

Original Paper

# Risk of Falling After Coronary Artery Bypass Grafting Surgery And its Related Factors



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## ABSTRACT

**Introduction:** A fall is a sudden descent on the ground or other lower levels. It is a serious safety threat for hospitalized patients. Coronary Artery Bypass Graft (CABG) surgery as an open heart surgery has complications such as cardiac arrhythmias and delirium that can increase the risk of fall.

**Objective:** This study aims to determine the risk of falls in patients after CABG surgery and investigate its associated factors.

**Materials and Methods:** This cross-sectional study was conducted on 302 patients undergoing CABG surgery in a specialized hospital in Rasht City, Iran, from November 2019 to July 2020. They were selected by a sequential sampling method. The data collection instrument included demographic information, disease-related factors, surgery-related factors (before, during, after), and the Morse Fall Scale (MFS) checklist. The study data were collected after the patient's surgery and transfer from the intensive care unit to the surgical ward. Descriptive statistics, as well as the Kolmogorov Smirnov, Wilcoxon, Mann-Whitney U, Kruskal-Wallis, and Spearman correlation, were used to analyze the collected data. A rank regression model was used to determine the factors related to the risk of falls in patients.

**Results:** The Mean±SD age of participants was 59.35±8.37 years. About 70.53% of the patients were male, and 46.03% were overweight (Body Mass Index ranged 25-29.9 kg/m<sup>2</sup>). The majority of patients at the time of admission to the surgical ward and before surgery (92.72%) had no risk of falls. After surgery and transfer to the surgical ward, 82.12% had a low risk of falls. The mean risk of falling was higher in patients over 60 years (P<0.05). With decreasing hemoglobin values on the morning of surgery, the risk of postoperative fall increased (P=0.046, r=-0.115). The sodium level on the morning of surgery had a significant negative correlation (P=0.040, r=-0.118) with the risk of falling, but urea level on the morning of surgery had a significant positive correlation (P=0.001, r=0.212) with the risk of falling. Using regression model, the results showed that with increasing age (B=0.23, 95%CI; 0.07-0.39, P=0.003), history of high blood pressure (B= 3.5, 95%CI; -0.69-0.39, P=0.003), decrease in hemoglobin (B=-5.47, 95%CI; -10.2- -0.6, P=0.02), an increase in creatinine (B=17.73, 95%CI; 8.17-27.29, P=0.001) and urea (B=6.09, 95%CI; 2.57-9.61, P=0.001) before the surgery, the risk of fall after CABG surgery increases.

**Conclusion:** Several factors can increase the risk of falls after CABG surgery. Considering that the risk of falls in patients undergoing CABG surgery in most medical centers is examined only at the beginning of admission, it is recommended to consider the possibility of postoperative falls based on the predicting variables.

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## Highlights

- Maintaining patient safety is one of the most important aspects of nursing care.
- Hospitalized patients are at low to high risk of falls due to their physical and mental conditions.
- Complications of Coronary Artery Bypass Graft (CABG) surgery may increase patients' risk of falling after surgery.
- Paying attention to the factors associated with patients falling after CABG surgery may help increase their safety.

## Plain Language Summary

One of the most important aspects of nursing care for hospitalized patients is maintaining the safety of patients. Changes in the physical, mental, and environmental conditions of patients following hospitalization may lead to falls and reduced patient safety. Patients admitted for open-heart surgery due to heart problems and the possibility of tissue circulatory disorders are at risk of falls. Coronary Artery Bypass Graft (CABG) surgery may increase the risk of falls due to the complications that it causes. This study was conducted to determine the risk of falls in patients after CABG surgery, as open-heart surgery, and to determine its associated factors. This study showed that patients were at higher risk of fall after surgery, and factors such as age, low hemoglobin, and sodium in the morning of surgery, and high blood creatinine were associated with increased risk of fall after CABG.

## Introduction

**C**oronary artery disease is one of the most common diseases that has endangered the lives of many patients [1, 2]. Patients with this disease need medical treatment for the rest of their lives. If medical treatments fail, it is necessary to use Coronary Artery Bypass Graft (CABG) surgery to save patients' lives and reduce the signs and symptoms of the disease [3]. Nearly 686000 CABG operations are performed annually in the United States and more than 40000 in Iran [4]. The majority of patients undergoing CABG are middle-aged or old [5]. The CABG surgery can cause short-term complications that increase the risk of falls during hospitalization [6, 7]. The most common complications after CABG are cognitive impairment and delirium. A study showed that 24.5% of patients undergoing CABG develop temporary delirium [8]. Moreover, the occurrence of cardiac arrhythmias after CABG may increase the risk of falling by impairing cerebral circulation [9-11].

