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Original Article

Factors Influencing a Prolonged ICU Stay After Coronary Artery Bypass Graft Surgery: A Cross-sectional Study

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ABSTRACT

Background: A prolonged hospital stay causes bed occupancy rates and increases hospital costs. This study aimed to determine the factors affecting the ICU length of stay after coronary artery bypass graft surgery (CABG).

Methods: In this descriptive cross-sectional study, 346 patients undergoing CABG between March 2015 and September 2016 were selected through convenience sampling. Based on their ICU length of stay, the patients were divided into 2 groups: ICU length of stay ≤ 72 hours (3 d) (Group A) and ICU length of stay > 72 hours (Group B).

Results: Among the 346 patients studied, 93 (27%) patients had an ICU length of stay ≥ 72 hours and 253 (73%) patients had an ICU length of stay < 72 hours. There was no statistically significant difference in the ICU length of stay between the women and men ($P = 0.536$). The subjects with a history of diabetes and hypertension were more likely to stay in the ICU for a longer period. For the patients with an ICU stay > 72 hours, the number of blood products received; the use of inotropes; the duration of cardiopulmonary bypass; the duration of intubation; cardiac, pulmonary, neural, and renal complications; infection, receiving inotropes in the ICU; postoperative bleeding; return to the operating room; receiving blood; and a history of bleeding were among the influential factors during the patients' stay in the ICU.

Conclusions: The results of this study showed that the factors increasing the ICU length of stay after CABG were old age, a reduced left ventricular ejection fraction, a prolonged cardiopulmonary bypass time, receiving inotropes, prolonged intubation, the use of the intra-aortic balloon pump, receiving blood products, and postoperative bleeding. ***(Iranian Heart Journal 2019; 20(4): 85-91)***

KEYWORDS: Coronary artery bypass grafting, Intensive care unit, Hospital stay, Cardiac surgery

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Among cardiovascular diseases, coronary artery disease is the most common cause of death the world over. It is estimated that around 500 000 coronary artery bypass graft (CABG) surgeries are performed annually in the United States. In Iran, 25 000 open-heart surgeries are performed per annum, of which about 50%-60% are CABG. The cost of these surgeries, which reflects the high prevalence of heart diseases, is so significant that the average cost of CABG for each patient has been estimated to exceed US$ 44 000. [1] On the other hand, a prolonged hospital stay after CABG has increased the cost of treatment and has significantly reduced the quality of life of individuals. [2] A prolonged hospital stay limits the number of surgical procedures planned to be performed because beds are not available to patients who are ready for surgery on time. [3] Cardiac intensive care units are specialized units where patients undergoing cardiac surgeries and those with severe diseases stay and receive medical care. [4] Despite recent efforts to shorten the intensive care unit (ICU) length of stay, patients are hospitalized in these units for varying time periods from 1 to several days to be monitored. A prolonged ICU stay is often associated with poor prognoses and increased morbidity and mortality rates. [5] Being aware of this association can be effective in reducing the ICU length of stay. [6] Procedures such as earlier tracheal extubation can help to shorten the ICU length of stay. [7] More than 36% of patients undergoing cardiac surgery stay in the ICU for a long time, which is associated with multiple organ failure and increased mortality rates from 11% to 94%. The causes of a prolonged ICU stay are not clear; nonetheless, such risk factors as old age, reduced ejection fractions, pulmonary diseases, organ failure, and reoperation for examining the intercostal space are deemed relevant. [8,9] The only factor differentiating between open-heart surgery and other surgical procedures is cardiopulmonary bypass (CPB). Indeed, post-CPB patients are likely to occupy the ICU beds for up to 36 hours due to bypass complications and long periods of anesthesia. [10] Predicting a prolonged postoperative ICU stay is an important issue in cardiac surgery. Despite the improvements made in the past decades in preoperative cardiac care, an increase in the number of elderly and high-risk patients has led to an increase in the rate of postoperative morbidity. [11,12] These patients stay in the ICU for a longer period and, as a result, the ICU bed occupancy rates are higher, the use of health resources is increased, and other surgical procedures are canceled or postponed. Predicting the ICU length of stay can help surgeons decide when to operate on a patient that requires a prolonged ICU stay. [13-15] The length of patients' ICU stay after CABG is influenced by factors such as age, sex, and influential perioperative factors. The present study attempted to identify the factors related to a prolonged ICU stay after CABG.

