ORIGINAL ARTICLE

Peri-operative determinants of prolonged CICU stay after coronary artery bypass graft surgery in elderly at a private tertiary care hospital: A case control study

Fazal Wahab Khan,[1] Shiraz Hashmi,[2] Syed Saad Naeem,[3] Benish Fatima,[4] Hashim Hanif,[5] Mubashir Zareen,[6] Saulat Hasnain Fatimi[7]

Abstract

Objective: To explore peri-operative risk factors associated with prolonged stay in cardiac intensive care unit among patients undergoing isolated coronary artery bypass grafting.

Methods: This retrospective case control study was conducted at the Aga Khan University Hospital, Karachi, comprised medical records of patients who had undergone cardiothoracic revascularisation surgery from January 2006 to December 2013. The patients were grouped into cases and controls at a ratio of 1:2 on the basis of length of stay at cardiac intensive care unit, i.e. ≥72 hours and <72 hours. Independent risk factors for prolonged cardiac intensive care unitstay were evaluated. SPSS 20 was used for data analysis.

Results: Of the 999 patients, 333(33.3%) were cases and 666(66.6%) were controls. The mean age of cases was 62.5±9.7 years and that of controls was 60.8±9.6 years (p=0.007). The number of males was 280(84.1%) among the cases and 489(73.4%)among the controls. Adjusted odds ratio and 95% confidence interval for age and male gender were 1.02 (1.0,1.03) and [1.90 (1.32,2.74)]; diabetics were at high risk of staying longer [1.51 (1.13,2.02)]; previous cardiovascular interventions [1.65 (1.05,2.59)], intra-aortic balloon pump insertion [1.45 (1.01,2.08)], initial ventilation time and post-operative bleeding tamponade were independently associated with prolonged cardiac intensive care unit stay [1.01 (1.00, 1.01)] and [1.9 (1.13,3.2)], respectively. The risk of dying among the cases was three times more after adjusting for all covariates in the model [3.1 (1.52,6.31)].

Conclusion: Advanced age, male gender, diabetes, previous cardiovascular interventions, post-operative intra-aortic balloon pump insertion, initial ventilation support and post-op bleeding tamponade were found to be the independent risk factors for prolonged cardiac intensive care unit stay.

Keywords: Peri-operative risk factors, Coronary artery bypass graft, Prolonged CICU stay, Elderly. (JPMA 66: S-19; 2016)

Introduction

Revisualisation has become progressively more complex and demanding over the past 2 decades, particularly due to high proportion of elderly patients presenting coronary vessel disease with associated co-morbidities[1,2] such as re-operations, advanced age, diabetes, hypertension, heart disease and renal dysfunction.[3] The presence of high-risk profile results in poor outcomes and contributes substantially to health care resources, overall expenditures,[4,5] as well as prolongs use of sophisticated specialised equipment and dedicated highly skilled health staff.[6] In the present era, the health care industry focuses on providing quality care and patient satisfaction at reduced costs; strategies to reduce cardiac intensive care unit (CICU) stay are highly desirable.[3]

Every cardiac patient who undergoes open-heart surgery goes to the CICU for several days depending on the individual's risk profile. Prolonged CICU stay has a significant impact on the morbidity and mortality of high-risk patients. Apart from an increase in overall health care expenditure and burden on the hospital's resources, it further doubles the out-of-pocket expenditures of the patient and their families.[1] It also reduces the availability of CICU bed for the other critical patients being transferred for post-operative care and other cardiac ailments, eventually limiting the number of operations performed. Moreover, it also increases hospital-acquired, or nosocomial infections.[7]

The aim of a health care institute providing cardiothoracic services is to provide quality care, complete revascularisation, myocardial protection, intensive care stay, fast-track extubation, early discharge from CICU to the step-down unit, early mobilisation, discharge and reducing overall costs. The data from loco-regional countries on the determinates of pre- and post-operative determinants for prolonged CICU stay is scarce. The current study was planned to evaluate the factors contributing to prolonged CICU stay in patients with isolated coronary artery bypass grafting (CABG).

