)				
	Hypertension					0.104	5.93 (0.69-50.81)
	Smoke	0.042	4.07 (1.06-15.69)				
Postoperative	MV > 24 h					0.006	6.10 (1.70-21.86)
	PNMV						
	Renal Failure						

1st Block - Analysis of the preoperative variables; 2nd Block – Analysis of the pre and intraoperative variables; 3rd Block – Analysis of the pre-. intra- and postoperative variables; OR – Odds ratio; CI – Confidence Intervals; ICU – Intensive Care Unit; EF – Ejection Fraction; MV - Mechanical ventilation; PNMV – pneumonia associated with MV

Table 3 shows the results of multivariate analysis in the ICU. There were no intraoperative variables that met the criteria to join blocks 2 and 3 of multivariate analysis. The predictors found in the bivariate analysis were diabetes, MV >24h and PNMV (Table 1). In multivariate analysis, diabetes and smoking were predictors of preoperative period for prolonged ICU. Considering all operative periods altogether, MV >24 hours was an observed predictor. The Hosmer-Lemeshow test was performed for block one (x^2=0.013, P=0.910) and block 3 (x^2=0.012, P=0.912), showing itself to be a suitable model for analysis.

Admission to the postoperative ward

Table 4 presents the frequencies and bivariate analysis of risk factors associated with hospitalization in the ward (>7 days).

Table 5 shows the comparison between median (extremes) of continuous predictor variables presented by patients who stayed less and for more than 7 days in the postoperative ward.

As continuous variables MV time and LVEF also had their corresponding categorical significant differences (Table 5), only the latter was considered in the logistic regression analysis. Predictor variables present in the final model in each block in the ward are presented in Table 6. In the case of this outcome, LVEF <50% was the risk factor of the preoperative period. Combining with the intraoperative period, diabetes was the only predictor. Considering the three operative periods, only the presence of infection was a risk factor for prolonged hospitalization in the ward. The Hosmer and Lemeshow presented for block 1, x^2=0.000 and P=0.883, for block 2, x^2=0.583 and P=0.965, and for block 3, x^2=0.955 and P=0.917, demonstrating the adequacy of the model used.

Table 4. Absolute frequencies (relative) and bivariate analysis of risk factors associated with staying in the ward for more and less than 7 days (n = 104).

	Variables	Ward > 7 days n = 29	Ward ≤ 7 days n = 75	*P*	OR (95% CI)
Preoperative	Gender				
	Woman	11 (34%)	21 (66%)	0.325*	1.57 (0.64-3.88)
	Man	18 (25%)	54 (75%)		
	Age (years)				
	> 60	17 (34%)	33 (66%)	0.181*	1.80 (0.76-4.30)
	< 60	12 (22%)	42 (88%)		
	BMI (kg/m^2)				
	<18.5 ou ≥ 24.9	5 (21%)	19 (79%)	0.380*	1.63 (0.54-4.87)
	18.5-24.9	24 (30%)	56 (70%)		
	Renal failure				
	Yes	3 (60%)	2 (40%)	0.131†	4.21 (0.67-26.63)
	No	26 (26%)	73 (74%)		
	EF (%)				
	< 50	11 (46%)	13 (54%)	0.020*	3.09 (1.17-8.11)
	≥ 50	17 (22%)	62 (88%)		
	Diabetes				
	Yes	16 (38%)	26 (62%)	0.056*	2.32 (0.97-5.55)
	No	13 (21%)	49 (79%)		
	Hypertension				
	Yes	25 (29%)	62 (71%)	0.774†	1.31 (0.39-4.41)
	No	4 (24%)	13 (76%)		
	Smoke				
	Yes	3 (25%)	9 (75%)	1.000 †	0.83 (0.21-3.32)
	No	26 (29%)	65 (71%)		
	Former smoker				
	Yes	10 (23%)	33 (77%)	0.377*	0.67 (0.28-1.63)
	No	19 (31%)	42 (69%)		
Intraoperative	On-pump time (min)				
	≥ 120’	16 (36%)	28 (64%)	0.099*	2.07 (0.87-4.92)
	< 120’	13 (22%)	47 (78%)		
	Number of bypasses				
	≥ 4	13 (34%)	25 (66%)	0.275*	1.63 (0.68-3.90)
	< 4	16 (24%)	50 (76%)		
	OI-SC				
	≤ 300	24 (27%)	64 (73%)	1.000†	0.94 (0.27-3.27)
	>300	4 (29%)	10 (71%)		
Postoperative	OI-UTI				
	≤ 300	24 (28%)	61 (72%)	0.866*	1.10 (0.36-3.39)
	> 300	5 (26%)	14 (74%)		
	MV (h)				
	> 24	8 (57%)	6 (43%)	0.021†	4.32 (1.35-13.86)
	≤ 24	21 (24%)	68 (76%)		
	Infection				
	Yes	11 (61%)	7 (39%)	0.001*	5.94 (2.01-17.49)
	No	18 (19%)	68 (81%)		
	PNMV				
	Yes	3 (75%)	1 (15%)	0.065†	8.54 (0.85-85.75)
	No	26 (26%)	74 (74%)		
	Renal failure				
	Yes	4 (67%)	2 (33%)	0.050†	5.84 (1.01-33.85)
	No	25 (26%)	73 (74%)		