One of the most important nursing care after CABG is to get patients out of bed after cardiac intensive care [12]. However, this early walking may be associated with an increased risk of falling in patients [13]. Although many medical centers assess the risk of falls in patients at the beginning of hospitalization, variables that may increase the risk of falls after CABG operation have not been considered [14]. Complications such as

sudden cardiac arrhythmias, temporary cognitive impairments, and sudden loss of blood supply to the brain may increase the risk of falling in patients after getting out of bed [15-19]. Therefore, this study was performed to determine the frequency of falls and related factors after CABG in Rasht in north of Iran.

## Materials and Methods

This research is an analytical study with a cross-sectional design. The study population consisted of patients who had undergone CABG at one of the specialized hospitals in Rasht City, Iran. The results of a similar study stated that the risk of falling due to atrial fibrillation was 0.6 times higher than those without this disorder [15]. Considering this probability, a test power of 80%, and a significance level of 95%, the sample size was determined 132. Since 34 individual and disease-related variables are examined in the present study, 5 samples were considered for each variable and, thus, the final sample size was set at 302. A sequential method was used for sampling. The inclusion criteria were as follows: no musculoskeletal disorders that prevent the patient from getting out of bed, no history of heart surgery (due to increased risk of complications from surgery), no epilepsy or use of antiepileptic drugs, and no blindness. Considering that a part of the questionnaire was completed before surgery and the rest after surgery, complications such as bleeding or arrhythmia that caused the

patient to return to the Intensive Care Unit (ICU) were criteria for exclusion from the study.

The data collection tool was a questionnaire with two sections. The first section has several parts and collects patients' demographics, disease, and operation-related information. The first part collected demographic information, including age, sex, height, and weight of the patient. The next part collected disease-related information, including a history of underlying diseases such as hypertension, diabetes, myocardial infarction, kidney disease, cerebrovascular disorders, history of chronic respiratory diseases, history of surgery, left main coronary artery stenosis, presence of valvular disorders, and the Left Ventricular (LV) ejection fraction. The other part collected surgery-related information in three periods: preoperative, intraoperative, and postoperative.

The preoperative factors include checking hemoglobin, hematocrit, platelets, and electrolytes such as potassium, sodium and urea nitrogen, creatinine, and blood sugar in the morning of surgery immediately before surgery. The intraoperative factors include checking emergency or elective surgery, receiving inotropic drugs, receiving intraoperative shock, intraoperative antiarrhythmic drugs, arterial blood oxygen saturation at the end of cardiopulmonary bypass pump and also at the entrance to the operating room, aortic cross-clamp duration, cardiopulmonary bypass time per minute, the number of transplanted vessels, mean temperature on pump, mean hemoglobin, hematocrit, serum potassium, sodium and glucose levels during pump, urinary output on pump, cell pack intake during surgery and Mean Arterial Pressure (MAP) during pump and LV ejection fraction during surgery.

The postoperative factors consisted of the duration of endotracheal tube retention in minutes, mean temperature from entry into Intensive Care Unit (ICU) to the removal of the endotracheal tube, mean systolic and diastolic pressure at admission into ICU until removal of the endotracheal tube, type of anesthesia in the ICU, the occurrence of cardiac arrhythmia while attending the ICU, use of pacemaker generator during hospitalization, use of the inotropic drug in the first 24 hours after entering the ICU, receiving cell packs and other blood products in the ICU, levels of hemoglobin, platelets, calcium, magnesium, potassium, sodium, urea nitrogen, creatinine and blood sugar at the time of entering the ICU, the incidence of respiratory complication of atelectasis, pneumothorax, and hemothorax in the ICU, and anatomical disorders not related to movement. These study variables were determined based on simi-

lar studies [8, 16] and were reviewed and approved by a cardiac surgeon and six nurses of patients with heart disease or undergoing heart surgery to determine their validity. There was no need to evaluate the reliability of this questionnaire.

The second section was the Morse Fall Scale (MFS). This scale has 6 items assessing history of falling: immediate or within 3 months, secondary diagnosis, ambulatory aid: bed rest/nurse assist crutches/cane/walker, IV/heparin lock, gait/transferring: normal/bedrest/immobile, weak, impaired, and mental status: oriented to own ability, forgets limitations. The total score ranges from 0 to 125. Scores of 0-24 indicate low risk, 25-50 a moderate risk, and scores > 51 show a high risk of falling [20]. The MFS is widely used in medical centers to assess the possibility of patients' falling at the beginning of hospitalization and has acceptable validity and reliability.

