

# Prevalence and Risk Factors for Prolonged ICU Stay After Adult Cardiac Surgery

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## Abstract

**Background:** The anticipation of the length of ICU stay would enable physicians to provide reliable information for better treatment methods. There are several risk factors for prolonged ICU stays after cardiac surgery in the related studies.

**Objectives:** The aim of this study was to assess the possible factors contributing to the prolonged ICU stay in a referral heart center.

**Methods:** In this retrospective case-control study, 515 adult patients admitted to ICU after cardiac surgery in Madani heart center in Tabriz (since March to September 2014) were divided into 2 short and prolonged ICU stay groups. ICU stays more than 3 days were considered prolonged. Various risk factors were compared between the two groups.

**Results:** A total number of 64.9% of the patients were in the prolonged ICU stay group and 35.1% had a short stay. Among 35 potential risk factors, some were significant factors affecting the length of ICU stay (age, type of surgery, previous cardiac surgery, a high dose of inotropes support, duration of surgery, length of CPB and aortic clamp time, arrhythmia in ICU, and re-operation).

**Conclusions:** We can reduce ICU stay using the correction of high levels of serum creatinine before surgery, improvement of functional class with drug treatment, shortening of CPB and aortic cross clamp times, adequate hemostasis with surgeon and more correction of the coagulation status of the patient by the anesthesiologist at the end of the surgery.

**Keywords:** Cardiac Surgery, Length of ICU Stay, Risk Factors

## 1. Background

Prolonged ICU stay is associated with a complicated clinical course and a significantly higher incidence of respiratory and renal insufficiency (1). With the advancement of science and the improvement of the quality of medical care, the mortality rate of patients after cardiac surgery has declined (2). On the other hand, the spectrum of the patients undergoing heart surgery goes to the older population, with more advanced diseases and more severe comorbidities (3). Therefore, the risk of the complications after heart surgery has increased, leading to a further increase in the number of patients with prolonged ICU stay (2). Prolonged ICU stays decrease the chance of survival and reduce the quality of life (4), resulting in increased costs and reduced hospital beds available in the ICU (5-7).

The accurate prediction of the length of ICU stay enables the physicians to offer reliable information for providing better care for patients and allocating funds to the health care systems, and, also, enables health care providers to change their routines (8, 9). Therefore, several

models have been proposed to predict the risk of ICU stay (5, 9, 10).

In these studies, the reason for a long stay in the ICU is unknown in most cases, but there are some risk factors that can prolong the patients' stay in the ICU. In various studies, the risk factors of a prolonged stay in the ICU after cardiac surgery were studied. However, due to the differences among the populations and the countries, and the definition of prolonged ICU stay in different centers, the predictive models of a hospital may not be applicable in another hospital (7, 11, 12). In the present research, we conducted a retrospective study on the medical records of patients undergoing cardiac surgery, to obtain the possible factors contributing to the long stay in the ICU in our medical center.

## 2. Objectives

We aimed to assess the risk factors for a prolonged ICU stay after cardiac surgery with the hope of taking effective

steps to reduce the duration of stay in the ICU after cardiac surgery through taking the risk factors seriously.

### 3. Methods

After the approval of the research vice-chancellor of Tabriz University of Medical Sciences, in a retrospective observational case-control research, we studied the medical records of adult patients ( $\geq 18$  years old) who underwent cardiac surgery and stayed in the ICU in Madani heart center in Tabriz, Iran, since March to September 2014 (for 6 months). We excluded patients who stayed in the ICU less than one day ( $< 24$  hours) or had incomplete records. The total number of the patients undergoing cardiac surgery in Madani hospital was 678 patients. We excluded the patients who were hospitalized less than 24 hours in the ICU (136 patients) or had incomplete medical records (27 patients). Finally, 515 patients were studied. Clinical and demographic information were extracted from physical history, anesthesia record, and ICU record of the patients. The prolonged ICU stay would refer to more than 3 days. We divided the patients into two groups: long ICU stay ( $> 3$  days, as a case group) and short ICU stay ( $\leq 3$  days, as a control group). All the mentioned factors before, during, and after the surgery were included in the questionnaire as risk factors for long ICU stay.

The following factors were evaluated as possible risk factors:

1) Before surgery:

Age, sex, body mass index (BMI), functional class, ejection fraction (EF), serum creatinine, need to inotropes, condition of surgery (elective or emergency), type of surgery (coronary, valvular, both, others), diabetes mellitus, cigarette smoking, narcotic addiction, previous cardiac surgery, unstable hemodynamic situation, chronic obstructive lung disease, need to intra aortic balloon pump (IABP), left ventricular hypertrophy (LVH).