OR – Odds ratio; CI – Confidence Intervals; ICU – Intensive Care Unit; BMI – Body Mass Index; EF – Ejection Fraction; OI-SC – oxygenation index leaving surgical center; OI-UCI – oxygenation index ; MV - Mechanical ventilation; PNMV – pneumonia associated with MV; (*) Chi-square; (†) Fisher’s exact test.
Note: the situations in groups "cases" with 22 and "controls" with 80 individuals indicate lack of data in one of the individuals

Table 5. Comparative analysis of the median values (extremes) of continuous predictor variables presented by the patients according to the time spent on the ward (n = 104).

	Length of stay on the ward (days)		
Variables	≤ 7	> 7	*P**
Age (years)	62.0 (47.0 - 82.0)	59.0 (37.0 - 79.0)	0.33
BMI (kg/m²)	26.0 (17.8 - 33.0)	27.8 (18.0 - 41.0)	0.14
EF (%)	64.0 (31.0 - 79.0)	56.5 (28.0 - 76.0)	0.05
On-pump (min)	105.0 (45.0 - 200.0)	120.0 (55.0 - 200.0)	0.21
Period of anoxia (min)	90.0 (0.0 - 152.0)	100.0 (40.0 - 170.0)	0.17
OI-SC	205.0 (86.8 - 406.0)	180.5 (101.0 - 574.0)	0.22
OI-ICU	231.0 (86.8 - 442.0)	185.0 (101.0 - 500.0)	0.11
MV (hours)	10.0 (3.0 - 47.0)	17.0 (4.0 - 598.0)	0.004

BMI – Body Mass Index; EF – Ejection Fraction; OI-SC – oxygenation index leaving surgical center; OI-UCI – oxygenation index; MV - Mechanical ventilation. Statistical analysis: Mann-Whitney Test

Table 6. Multivariate logistic regression of factors associated with $P \leq 0.20$ for prolonged length of stay in the ward (n = 104).