After receiving ethical approval from Guilan University of Medical Sciences, the researcher attended cardiac surgery departments and completed the questionnaires. Data collection in this study was done before, during, and after surgery. Variables related to demographic information, disease, and fall were completed before surgery, and variables related to surgery, including intraoperative and postoperative variables and the MFS, were completed after surgery and discharging from the ICU and transferring to the cardiac surgery ward. A research team member collected all information, and the data collection lasted from November 2019 to July 2020. During the sampling period, 327 patients underwent CABG in the study ward, and 302 patients with inclusion criteria were included in the research.

The obtained data were analyzed in SPSS v.16 software using descriptive statistics and statistical tests, including the Kolmogorov Smirnov, Wilcoxon, Mann-Whitney U, Kruskal-Wallis, and Spearman correlation. Rank regression was used to determine the factors related to the probability of fall after surgery. P values less than 0.05 were considered the significance level of the tests.

## Results

The Mean±SD age of the participants was 59.35±8.37 years, 70.53% were male, and 46.03% were overweight (BMI range: 25-29.9 kg/m<sup>2</sup>). The majority of them had hypertension (82.45%), hyperlipidemia (76.49%), and diabetes (42.72%). Only 24.27% had the left main coronary artery stenosis. In total, only about 4% had a history of cerebrovascular disorders. Regarding preoperative factors, the Mean±SD hemoglobin value in the morning (just

before transferring to the operating room) was  $11.82 \pm 1.14$  mg/dL. The Mean  $\pm$  SD blood sugar at this time was  $129.94 \pm 55.83$  mg/dl. Descriptive statistics related to postoperative factors are presented in Table 1. The Mean  $\pm$  SD risk of falling after transfer from the ICU was  $39.97 \pm 12.38$ , while it was  $15.5 \pm 7.07$  at the beginning of hospitalization and before surgery. According to the results, 13.91% of patients had a high risk of falling after surgery.

The Wilcoxon test results showed that the difference in the MFS scores at hospitalization and after surgery was significant ( $P=0.001$ ). Moreover, the Kruskal-Wallis and Mann-Whitney U test results showed that the difference in the mean MFS scores after transferring from the ICU and at the time of being allowed to move and leave the bed was significantly associated with age ( $P=0.001$ ), high blood pressure ( $P=0.003$ ), and intake of an intraoperative antiarrhythmic drug ( $P=0.004$ ).

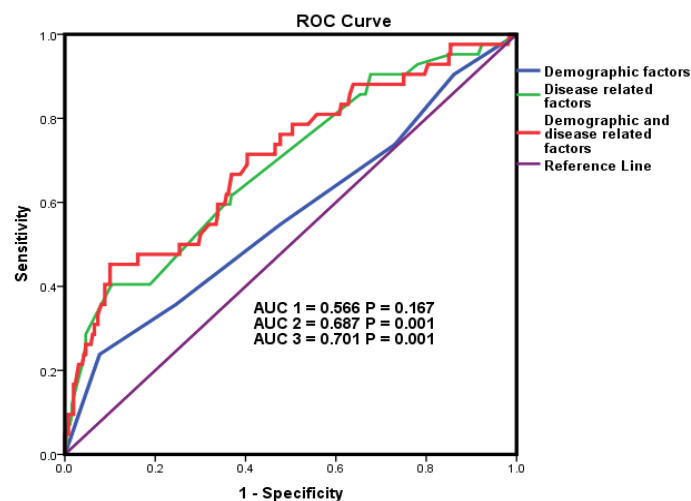
The Spearman test showed that the risk of falls after CABG and transfer from ICU to cardiac surgery ward had a significant relationship with age ( $P=0.001$ ,  $r=0.291$ ), hemoglobin level ( $P=0.04$ ,  $r=-0.115$ ), sodium level ( $P=0.04$ ,  $r=-0.118$ ), urea level ( $P=0.001$ ,  $r=0.212$ ), and calcium level ( $P=0.03$ ,  $r=-0.122$ ) all in the morning of surgery as well as the duration of cardiopulmonary pump use ( $P=0.01$ ,  $r=-0.138$ ), receiving cell pack intake during surgery ( $P=0.002$ ,  $r=-0.177$ ), sodium level at the time of entering the ICU ( $P=0.02$ ,  $r=-0.129$ ), and serum urea level at the time of entering the ICU ( $P=0.01$ ,  $r=0.139$ ) (Table 2).