METHODS

In this cross-sectional study, 346 patients undergoing CABG between March 2016 and September 2017 in Rajaei Cardiovascular, Medical, and Research Centre in Tehran, Iran, were selected through convenience sampling. The inclusion criteria were comprised of age > 18 years and undergoing CABG, valve surgery, coronary/valve surgery, and aortic surgery. The patients who died after surgery were excluded from the studied population. A questionnaire was filled in by using the information obtained from the patients' medical records. This questionnaire consisted of 4 parts: demographic characteristics, various risk factors (before, during, and after surgery), the ICU length of stay (h), and in-hospital mortality. The data were analyzed by SPSS, version 21. The mean ± the standard deviation was used for the descriptive variables that were expressed numerically and had normal distributions and

the median (interquartile range [3rd quartile–1st quartile or 75th percentile–25th percentile]) was used as average for the variables without normal distributions. For the descriptive ordinal and nominal variables, numbers (%) were used to express their quantity. The one-sample Kolmogorov–Smirnov test was employed to determine whether the distribution of the variables was normal. For the numerical variables, the independent *t*-test was utilized for the variables with normal distributions and the Mann–Whitney test for those without normal distributions. The Mann–Whitney test was also applied for the inter-group comparison of the ordinal variables. The Pearson χ^2 test or the Fisher Exact test was drawn upon for the inter-group comparison of the numerical variables and binary logistic regression was used for the multivariate analysis. A *P* value ≤ 0.05 was considered statistically significant. Ethical considerations were observed during the whole research.

RESULTS

In this study, 346 patients undergoing CABG were equally divided into 2 groups: Group A (ICU length of stay ≤ 72 h) and Group B (ICU length of stay > 72 h) in order to determine the factors causing an ICU length of stay > 72 hours after CABG.

Out of the 346 patients undergoing CABG, 249 (72%) patients were male and 97 (28%) were female. The average age, height, and weight of the patients were 62.5 ± 10.3 years, 165 ± 12 cm, and 81 ± 10.2 kg, respectively; and the average body mass index was 26.4 kg/m^2.

Additionally, 253 (73%) patients had an ICU length of stay ≤ 72 hours and 93 (27%) had an ICU length of stay > 72 hours. The average ICU length of stay was 61.6 ± 5.9 hours in Group A (≤ 72 h) and 101.6 ± 8.5 hours in Group B (> 72 h). Table 1 depicts the demographic data of the patients based on the ICU length of stay. As is shown in Table 1, factors such as age, left ventricular ejection fraction, and a high-grade New York Heart Association (NYHA) functional class (III/IV) were significantly related to a prolonged ICU stay.

Table 1. Demographic characteristics of the patients

Variable	Group A (n=253) ICU Stay ≤72h	Group B (n=93) ICU Stay >72h	*P* Value
Gender (M/F)	158/95	49/23	0.09
Age (y)	56.5 ± 11.3	61.7±7.5	0.001
BMI	23.9	24.5	0.09
LVEF (%)	42±3	37±4	0.03
DM	13	28	0.16
High-grade NYHA FC (III/IV),%	48	67	0.01

ICU, Intensive care unit; BMI, Body mass index; LVEF, Left ventricular ejection fraction; DM, Diabetes mellitus; NYHA FC, New York Heart Association functional class

Table 2. Intraoperative factors increasing the ICU length of stay

Variable	Group A (n=253) ICU Stay ≤72h	Group B (n=93) ICU Stay >72h	*P* value
Elective	224	73	
Emergency	29	20	0.13
Inotrope use in OR	241	67	0.01
Anesthesia time, min	280	329	0.04
Duration of aortic cross-clamp, min	53	67	0.03
CPB time, min	101	129.5	0.00
CPR	3	16	
Packed RBC transfusion, %	14.1	19.3	0.01

ICU, Intensive care unit; OR, Operating room CPB, Cardiopulmonary bypass;

CPR, Cardiopulmonary resuscitation

Table 3. Postoperative factors increasing the ICU length of stay

Variable	Group A (n=253) ICU Stay ≤72h	Group B (n=93) ICU Stay >72h	*P* value
Extubation time at ICU, h	9±1.5	17±3.5	0.03
High-dose inotropes, %	5.7	13.2	0.00
Re-operation duo to bleeding,%	1	9	0.00
Infection, %	10	17	0.01
CNS complications, %	1	3	0.15
ARF, %	1	2	0.05
Re-intubation	2	18	0.04

ICU, Intensive care unit; CNS, Central nervous system; ARF, Acute renal failure

Table 4. Logistic regression of the factors affecting the ICU length of stay

Variable	β	*P* value	OR (95% CI)
Intubation time	0.53	0.00	1.61[0.99-3.11]
Packed cells in ICU	0.21	0.01	1.15[1.01-2.16]
Inotrope infusion time in ICU	0.38	0.03	14.34[1.96-26.13]
Preoperative low ejection fraction	0.11	0.01	1.23[0.99-2.21]