Patients and Methods

This retrospective, case-control study was conducted at

[1,2,5-7]Section of Cardiothoracic Surgery, Department of Surgery, Aga Khan University Hospital, [3,4]Interns, Section of Cardiothoracic Surgery, Department of Surgery, Aga Khan University Hospital, Karachi.

Correspondence: Fazal Wahab Khan. Email: fazal.khan@aku.edu

the Aga Khan University Hospital (AKUH), Karachi, and comprised patients having undergone CABG from January 2006 to December 2013. Patients aged ≥40 years who had undergone isolated CABG were included. Patients whose length of stay at CICU was ≥ 72 hours were identified as cases, and the remaining were controls (with <72 hours of CICU stay); however, the number of controls was reduced and were randomly selected at a ratio of 1:2.[8,9] The patients who had valve surgery or those who stayed back in CICU due to administrative issues were excluded.

Data was collected on a structured proforma to capture demographic, clinical and pre- and post-procedural information. A trained research associate filled the proforma from the patient's file that was reviewed by another investigator for validation purposes. The ethical approval was obtained from institutional review committee of the AKUH.

The CICU stay was defined as when a patient was transferred to the step-down from CICU post-operatively and if they did not require any invasive or non-invasive respiratory support, intra-aortic balloon pumping (IABP), administration of inotropes, or renal support. Prolonged CICU stay was defined as when the patient stayed ≥72 hours in the CICU. Early death was defined as mortality occurred during admission period and late death as mortality within 30 days of surgery after discharge. Sepsis was defined as when two or more of the following abnormalities were present: a) temperature >38.3°C or <36°C, b) heart rate >90 beats/min, c) respiratory rate >20 breaths/minute or arterial carbon dioxide tension (PaCO2) <32 mmHg, d) white blood cells (WBC)>12,000 cells/mm^3 or <4000 cells/mm^3. The duration for prior myocardial infarction was taken at one week before surgery. Respiratory compromised patient: those who had some pre-existing respiratory or post-operative need of biphasic positive airway pressure (BIPAP) or dependency of the BIPAP. Renal dysfunction: increase of serum creatinine to ≥4.0 mg/dL or three times of the most recent pre-operative creatinine level, and a urine output of <0.5 ml/kg/hr or a new requirement for dialysis post-operatively.

Statistical analysis was performed using SPSS 20. Normality for all continuous variables was assessed using the Kolmogorov-Smirnov test prior to any statistical comparisons. Data was expressed as mean and standard deviation or median and inter-quartile range (IQR) depending on the distribution of the data. The categorical variables were presented as frequency and percentages. Chi-square or T-test was used for group comparison.

Sample size was calculated using OpenEpi software. A logistic regression of a binary response variable (Y) i.e. prolonged CICU stay, on a binary independent variable (X) was conducted.

Logistic regression was used to determine the determinants of prolonged CICU stay, which was used as the dependent variable. Criteria for entry and removal of variables were based on the likelihood ratio test, with entrance and removal limits set at P<0.10 at univariate level. A correlation matrix was assessed prior to conducting the multivariate regression to check for co-linearity among the independent variables.[6] Multivariate analysis was performed to control potential confounding variables. Crude and adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were presented for the predictive factors related to the CICU stay. Hosmer Lemeshow goodness-of-fit statistics were calculated for model accuracy. P<0.05 was considered significant.