The results of rank regression showed that the variables of age ( $P=0.003$ ), history of high blood pressure

( $P=0.046$ ), preoperative urea level ( $P=0.01$ ), preoperative creatinine increase ( $P=0.001$ ), hemoglobin level lower than the normal range, and increased preoperative sodium ( $P=0.009$ ) were associated with increased risk of fall after transfer from the ICU (Table 3). Thus, 6.6% of demographic factors, 18.7% of disease-related factors, and 30.1% of both demographic and disease-related factors were associated with the risk of falling after CABG. The ROC (Receiver Operating Characteristic Curve) was used to determine the relationship of demographic factors, disease-related factors (preoperative, intraoperative, and postoperative factors), and both demographic and disease-related factors. Area Under Curve (AUC) was not significant for demographic factors alone ( $P=0.1$ ,  $AUC=0.566$ ), while it was significant for disease-related factors ( $P=0.001$ ,  $AUC=0.687$ ) and demographic and disease-related factors together ( $P=0.001$ ,  $AUC=0.701$ ) (Figure 1).

## Discussion

The present study results showed that the risk of falls in patients after CABG and after discharge from the ICU increased significantly compared to before surgery. Few studies have examined the risk of a fall after CABG. Manemann's study using the MFS showed that 38% of patients with cardiovascular disease were at high risk of falling [16]. Partridge et al. showed that after surgery and in the hospitalization phase, more than half of arterial vascular surgical subjects had physical dysfunction [17], increasing the risk of falls. Gringauz et al., who examined the frequency of falls in hospitalized patients using the MFS tool, also showed that patients were more likely to fall [15]. Shirvani et al. [18] suggested cognitive



**Figure 1.** Predictability of demographic factors, disease-related factors (preoperative, intraoperative and postoperative factors) and both demographic and disease-related factors

**Table 1.** Descriptive statistics for postoperative factors associated with falls in coronary artery bypass graft patients in intensive care unite (n=302)

Variables	Mean±SD	Median	Min	Max
Temperature (Centigrade)	143.36±570	555	290	1405
Hemoglobin (mg/dl)	36.64 ±0.26	36.60	36.60	36.60
Platelet (mcl)	10.28±1.16	10.20	6.80	13.50
Serum calcium level (mg/dl)	195274.83±55873.12	188000	72000	375000
Serum magnesium (mEq/l)	8.07±0.51	8.10	4.50	9.70
Serum potassium (mEq/l)	2.34±0.33	2.40	1.50	3.80
Serum sodium (mEq/l)	4.76±0.73	4.70	3.20	6.90
Serum urea (mEq/l)	132.67±3.34	133	118	145
Serum creatinine (mg/dl)	16.54±4.04	16	10	37
Blood sugar (mg/dl)	1.09±0.32	1.05	0.07	2.40
Blood sugar	189.79±69.31	175	77	391

disorders such as delirium as one of the reasons for the increased risk of falls after CABG. They recommended that early mobilization be planned for these patients to reduce the progression of their cognitive impairments. The presence of cognitive impairments in these patients may be a factor in increasing the risk of falls.

The present study results showed that the risk of falling had a significant relationship with age, such that the falling risk increased with increasing age. Rank regression also showed that aging could predict the risk of

falls after CABG. Lim et al. [19] and Lee et al. [21] also showed that the risk of falling increases with aging. This high risk may result from increasing age and movement problems in patients, especially patients with coronary artery disease, which reduces the blood supply to the central and peripheral nervous systems, leading to an increased risk of falling. Moreover, heart surgery as a major stressor can cause fear and anxiety in patients. The results of Paryad showed that these patients suffer from postoperative anxiety. Patients' anxiety may

**Table 2.** Relationship of the risk of Fall in coronary artery bypass graft patients with preoperative factors

Variables	P*	r
Age	0.001	0.291
Hemoglobin level in the morning	0.04	0.115
Sodium level in the morning	0.04	0.118
Urea level in the morning	0.001	0.212
Duration of cardiopulmonary pump use	0.01	-0.138
Receiving cell pack intake during surgery	0.002	-0.177
Calcium level in the morning	0.03	-0.122
Sodium level at the time of entering the ICU	0.02	-0.129
Urea level at the time of entering the ICU	0.01	0.139

\* The Spearman correlation test.

