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## Causes and Predictors of Early 30-Day Rehospitalization after Isolated Elective Coronary Artery Bypass Surgery.

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## ORIGINAL STUDY

# Causes and predictors of early 30-day rehospitalization after isolated elective coronary artery bypass surgery

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### Abstract

**Background:** Despite advancements in interventional cardiology, coronary artery bypass grafting (CABG) remains essential for many CAD (coronary artery disease) patients. While surgical outcome scoring exists, early post-CABG rehospitalization remains poorly understood.

**Aim:** This study investigates risk factors and underlying causes of 30-day readmission following elective isolated CABG.

**Methods:** A prospective analysis of 550 consecutive elective isolated CABG patients at the National Heart Institute (January 2022–June 2023) was undertaken to investigate the 30-day readmission rate, diagnoses, and independent predictors using a follow-up phone call strategy.

**Results:** Analysis revealed a 2.9% (16/545) 30-day readmission rate. Surgical site infection was the most common cause (50%). Notably, no single pre-existing patient characteristic emerged as an independent predictor for early readmission using multivariable logistic regression analysis.

**Conclusions:** Our analysis revealed a nonsignificant association between established preoperative risk factors and 30-day readmission following elective isolated CABG. Notably, surgical site infection emerged as the predominant etiology for readmission, exceeding previously documented frequencies.

**Keywords:** Coronary artery bypass grafting, Readmission, Risk factors

## 1. Introduction

Unplanned readmission after coronary artery bypass grafting (CABG) poses a significant financial burden on the US healthcare system. A 2004 study found that unplanned readmissions accounted for \$17.4 billion, or roughly 17%, of total Medicare hospital payments that year. This highlights the importance of research on post-CABG readmission to reduce costs and improve patient outcomes [1]. Studies have shown a correlation between early readmission and increased in-hospital mortality rates [2]. Furthermore, hospital readmission rates are increasingly used to assess the

quality of care [3]. Li *et al.* further highlighted substantial variations in readmission rates across hospitals, with a mean ranging from 0 to 26.9% and a median of 13.1%. The principal reasons for early rehospitalization varied between various studies. While postoperative infections are a leading cause in some studies [1,2,4], others identify cardiac issues as primary drivers [3]. Additionally, diverse etiologies like diabetic ketoacidosis, transient ischemic attack, deep venous thrombosis, and gastrointestinal bleeding have been documented. While studies have demonstrated its financial burden and association with quality of care in the US [1,2], no national, peer-reviewed research has investigated

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this issue in the Egyptian context. This knowledge gap hinders efforts to understand the prevalence, underlying causes, and potential predictors of early readmission following CABG in Egypt. Addressing this gap through dedicated research is crucial to improving patient outcomes, optimizing resource allocation, and ultimately enhancing the quality of medical services offered by the Egyptian healthcare system.

## 2. Patients and methods

A prospective cohort study at the National Heart Institute, Egypt, investigated early readmission following isolated CABG surgery. The institutional review board approved this study (IHC00082).

### 2.1. Ethical information

The current study was approved by the General Organization for Teaching Hospitals and Institutes (GOTHI) with an IRB number coded as IHC00079, date: 1/05/2024.

After obtaining a signed consent, a total of 545 consecutive patients (January 2022–June 2023) undergoing cardiopulmonary bypass (92%) with a standardized surgical approach were included. Myocardial protection employed intermittent antegrade warm blood hyperkalemic arrest and mild systemic hypothermia. Analyses excluded four in-hospital deaths and one patient exceeding the initial 30-day discharge window. The anesthetic technique employed has been previously documented [5].

Upon discharge, a standardized follow-up protocol was implemented. Patients were instructed to contact a designated study author for any post-operative concerns and offered the option to visit the outpatient clinic or emergency department for a comprehensive evaluation. This evaluation included a detailed medical history, physical examination, and necessary laboratory tests. Based on the evaluation findings, a decision for readmission was made. Importantly, presentation to the emergency department did not automatically equate to readmission. Only patients with confirmed surgical complications were admitted and included in the subsequent re-hospitalization analysis, as determined by the evaluation.

Patient medical information was extracted from hospital records, including demographics (age, gender), comorbidities (diabetes mellitus [DM], hypertension [HTN], peripheral vascular disease [PVD], myocardial infarction [MI]), preoperative left ventricular ejection fraction (LVEF), postoperative atrial fibrillation (AF), and serum creatinine level.