All data are shown with median (interquartile range).
ICU, Intensive care unit; OR, Odds ratio; CI, Confidence interval

DISCUSSION

The findings of this study included the results of a survey on demographic features and perioperative factors causing a prolonged ICU stay after CABG obtained from 346 participants. From this total, 93 patients had an ICU length of stay > 72 hours (Group A) and 253 patients an ICU length of stay ≤ 72 hours (Group B). We found that the factors increasing the ICU length of stay after CABG include old age, a decreased left ventricular ejection fraction, a high-grade NYHA functional class (III/IV), the use of the intra-aortic balloon pump (IABP), a prolonged CPB time, receiving inotropic drugs, prolonged intubation, receiving blood products, and postoperative bleeding.

In the elderly, cardiac reserve decreases and comorbidities increase. This diminished health capacity and physical power can affect postoperative recovery and the ICU length of stay. Due to muscle weakness and reduced mass and tone in skeletal muscles, elderly patients remain on mechanical ventilation for longer periods. [11,16,17] In a study by Siberman et al, [18] elderly patients were hospitalized in the ICU for more than 14 days after cardiac surgery. Prolonged extracorporeal circulation can lead to respiratory failure for many reasons, which in turn can prolong the ICU stay. In the current study, we found a significant relationship between the ICU length of stay and the use and duration of CPB.

Azarfarin et a1 [l1] reported that 34.3% of their patients were hospitalized in the ICU for longer than 96 hours after open-heart surgery and concluded that the factors causing the increase in the ICU length of stay were receiving blood products, a prolonged intubation time, and the use of inotropes in the ICU. In a study by Cserep et al, [19] 14.5% of the patients stayed more than 3 days in the ICU and 23.2% stayed over 10 days in the hospital after cardiac surgery. According to their report, factors such as a history of chronic obstructive pulmonary disease, the operative duration, the NYHA functional class III/IV, neurological problems, arrhythmias, female sex, and infection were the factors increasing the hospital and ICU length of stay. In the studies of Mirinazhad et al, [20] Suzanny Flegler et al, [21] Tunc et al, [13] and Almashrafi et al, [4] factors such as arrhythmias,

the operative duration, age, sex, pulmonary disease, renal disease, the postoperative use of the IABP, receiving blood products, the number of grafts, the type of surgery, a history of cardiac surgery, receiving inotropes, and aortic clamps were mentioned as the most influential factors in increasing the ICU length of stay, which is consistent with the results of the present study.

Transfusion of blood and other blood products can be associated with high mortality and morbidity rates. Blood transfusion can play a role in the development of pulmonary diseases as it activates cytokines and the complement system. Additionally, blood transfusion can increase the risk of infection and mortality after cardiac surgery. All of these factors will cause a prolonged ICU stay. [20] In this study, transfusion of blood products and high numbers of transfused products were significantly associated with a prolonged ICU stay.

The most common hemodynamic disorder after the use of CPB is the reduction of peripheral resistance. When peripheral resistance is low, it is difficult to discontinue the cardiopulmonary pump. With the administration of vasoconstrictors before cutting off the pump, the systemic vascular resistance can be normalized. Sometimes inotropes such as dopamine, epinephrine, norepinephrine, and dobutamine are required. In more severe cases, a combination of epinephrine or norepinephrine and amrinone with or without the IABP is necessary to maintain the cardiac output. [21] Michalopoulos et al [24] found that receiving inotropes in the operating room and in the ICU during the first 6 hours after the operation was the most important factor in determining the ICU length of stay. The results of the study by Hein et al [23] showed that the amount of fresh frozen plasma received in the operating room and prolonged intubation were 2 important risk factors for a prolonged ICU stay.

Limitations

Due to the retrospective nature of the present investigation, some of the records of the study population were incomplete.

CONCLUSIONS

The results of this study showed that the factors that increase the ICU length of stay after CABG can be divided into 3 groups of preoperative, intraoperative, and postoperative. Old age, a high-grade NYHA functional class (III/IV), and a decreased left ventricular ejection fraction were among the preoperative factors; a prolonged CPB time and receiving inotropic drugs were among the intraoperative factors; and prolonged intubation, the use of the IABP, postoperative bleeding, and receiving blood products were among the postoperative factors. Recognizing the abovementioned factors by physicians and nurses of the ICU and playing an active role in the management of postoperative complications can be effective in reducing the hospital and ICU length of stay.

Conflict of Interest

The authors declare no conflict of interest.

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