2) During surgery:

Duration of surgery, cardiopulmonary bypass (CPB) and cross clamp of aorta, use of blood products, need to inotropes after CPB, need to pacemaker after CPB, arrhythmia after CPB.

3) After surgery (in ICU): time of weaning from ventilator, need to a high dose of inotropes, arrhythmia, infection, acute renal failure (ARF), complication in central nervous system, reoperation due to bleeding or other complications and cardiac arrest.

The equipment used for the measurement of the variables was calibrated with routine standard program. After data collection, we analyzed the data with SPSS software 16 (SPSS Inc. IBM). We used the t-test for parametric data and chi-square or fisher exact test for non-parametric data. We

interpreted the data with repeated measures using ANOVA test. To consider the ethics in our hospital, we obtained a written consent from the patients to use their medical information in the case of medical sciences.

### 4. Results

In this study, out of 515 patients, 181 patients (35.1%) were in short ICU stay (group 1) and 334 patients (64.9%) were in long ICU stay (group 2) group. The mean age of the patients in group 1 and 2 were  $51.6 \pm 13.8$  and  $62.6 \pm 15.2$  years, respectively, demonstrating a significant difference between the groups ( $P = 0.01$ ). There were no significant differences between the two groups concerning BMI and gender. Table 1 presents the demographic data of the patients.

Table 1. Demographic Data of Patients

Variables	Group 1 (Short ICU Stay)	Group 2 (Long ICU Stay)	P Value
Age	$51.6 \pm 13.8$	$62.6 \pm 15.2$	0.01
BMI	$27.2 \pm 2$	$28.1 \pm 2$	0.08
Gender (m/f)	109/72	199/135	0.3

Combined surgery (CABG + Valvular), history of previous cardiac surgery, high serum Creatinine, and high grade NYHA classification were significantly high in the long ICU stay group. There was no significant difference between the two groups concerning other pre-surgery factors (Table 2). During the surgery, the need to a high dose of inotropes, the duration of CPB, and cross clamp of Aorta were high in the long ICU stay group, but there was no significant difference between the two groups (Table 3). After the surgery, in ICU, long mechanical ventilation time, the need to a high dose of inotropes, arrhythmia, and reoperation due to bleeding were high in the long ICU stay group (Table 4).

### 5. Discussion

Several studies were conducted on the factors affecting the ICU stay period after cardiac surgery and many factors were proposed as risk factors. Various conditions in different hospitals and populations make it difficult to interpret these risk factors; therefore, studies have different views. Owing to the advances in science and the increase of survival rate to take high-risk patients to the operating room, the prolonged stay in ICU has increased (1). In any case, understanding the risk factors of a long ICU stay can help

**Table 2.** Risk Factors Before Surgery

Variables	Group 1 (Short ICU Stay)	Group 2 (Long ICU Stay)	P Value
Combined surgery (CABG + Valvular)	0	16	0.001
Previous cardiac surgery (n/total)	1/181	12/334	0.036
Ejection fraction, %	45 ± 5	42 ± 5	0.08
Type of surgery (Elective/emergency)	95/5	93/7	0.14
Need to inotropes, %	1	0.9	0.65
Unstable hemodynamic, %	1.1	1.8	0.45
COPD (%)	2.8	3.6	0.35
High serum Cr, % <sup>a</sup>	5	9.9	0.05
LVH, %	11.6	15	0.018
IABP, %	2.2	4.2	0.14
Smoker, %	35.4	38.6	0.46
Diabetes mellitus, %	21.5	26.3	0.23
Opiate addiction, %	12.7	8.7	0.07
High grade NYHA classification (III, IV), %	55.8	65	0.05

Abbreviations: COPD, chronic obstructive pulmonary disease; IABP, Intra aortic balloon pump; LVH, Left ventricular hypertrophy; NYHA functional classification, New York heart association functional classification.

<sup>a</sup>Serum Cr > 1.5 mg/dL.

**Table 3.** Risk Factors During Surgery

Variables	Group 1 (Short ICU Stay)	Group 2 (Long ICU Stay)	P Value
Need to high dose inotropes, %	10.4	18.2	0.02
CPB time, min	91 ± 11	118 ± 14	0.008
Duration of aortic cross clamp, min	82 ± 12	103 ± 15	0.02
Arrhythmia, %	12.2	15.9	0.25
Packed RBC transfusion, %	17.1	19.8	0.4

medical teams to adjust these factors to reduce the length of ICU stay in some patients (13).