Results

Of the 4,687patients, 3,315(70.73%) were included. Of them, 333(10%) were cases and 2,982(90%) were controls. Of the controls, 666(22.33%) were finally selected to keep the 1:2 ratio with the cases. The mean age of the cases was higher than the controls (62.5±9.7 vs. 60.8±9.6 years) (p=0.007). The number of males was 280(84.1%) among cases and 489(73.4%) among controls compared to 53(15.9%) and 177(26.6%) females, respectively (p=≤0.001). The mean weight was 70.6±12.9kg and 71.6±13.3kg (p=0.248) among cases and controls, mean height was 162.6±8.6cm and 163.8±8.2cm (p=0.028) and mean body mass index (BMI) was 26.7±5.1 kg/m^2 and 26.7±4.6kg/m^2 (p=0.788) (Table-1).

Besides, 207(62.2%) cases and 341(51.2%) controls were diabetics (p=0.001), 264(79.3%) and 496(74.5%) hypertensive (p=0.099), 224(67.3%) and 409(61.4%) had dyslipidaemia (p=0.071), 44(13.2%) and 57(8.6%)had previous revascularisation (p=0.021), and 229(68.8%) and 401(60.2%) myocardial infarction (p=0.008). Moreover, 131(39.3%) cases were smokers compared to 304(45.6%) controls (p=0.059).

Post-operative indices also showed a significant differences between the cases and controls. The mean post-op creatinine was 2.0±1.0 in cases vs. 1.8±0.9 in controls, and dialysis was required in 21(6.3%) vs. 14(2.1%) patients, whereas IABP insertion and infusion of blood product in 121(36.3%) vs. 144(21.6%) and 276(83.6%) vs. 506(76%) patients in both the groups, respectively. Median (IQR) initial ventilator time was 31 (22-50) vs. 20 (18-30) hours (p<0.001) and mean cross-clamp time was 70 ±23.5 and 67±23.7 minutes (p=0.035). Sepsis was

Table-1: Socio-demographic and preoperative clinical characteristics of cases vs. controls, n=999.

Characteristics	Cases n=333	Controls n=666	p value*
Age (years)	62.5 ±9.7	60.8 ± 9.6	0.007
Gender			
- Male n(%)	280 (84.1)	489 (73.4)	<0.001
- Female n(%)	53 (15.9)	177 (26.6)	
Weight (kg)	70.6 ± 12.9	71.6 ± 13.3	0.248
Height (cm)	162.6 ± 8.6	163.8 ± 8.2	0.028
BMI	26.7 ± 5.1	26.7 ± 4.6	0.788
Smokers			
- Ever n(%)	131 (39.3)	304 (45.6)	0.059
- Never n(%)	202 (60.7)	362 (54.4)	
Diabetes n(%)	207 (62.2)	341 (51.2)	0.001
Hypertension n(%)	264 (79.3)	496 (74.5)	0.099
Dyslipidaemia n(%)	224 (67.3)	409 (61.4)	0.071
Chronic lung disease n(%)	19 (5.7)	29 (4.4)	0.346
Family H/O CAD n(%)	130 (39.0)	317 (47.6)	0.010
H/O CV intervention n(%)	44 (13.2)	57 (8.6)	0.021
H/O Myocardial infarction n(%)	229 (68.8)	401 (60.2)	0.008
H/O Angina n(%)	329 (98.8)	659 (98.9)	0.999
Diseased vessel n(%)			
- Single	5 (1.5)	17 (2.6)	0.533
- Double	35 (10.5)	74 (11.1)	
- Triple	293 (88.0)	575 (86.3)	
Congestive Heart failure n(%)	324 (97.3)	636 (95.5)	0.224
NYHA grading			
- ClassI	11 (3.4)	38 (6.0)	<0.001
- ClassII	70 (21.6)	247 (38.8)	
- ClassIII	148 945.7)	239 (37.6)	
- ClassIV	95 (29.3)	112 917.6)	
Ejection fraction	41.3 ± 17.2	43.7 ± 14.7	0.025
Creatinine (mg/dl)	1.5 ± 1.1	1.3 ± 1.0	0.005
Inotropes required n(%)	27 (8.1)	35 (5.3)	0.078

*Independent samples t-test for continuous and Pearson'schi-square or Fisher's exact test for categorical variables where applied; mean and ± standard deviation (SD), p values relate to group differences.
BMI: Body mass index
CAD: Coronary artery disease
CV: Cardiovescular
NYHA: New York Heart Association
H/O: History of.

found in 31(9.3%) cases and 17(2.6%) controls (p=0.001) and the hard outcomes mortality in 50(15%) and 20(3%) (p=≤0.001) (Table-2).