		1st Block		2nd Block		3rd Block	
	Variables	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)
Preoperative	Age > 60 years						
	Renal faliure						
	EF < 50 %	0.022	3.09 (1.18-8.11)	0.080	2.46 (0.90-6.73)		
	Diabetes			0.040	2.81 (1.05-7.53)		
Intraoperative	On-pump > 120 min			0.062	2.59 (0.95-7.01)	0.101	2.24 (0.86-5.84)
Postoperative	MV > 24 h						
	Infection					0.010	4.54 (1.45-14.24)
	PNMV						
	Renal faliure					0.055	6.39(0.96-42.39)

1st Block – Analysis of the preoperative variables; 2nd Block – Analysis of the pre and intraoperative variables; 3rd Block – Analysis of the pre-. intra- and postoperative variables; OR – Odds ratio; CI – Confidence Intervals; ICU – Intensive Care Unit; EF – Ejection Fraction; MV - Mechanical ventilation; PNMV – pneumonia associated with MV

DISCUSSION

The focus of this study was to characterize the clinical and surgical risk factors associated with prolonged hospital stay after surgery for isolated CABG with cardiopulmonary bypass in a specialized tertiary institution, reference in the region of the study.

Preliminarily, the findings should be interpreted considering that different experimental designs have been employed in the literature, as well as the lack of uniformity of key issues such as the characteristics of the samples and the cutoffs used to categorize the variables. Moreover, there are few studies in Brazil on risk factors for prolonged ICU outcomes and ward after CABG. Another important issue is that some studies include, in the same sample, patients undergoing other cardiac surgery associated with CABG [7,8,15]. The heterogeneity of the samples in the use of CPB [6,9] and diversity as the cutoff for prolonged hospitalization, rangesfrom 2 to 10 days in the ICU [7,9] and 7-14 days of the total time in the postoperative period [13,16].

In this context our findings acquire special importance, since the sample was homogeneous as to the type of surgery, ie, exclusively CABG, as well as the fact that all have undergone CPB, aspects of probable impact on recovery time after surgery. About cutoff for prolonged hospitalization, established by the 70th percentile of the sample, similar to other studies [8,14,16], we should consider that some authors justify a clinical arbitrary choice [10,17]. Bucerius et al. [11] justified that these times of hospitalization included almost all patients with postoperative complications able to prolong the intensive treatment. Christakis et al. [14] that defined time >3 days in the ICU showed that even two days could possibly be considered as prolonged time.

Among the preoperative variables, diabetes was presented as predictor of prolonged ICU, increasing by 3.2 times the odds of this outcome. Diabetes also shown to be a predictor for prolonged time in the ward, when combined with other preoperative and intraoperative factors as CPB >120 minutes, increasing by 2.81 times the chance of prolonged stay. These observations support the fact that diabetes per se, is a risk factor for coronary heart disease [1,18] and its more severe degree [19]. Furthermore, diabetes is associated with a greater number of surgical complications such as perioperative myocardial infarction [20], prolonged MV [20], infection [18] and cerebrovascular accidents [18], which prolongs the ICU. Also, the use of CPB worsens glycemic control, may increase the frequency of these complications [20]. Thus, the combination of diabetes with some of these variables can justify its expression as a risk factor.

Our observations related to diabetes were similar to other studies that have shown a higher proportion of diabetics in the group with prolonged hospitalization [9,16,18,21], and that this disorder, itself, is a risk factor for prolonged hospitalization [11,13]. However, other studies found no association between diabetes and risk for prolonged hospitalization [6,7,16].

LVEF <50% constituted a pre-operative risk factor for prolonged stay in the ward, increasing by 3.04 times the odds for this outcome. Regarding the ICU, it is possible that the LVEF was not a risk factor in view of the cutoff point adopted and possible interaction with other variables, such as the MV [11]. The association between lower LVEF and longer hospitalization was also observed by Hein et al. [10]. Other authors [9,16] observed this association when the LVEF was <50% or even lower, between 30 and 40% [8,11].

In the group, smoking increased by 4.07 times the chance of prolonged hospitalization in the ICU. Christakis et al. [14] also observed that smoking was a predictor for pre-operative hospital stay >3 days in the ICU, with OR=2.0. Others did not observe this association to stay >10 days in the ICU and >7 days total [13]. In the study of Al-Sarraf et al. [22] smoking was associated with higher incidence of pulmonary infections, atelectasis, and MV >48 hours and stay >3 days in the ICU, as this study. These data suggest that smoking has not manifested as a risk factor when all factors for prolonged ICU stay are jointly considered due to its effect on the time of the MV, which was a predictor for this outcome.