In this study, we divided the adult patients undergoing cardiac surgery into two groups with long and short

**Table 4.** Risk Factors After Surgery (ICU)

Variables	Group 1 (Short ICU Stay)	Group 2 (Long ICU Stay)	P Value
Extubation time at ICU, h <sup>a</sup>	8 ± 1.5	15 ± 3	0.001
High dose inotropes, % <sup>b</sup>	5.5	12.2	0.01
Arrhythmia, %	8.2	14.6	0.036
Re-operation duo to bleeding, %	0.01	6.6	< 0.0001
Infection, %	12.2	16	0.2
ARF, %	2.2	3.6	0.38
CNS complications, %	0	0.6	0.29

Abbreviations: ARF, acute renal failure; CNS, central nervous system.

<sup>a</sup>Duration of mechanical ventilation at ICU after surgery.

<sup>b</sup>Inotropes dose > 10 µg/kg/min.

ICU stays and we compared the two groups for many risk factors. For the ease of interpretation and application in the management of patients, we divided these factors into three categories: before, during, and after surgery. In the present study, 64.9% of the patients had a long ICU stay, showing a higher prevalence than other studies (4, 6).

In the preoperative risk factors, older age, coronary bypass grafting plus valvular surgery, high degree NYHA classification, high serum creatinine, and left ventricular hypertrophy were higher in the long ICU stay group. Results on the older age, coronary plus valvular surgery, and high degree NYHA classification were consistent with other studies, while high serum creatinine and left ventricular hypertrophy were not examined as risk factors in other studies (6, 8-10). In addition, Arabi et al. did not see older age as a risk factor (4). In the present study, no differences were observed between males and females that were consistent with the study results of Lagercrantz et al. (4). While, in the study by De Cocker et al. ICU stay was longer in women (9). In this study there was no significant difference between the two groups in BMI, left ventricular ejection fraction, diabetes mellitus, and the need to inotropes before surgery. These results were not consistent with some studies (4, 8, 11).

In the case of intraoperative factors, the need to a high dose of inotropes, longer CPB, and aortic cross clamp time were significantly high in the long ICU stay group. The result is consistent with the study of Azarfarin et al. (7). However, the prevalence of arrhythmias during surgery was not different in the two groups, being inconsistent with the study results of Rosenfeld et al. (14). In addition, there was no significant difference between the two groups in terms

of the transfusion of packed cell blood, not being examined in previous studies.

In the case of postoperative factors (in ICU), later extubation, the need to a high dose of inotropes in ICU, and re-operation due to bleeding were significantly high in the long stay group, which was consistent with some studies (4, 6). However, there was no difference regarding arrhythmias, infection, acute renal failure, and the complications of central nervous system, being different with the results of some previous studies (4, 6, 10).

This study demonstrated that many risk factors are more common in patients with a longer ICU stay. Among these factors, some can be reduced with good care and patient control.

Thus, we suggest that the team of cardiac surgery might be able to reduce the ICU stay through the following corrective actions for the patients undergoing cardiac surgery:

1) Correction of high levels of serum creatinine before surgery.

2) Improvement of NYHA classification degree with drug treatment.

3) Shortening of CPB and aortic cross clamp times as much as possible.

4) Higher accuracy by cardiac surgeon in adequate hemostasis and more correction of the coagulation status of the patient by the anesthesiologist at the end of the surgery to reduce post-surgery bleeding and the need to re-operation.

### 5.1. Limitations

There are several limitations in this study. We obtained the data from the patients' medical records, thus the collected data may be inaccurate. We could not be able to collect some important data on patients (myocardial infarction, re-intubation in ICU, intra-operative phrenic nerve injury, and delirium). Therefore, a prospective controlled study is needed to assess the other factors of prolonged ICU stay after heart surgery. Some nonmedical factors can influence ICU stay, such as the late transfer of the patient from ICU to the surgical ward in holidays or the lack of empty beds in the post-surgery wards.

### Footnote

**Authors' Contribution:** Mousa Mirinazhad, Dalir Parsa, Gholamreza Faridaalae, Eissa Bilehjani, and Bahman Naghipour participated in producing the study idea, conducting the research protocol, and collecting its data. Mohammad Iradjian contributed in the data analysis and thesis

writing and the manuscript. Bahman Naghipour and Gholamreza Faridaalae wrote the manuscript and submitted it.

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