The adjusted full logistic model [OR (95% CI)] showed that increased age [1.02 (1.00, 1.03)], male gender [1.90 (1.32, 2.74)] and being diabetes [1.51 (1.13, 2.02)] were independent pre-op risk factors for prolonged stay in the CICU. Post-operative factors such as IABP insertion [1.45 (1.01, 2.08)], initial ventilation time [1.01 (1.00, 1.01)] and bleeding tamponade [1.90 (1.13, 3.20)] were found to be the independent determinants of extended stay. All other

Table-2: Intra and Postoperative clinical characteristics of cases vs. controls, n=999.

Characteristics	Cases n=333	Controls n=666	p value*
Creatinine (mg/dl)	2.0 ± 1.0	1.8 ± 0.9	<0.001
Dialysis required n(%)	21 (6.3)	14 (2.1)	0.001
Blood product used n(%)	276 (83.6)	506 (76.0)	0.005
IABP insertion n(%)	121 (36.3)	144 (21.6)	<0.001
Initial Ventilation time (hrs) Median (IQR)	31 (22-50)	20 (18-30)	<0.001
Distal Anastomoses with arterial conduits	0.77 ± 0.5	0.86 ± 0.3	0.001
Distal Anastomoses with venous conduits	2.6 ± 0.9	2.4 ± 0.9	0.032
Cross clamped time (min)	70.1 ± 23.5	66.7 ±23.7	0.035
Cardioplegia n(%)	317 (95.2)	650 (97.6)	0.042
Heart failure n(%)	2 (0.6)	3 (0.5)	0.999
Sepsis n(%)	31 (9.3)	17 (2.6)	<0.001
Cardiac (Bleeding) tamponade n(%)	44 (13.2)	38 (5.7)	<0.001
Cardiac arrest n(%)	24 (7.2)	7 (1.1)	<0.001
Heart block n(%)	5 (1.5)	6 (0.9)	0.391
Stroke > 72 hrs n(%)	9 (2.7)	2 (0.3)	0.001
Mortality n(%)	50 (15.0)	20 (3.0)	<0.001

*Independent samples t-test for continuous and Pearson'schi-square or Fisher's exact test for categorical variables where applied; mean ± standard deviation (SD), p-values relate to group differences.
IABP: Intra-aortic balloon pump
IQR: Interquartile range.

Table-3: Crude and adjusted odds ratio that led to prolonged stay at CICU after CABG n=999.