As for MV, its use for more than 24 hours was found to be a risk factor for prolonged ICU stay, as observed in other studies [9,13,21]. However, the MV is correlated with other factors associated with prolonged hospital. As pointed out by Doering et al. [23], some preoperative factors may influence postoperative factors also correlated with prolonged length of stay in the ICU. Thus, correlation between prolonged MV and higher age [12], females [12], diabetes [24], hypertension [24], LVEF <30% [24], chronic RF [24] and BMI <20 [25] have been observed. The prolonged MV also correlates with surgical factors such as aortic clamping [24], cardiopulmonary bypass time >120 minutes [25] and other postoperative factors such as RF [25]. Yende & Wunderink [26] reported that one of the most common causes of VM >24 hours after CABG was hypoxemia, where oxygenation index <300 proved to be a risk factor for stay >5 days in the ICU, with an odds ratio of 9,1 [15]. The severe hypoxemia may still have their risk doubled when CPB is used, and the risk tripled when CPB >120 minutes [27].

Unlike the observations that associate CPB with systemic and respiratory complications, we did not observe this association, as other studies [15,17]. Other authors indicated that CPB [11] and aortic clamping [10] were risk factors that increased by 1.59 times the length of stay in the ICU when the CPB was greater than 120 minutes [11]. These findings, however, were not evident in our study, possibly because the sample was comprised only of patients undergoing CPB or possible interactions between different factors.

With respect to infection nonspecifically, there was 4.7-fold increase in the risk of prolonged stay in the ward when all factors were examined for this outcome. Some studies have evaluated for specific infections, such as infection presence of scar tissue, which Weintraub et al. [16] reported a relative risk of 7.9 in the univariate analysis, to be held 10 days of hospitalization. Lazar et al. [13] observed that infection scar was more prevalent in the group with length of stay >7 days total, as well as a risk factor for the outcome.

It was also observed that renal impairment was a risk factor for prolonged hospitalization in the ward when installed in the postoperative period, as was to be expected. Wong et al. [12] also observed a postoperative IR an odds ratio of risk equal to 17.45 in univariate analysis and equal to 18.9 in the multivariate one. Other authors also indicated the RF as a risk factor for prolonged ICU [28], and others only when it was an existing condition in the preoperative period [8,11,12]. Differences in values of RF risk indicators between different studies may be associated with the diagnosis itself. Among these studies, Lazar et al. [13] had used the same criterion we used in this study (creatinine >1.5 mg/dl).

Another finding of note was that older individuals were more likely not to prolonged stay in the ICU or in the ward, compared to younger ones. In most other studies, age was associated with longer hospital stays, with odds ratios ranging between 1.02 and 2.59. Some authors, considering the cutoff at the age of 60 years, as in our study, observed a correlation of this age with time greater than 48 hours in the ICU [6,8,10]. Other authors observed the same correlation when they adopted 70 years [10] or 80 years as the cutoff [11]. Bashour et al. [7] observed that for every 10 year increase in age, the length of stay increased by 1.9 times. The association of older age with prolonged hospitalization may be due to the fact that this age group have a higher rate of preoperative co-morbidities as hypertension, diabetes and chronic obstructive pulmonary disease, and the severity of the disease [10,29].

Such as age, other factors were not associated with length of stay or when association was observed in the bivariate analysis, this was not maintained in multivariate analysis. This may have occurred due to the nature of the non-associative factor, the possible interaction between the variables, the chosen cutoff or the number of individuals evaluated. One such factor was hypertension, for which Bashour et al. [7] also found no association with hospitalization time, unlike other studies [9,16]. Another factor was the female gender that, unlike our observations, was identified as a risk factor with an odds ratio equal to 1.93 [12] and relative risk of 2.6 [11].