**Table 3.** Regression coefficients for demographic and disease-related factors associated with the risk of falling after coronary artery bypass graft

Variables	B	SD	P	95%CI	
				Lower	Upper
(Constant)	25.144	5.518	0.0001	14.285	36.004
Age	0.239	0.081	0.003	0.079	0.399
History of high blood pressure	3.580	1.784	0.046	0.069	7.091
Hyperuremia	6.092	1.788	0.001	2.574	9.610
Hypermagnesemia	-2.377	1.374	0.085	-5.080	0.327
Preoperative creatinine increase	17.731	4.857	0.001	8.171	27.290
Hemoglobin level upper than normal	-5.472	2.451	0.026	-10.296	-0.647
Hyponatremia	4.223	1.605	0.009	1.064	7.382

also increase their fear of being forced, leading to an increased risk of falling [22].

The present study results showed that CABG patients with hypertension were more likely to fall. This finding is consistent with the results of Van Rensburg [23]. Khovasova's study showed that arterial hypertension could increase the risk of patients falling [11]. Hypertension may be associated with impaired blood flow to patients' central nervous systems and affect their balance when getting out of bed and moving. Another variable associated with the increased risk of falls after CABG was the increased preoperative urea and creatinine. People who high urea and creatinine levels before surgery were at higher risk for falls after surgery. The results of Davis showed that patients with elevated serum urea might show some degree of consciousness loss [24].

Lack of full consciousness may increase the risk of falls in patients after CABG. Hemoglobin deficiency on the morning of surgery was also associated with an increased risk of falls after CABG. Lucero's study showed that serum hemoglobin could be related to an increased risk of falls in patients [25]. A decrease in hemoglobin is associated with a reduction in the transfer of oxygen to vital organs, causing the possibility of weakness, changes in blood pressure, and subsequent cognitive impairments. All of these complications can affect the patient's balance after heart surgery. The increase in serum sodium was also associated with an increased risk of falls in CABG patients.

Elevated serum sodium can be one of the factors influencing the rise in blood pressure, and the resulting hypovolemia may cause dizziness and muscle weakness.

Such symptoms can increase the patient's risk of falling. Leong's study reported nervous dysfunction, muscle weakness, decreased fluid volume, and tachycardia following elevated serum sodium levels. All of which may increase the risk of falls. The final model confirmed the significant effect of the variables of age, history of high blood pressure, increased preoperative urea and creatinine, and increased preoperative sodium on the risk of fall in CABG patients. It seems that paying attention to the above variables in developing care programs for patients who have undergone CABG can reduce the risk of falling after surgery.

According to the results of this study, the probability of falling after CABG surgery and after transferring from the ICU to the general cardiac ward was significantly different from the fall probability rate at the beginning of hospitalization. This finding indicates that it is necessary to estimate the risk of falling after transfer from the ICU. Determining the risk of falls at the beginning of hospitalization is necessary but not sufficient; determining the risk of falls after CABG surgery and discharge from the ICU can be helpful in care planning for nurses. Due to the increase in the daily function of patients after CABG, it is recommended to estimate the risk of falls on a daily basis until the patients get discharged. In this case, a suitable daycare plan can be designed for these patients based on their falling risk.

## Conclusion

Many patients experience severe anxiety before and after heart surgery, affecting their fear and anxiety about moving after surgery. However, this factor was not mea-



sured in the present study, which can be one of its limitations. Demographic and disease-related factors predicted 70% of the risk of falls after CABG surgery. This result emphasizes the above variables in predicting the risk of falls in CABG patients. Since the number of CABG surgeries is increasing, it is recommended to conduct studies in different medical centers to determine the factors related to the risk of falls in these patients. The use of various facilities in different care departments, the number of nurses present in each ward, and the presence of a physiotherapy team to help move these patients can reduce the risk of falling after CABG surgery.

## Ethical Considerations

### Compliance with ethical guidelines

Before the study, ethical approval was obtained from the Ethics Committee of Guilan University of Medical Sciences (Code: IR.GUMS.REC.2019.370). All participants signed an informed consent form before the study, and their information was kept confidential.

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### Authors' contributions

Study design and conceptualization: Maryam Rajabi, Ezzat Paryad, and Atefeh Ghanbari Khanghah; Data collection: Maryam Rajabi; Data analysis: Ehsan Kazemnezhad leili, Ezzat Paryad, and Atefeh Ghanbari Khanghah; Initial draft preparation: Maryam Rajabi and Ezzat Paryad; Final approval: All authors.

### Conflict of interest

The authors declared no conflict of interest.

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