Variables	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age in years	1.02 (1.01, 1.03)	0.007	1.02 (1.00,1.03)	0.051
Male Gender	1.91 (1.36, 2.69)	<0.001	1.90 (1.32,2.74)	0.001
Diabetes	1.57 (1.20, 2.05)	0.001	1.51 (1.13,2.02)	0.005
Dyslipidaemia	1.29 (0.98, 1.70)	0.070	1.17 (0.87,1.58)	0.300
Pre-op Creatinine (mg/dl)	1.18 (1.05, 1.34)	0.008	1.05 (0.9,1.23)	0.527
CHF	1.7 (0.80, 3.62)	0.170	1.47 (0.67,3.21)	0.338
Arrhythmia	2.26 (1.31, 3.88)	0.003	1.63 (0.88,3,00)	0.118
Ejection Fraction	0.99 (0.98, 1.00)	0.019	1.00 (0.99,1.01)	0.583
Previous CV Interventions	1.63 (1.07,2.47)	0.022	1.65 (1.05,2.59)	0.029
Cross Clamped Time	1.01 (1.00, 1.01)	0.035	1.00 (1.00, 1.01)	0.141
IABP insertion	2.07 (1.55, 2.76)	<0.001	1.45 (1.01,2.08)	0.044
Cardioplegia used	2.05 (1.01,4.15)	0.046	1.81 (0.85,3.84)	0.124
Inotropes used	1.59 (0.95,2.68)	0.080	1.21 (0.65,2.23)	0.548
Post-op blood product used	1.53 (1.09, 2.14)	0.013	1.22 (0.85,1.76)	0.279
Initial Ventilation time (hrs)	1.01 (1.01, 1.02)	<0.001	1.01 (1.00,1.01)	0.001
Post-op Bleeding Tamponade	2.52 (1.59, 3.97)	<0.001	1.90 (1.13,3.20)	0.015
Post op Creatinine (mg/dl)	1.26 (1.1, 1.44)	0.001	1.05 (0.88,1.25)	0.620
Septicaemia	3.92 (2.14, 7.19)	<0.001	1.68 (0.71,3.96)	0.238
Operative Mortality	5.71 (3.34,9.76)	<0.001	3.1 (1.52,6.31)	0.002

*Adjusted for all variable in the model
CICU:Cardiac intensive care unit
CABG: Coronary artery bypass grafting
OR: Odds ratio
CI: Confidence interval
CHF: Congestive heart failure
CV: Cardiovescular. IABP: Intra-aortic balloon pump.

variables at a univariate level demonstrated higher OR, particularly sepsis, however differences did not attain the significance level in multivariate model (Table-3).

The Hosmer-Lemeshow goodness-of-fit statistic across groups of risk was not statistically significant (p=0.065), indicating model perfect fit.

Discussion

Very little is known about the risk factors associated with prolonged CICU stay after revascularisation, particularly in low-resource countries. Available studies commonly used risk scores approaches that were based on similar patient data and had considerable difference in terms of designs and initial population.[10,11] Risk stratification for certain morbidity parameter are highly desired on account of their influence on quality of life and health care cost.[12] Mortality is a more frequently reported parameter of these scores; however, predicting morbidity on risk score is not an easy task because it consists of heterogeneous events and variable factors that might have different point estimates in a specific population. Geissler et al. reported that the predictive value for morbidity was significantly lower for all score systems, even those specially designed for morbidity.[10] Furthermore, Borras et al. have shown that a multivariate statistical model improves the accuracy of subjective predictions.[13] Thus risk models based on independent risk factors can be better tools of risk assessment for prolonged CICU stay.

Using the same approach we found that that an increased age is associated with prolonged stay in the CICU. Bashour et al. and Hammermeister et al.[14,15] reported that the length of stay increased by 1.9 times for every ten-year increase in age. The association of advanced age with prolonged CICU stay in our sample may be due to the presence of high pre-operative co-morbidities such as diabetes, hypertension, low ejection fraction, renal dysfunction and the severe vascular disease.[16,17] On the contrary, studies by Elayne et al. demonstrated no age-related association with prolonged stay in the CICU[18] but an association with active lifestyle across the population was emerged. Compared to women, men (>70%) had higher risk profile and thus stayed longer in CICU. However, some studies showed that women have longer CICU stays compare to men[19] that could be due to high risk scores in the population. Pre-operative existence of diabetes is found to be a consistent independent risk factor[8] and resulting in higher risk of extended stays in CICU, (OR=1.51;95% CI=1.13,2.02).

Pre-operative factors including hypertension (79%), angina (98%), chronic lung disease (6%) and history of smoking (39%), were insignificant contributors to prolonged stays.[20] In a few studies, low ejection fraction<30%, myocardial infarction, arrhythmia,[21] organ failure, renal dysfunction and dyslipidemia are reported as risk factors of prolonged ICU stay. Our comparative descriptive results support these findings, however they lost statistical significance in multivariate model due to sparse positive observations.