Regarding the number of grafts, unlike our study, others have observed a correlation of this factor with prolonged ICU, using a cutoff above or equal to 2 [11] or above 3 grafts [14].

The PNMV was found to be a factor associated with longer ICU stay, only in the bivariate analysis (OR=12.0), which was also observed by Wong et al. [12] for time > 48 hours in the ICU, with an odds ratio equal to 75.6.

Regarding BMI, other authors [10] did not identify the influence of this factor in the length of stay in ICU. However, in the study by Van Venrooij et al. [30] BMI ≤ 21 kg/m^2 was identified as a risk factor for hospitalization > 48 hours in the ICU and BMI ≤ 23.5 kg/m^2 for time >7 days after CABG indicating that parallel to the known association between overweight and morbidity and mortality, decreased weight and/or weight reduction in the preoperative phase may be indicators of increased risk for prolonged hospitalization [30].

Possible limitations in our study can be identified. It was a case-control data study using previous history recorded by different observers, which may increase the heterogeneity and reduce reliability. However, this possibility was mitigated since all observations derived from examinations, diagnoses and clinical information recorded in records of an institution of education and research, in which the data are confronted by several members of the clinical staff. With respect to the control group, the possible restrictions by differences in relation to the group of cases were obviated considering that the risk factors were analyzed for outcomes according to length of stay. This criterion also avoided the probability of erroneous inclusion of patients in the groups.

Another relative limitation was the sample size that was small in comparison with similar studies and relatively lower than desired for the number of predictors that entered the final model of logistic regression [31]. This limitation, however, does not invalidate the results, which showed, undoubtedly, from the standpoint of statistical significance, that some factors were predictors of outcomes, which does not mean that other predictors could not be identified with increasing size sample. Furthermore, the use of Hosmer and Lemeshow indicated the adequacy of the model used to analyze the data.

Some aspects of the study obviate or mitigate the limitations of sample size:

1) the relationship between these individuals and independent predictor variables indicates that all were present in each individual in varying proportions, which mitigates the effects of sample size smaller than the usually recommended, although not override it.

2) our study was limited to patients undergoing isolated CABG with cardiopulmonary bypass in a given period of time (one year) in a single referral center, privileging the homogeneity of the sample against a larger number of individuals.

3) Another aspect of reliability of the results of the logistic model is obtained with the potential reproducibility of data subjects for further studies [32].

In particular, our model presents reliable as it can predict prolonged periods of stay in the ICU and in the ward for further analysis than presently done, considering that the predictor variables included are those mainly involved in these outcomes. Moreover, for each predictor variable, the significance of the odds ratio was high and the confidence intervals showed up distinctly narrow.

CONCLUSIONS

The bivariate and multivariate analyzes of the relationships between risk factors in the pre-, intra- and postoperative period and prolonged ICU stay after coronary artery bypass grafting with cardiopulmonary bypass, suggest that diabetes and smoking were risk factors predictors of the pre-operative period and mechanical ventilation the only predictor for the postoperative outcome. For the prolonged length of stay in the ward the following predictors were identified: LVEF <50% in the preoperative period, diabetes, in the period immediately after surgery, and nonspecific infection postoperatively. These findings point to the necessary evaluation of strategies aimed at reducing hospitalization time and suggests special attention to certain clinical and/or surgical conditions that may, when prevented or better controlled, reduce the length of hospital stay for patients undergoing coronary artery bypass grafting.

Authors' roles & responsibilities	
EKO	Conception of the research proposal, data collection, statistical analysis and manuscript writing
ALRT	Contribution in the protocol design, data collection, manuscript revision
PLT	Protocol design definition, statistical analysis and final review of the manuscript
LFJJ	Conceptual revision of the manuscript, statistical analysis advisor, clinical-cardiologic interpretations and final manuscript revision
LGGP	Protocol design definition, statistical analysis, writing of the final version of the manuscript, research project advisor

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