Similarly, sepsis is a common cause of delayed presentation; and our univariate estimate shows about 4 times greater risk in cases. However, it did not attain statistical significance while adjusting for other confounders. Our findings also suggest that prolonged stay in CICU leads to a higher mortality rate (i.e. 15% vs. 3%) which is worrisome and strategies should be designed to reduce factors for further curtailing the mortality rates. Clinicians can initiate preventive measures through aggressive treatment to reduce risk factors prior to surgery.[22] A small reduction in CICU will result in a large cost saving. Resource planning can be more effective if factors contributing to high resource use are appropriately managed.[22] Prolonged stays result in consumption of CICU beds, resources, cost and hospital staff and overall health care burden.

To our knowledge, it is the first retrospective large-scale study conducted in loco-regional context encompassing demographic, clinical and cardiac-related factors with almost entire information on all cardiac procedures in the patients and no bias in patient selection to explore predictors of length of CICU stay after CABG. It has further enhanced its efficiency by 1:2 cases-to-controls ratio. Only vascular surgeries were included and valvular procedures were excluded to get more precise estimates.[22]

However, the study has some limitations as well. For instance, the data was obtained from a single private teaching tertiary care hospital and therefore cannot be generalised. Although we measured many pre-operative clinical variables, several factors that might have influenced our results were not taken into consideration, such as hepatic function and nutritional condition. Lastly, we did not analyse socioeconomic status, costs or the quality-of-life assessment of the surviving patients. These variables are equally vital, although our primary objective was to identify immediate post-operative predictors of prolonged stay in the CICU after CABG from societal and policy perspectives.

On the basis of our findings we recommend that no more than one high-risk patient per day be scheduled to avoid bed shortage and wastage of other resources. To cope with the increasing burden of revascularisation procedures in elective elderly high-risk patients

scheduling of such patients should be done towards the end of the week so that the weekend time can be used for these patients and weekdays can be spared for the low-risk patients. The pre-operative actions and intra-operative strategies should be tailored to accommodate these high-risk patients. Further prospective studies should be conducted to gain more information on intra-operative and post-operative determinants so that cost-effective and risk-stratified models can be constructed.

Conclusion

Advanced age, male gender, diabetes and post-operative initial ventilation time, bleeding tamponade and IABP insertion were found to be independent risk factors for prolonged CICU stay after CABG. A complex relationship exists among these factors. Identification of these risk factors will highlight patient selection, scheduling, enhance pre-operative patient counselling, risk stratification to implement specific measures that would guide best allocation of available resources in cardiothoracic services.

Acknowledgements

We are grateful to residents, physicians, research assistants and the administration staff of the AKUH's cardiothoracic surgery department who facilitated the study.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Kurki TS, Häkkinen U, Lauharanta J, Rämö J, Leijala M. Evaluation of the relationship between preoperative risk scores, postoperative and total length of stays and hospital costs in coronary bypass surgery. Eur J Cardiothorac Surg 2001 20: 1183-7.
2. Warner CD, Weintraub WS, Craver JM, Jones EL, Gott JP, Guyton RA. Effect of cardiac surgery patient characteristics on patient outcomes from 1981 through 1995. Circulation 1997; 96: 1575-9.
3. Cohn LH, Rosborough D, Fernandez J. Reducing costs and length of stay and improving efficiency and quality of care in cardiac surgery. Ann Thorac Surg 1997; 64: S58-S60.
4. Burchardi H, Moerer O. Twenty-four hour presence of physicians in the ICU. Crit Care 2001; 5: 131.
5. Brown PP, Kugelmass AD, Cohen DJ, Reynolds MR, Culler SD, Dee AD, et al., The frequency and cost of complications associated with coronary artery bypass grafting surgery: results from the United States Medicare program. Ann Thorac Surg 2008; 85: 1980-6.
6. Eltheni R, Giakoumidakis K, Brokalaki H, Galanis P, Nenekidis I, Fildissis G. Predictors of prolonged stay in the intensive care unit following cardiac surgery. ISRN Nurs 2012; 2012: 691561.
7. Atoui R, Ma F, Langlois Y, Morin JF. Risk factors for prolonged stay in the intensive care unit and on the ward after cardiac surgery. J Card Surg 2008; 23: 99-106.
8. Bucerius J, Gummert JF, Walther T, Doll N, Falk V, Schmitt DV, et al. Predictors of prolonged ICU stay after on-pump versus off-pump coronary artery bypass grafting. Intensive Care Med 2004; 30: 88-95.
9. Janssen DP, Noyez L, Wouters C, Brouwer RM. Preoperative prediction of prolonged stay in the intensive care unit for coronary bypass surgery. Eur J Cardiothorac Surg 2004; 25: 203-7.
10. Geissler HJ, Hölzl P, Marohl S, Kuhn-Régnier F, Mehlhorn U, Südkamp M , et al. Risk stratification in heart surgery: comparison of six score systems. Eur J Cardiothorac Surg 2000; 17: 400-6.
11. Pinna-Pintor P, Bobbio M, Colangelo S, Veglia F, Giammaria M, Cuni D, et al. Inaccuracy of four coronary surgery risk-adjusted models to predict mortality in individual patients. Eur J Cardiothorac Surg 2002; 21:199-204.
12. Ferraris VA, Ferraris SP, Singh A. Operative outcome and hospital cost. The J Thorac Cardiovas Surg 1998; 115: 593-603.
13. Pons JM, Borras JM, Espinas JA, Moreno V, Cardona M, Granados A. Subjective versus statistical model assessment of mortality risk in open heart surgical procedures. Ann Thorac Surg 1999; 67: 635-40.
14. Bashour CA, Yared JP, Ryan TA, Rady MY, Mascha E, Leventhal MJ, et al., Long-term survival and functional capacity in cardiac surgery patients after prolonged intensive care. Crit Care Med 2000; 28: 3847-53.
15. Hammermeister KE, Burchfiel C, Johnson R, Grover FL. Identification of patients at greatest risk for developing major complications at cardiac surgery. Circulation 1990; 82(5 Suppl): IV380-9.
16. Hein OV, Birnbaum J, Wernecke K, England M, Konertz W, Spies C. et al., Prolonged intensive care unit stay in cardiac surgery: risk factors and long-term-survival. Ann Thorac Surg 2006; 81: 880-5.
17. Anderson AJPG, Neto FXRB, Costa MA, Dantas LD, Hueb AC, Prata MF. Preditores de mortalidade em pacientes acima de 70 anos na revascularização miocárdica ou troca valvar com circulação extracorpórea. Rev Bras Cir Cardiovasc 2011; 26: 69-75.
18. Oliveira EKd, Turquetto ALR, Tauil PL, Junqueira Jr LF, Porto LGG. Risk factors for prolonged hospital stay after isolated coronary artery bypass grafting. Braz J Cardiovasc Surg 2013; 28: 353-63.
19. Cheng DC. Fast track cardiac surgery pathways: early extubation, process of care, and cost containment. Anesthesiology 1998; 88: 1429-33.
20. Arom KV, Emery RW, Petersen RJ, Schwartz M. Cost-effectiveness and predictors of early extubation. Ann Thorac Surg 1995; 60:127-32.
21. Weintraub WS, Jones EL, Craver J, Guyton R, Cohen C. Determinants of prolonged length of hospital stay after coronary bypass surgery. Circulation 1989; 80: 276-84.
22. Almashrafi A, Alsabti H, Mukaddirov M, Balan B, Aylin P. Factors associated with prolonged length of stay following cardiac surgery in a major referral hospital in Oman: a retrospective observational study. BMJ open. 2016; 6: e010764.