Statistical analysis was performed using SPSS software (SPSS Inc., Chicago, Illinois). The student's *t*-test was used to compare continuous variables. Where appropriate, categorical or binary variables were compared using Pearson  $\chi^2$  or Fisher's exact tests. All variables included in the model were analyzed via Multivariate logistic regression to control for potential confounding or effect modification. Statistical significance was defined as a 2-sided *P* value of less than 0.05.

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Table 1. Demographic characteristics and clinical variables.

Characteristics	Number of patients (%)	
Sex		
Male	393 (72.1)	
Female	152 (27.8)	
Age (year)		
<70	499 (91.5)	
≥70	46 (8.4)	
Diabetes	135 (24.7)	
Myocardial Infarction	115 (21.0)	
Hypertension	188 (34.4)	
Serum creatinine mg/dl		
<1.4	498 (91.3)	
≥1.4	48 (8.8)	
LVEF%		
<40	190 (34.8)	
≥40	355 (65.1)	
Postoperative AF	40 (7.3)	
ON- pump CABG	502 (92.1)	
Length of stay (days)		
<5 days	499 (91.5)	
≥5 days	46 (8.4)	
Length of stay (days)	Mean	SD
	3.9	1.8

Table 2. Relations between % of re-hospitalized & non-re-hospitalized Concerning well-known risks.

Variables	Re-hospitalization		P value
	No	Yes	
Sex, n (%)			
Male	383 (97.9)	10 (2.1)	0.16
Female	146 (96.0)	6 (3.2)	
Diabetes, n (%)			
No	401 (97.8)	9 (2.2)	0.06
Yes	128 (94.8)	7 (5.1)	
Myocardial Infarction, n (%)			
No	418 (97.2)	12 (2.7)	0.4
Yes	111 (96.5)	4 (3.4)	
Hypertension, n (%)			
No	350 (98)	7 (2)	0.8
Yes	179 (95.2)	9 (4.7)	
Cardiopulmonary By-pass, n (%)			
No	39 (90.6)	4 (9.4)	0.12
Yes	490 (97.6)	12 (2.3)	
Atrial Fibrillation, n (%)			
No	493 (97.8)	12 (2.1)	0.09
Yes	36 (90.0)	4 (10)	

Table 3. Mean of continuous characteristics between re-hospitalized and non-re-hospitalized.

Variable	Rehospitalization	Mean	SD	P value
Age	No	55.3	10.3	0.8
	Yes	56.2	10	
Creatinine	No	0.7	0.3	0.32
	Yes	1.8	2.2	
EF	No	41.2	10.5	0.21
	Yes	37.8	12.5	
Length of Stay	No	2.8	1.4	0.7
	Yes	3.4	2.1	

Table 4. Thirty days re-hospitalization logistic regression analysis.

Variables	Odds Ratio	P value	95% CI
Female	1.3	0.42	0.45, 3.78
Age $\geq$ 70	1.8	0.15	0.92, 3.54
Diabetes	2.1	0.08	1.12, 3.98
Hypertension	0.9	0.72	0.31, 2.59
Myocardial Infarction	0.7	0.48	0.22, 2.23
On-Pump CABG	0.3	0.11	0.14, 0.79
Creatinine $\geq$ 1.4	1.5	0.34	0.52, 4.32
Atrial Fibrillation	2.4	0.06	1.24, 4.68
Length of Stay >5 days	0.8	0.83	0.29, 2.24
EF <40%	1.0	0.12	1.02, 3.57

a detailed medical history, physical examination, and necessary laboratory tests. Based on the evaluation findings, a decision for readmission was made. Importantly, presentation to the emergency department did not automatically equate to readmission. Only patients with confirmed surgical complications were admitted and included in the subsequent re-hospitalization analysis, as determined by the evaluation.

Patient medical information was extracted from hospital records, including demographics (age,

gender), comorbidities (diabetes mellitus [DM], hypertension [HTN], peripheral vascular disease [PVD], myocardial infarction [MI]), preoperative left ventricular ejection fraction (LVEF), post-operative atrial fibrillation (AF), and serum creatinine level.

Statistical analysis was performed using SPSS software (SPSS Inc., Chicago, Illinois). The student's *t*-test was used to compare continuous variables. Where appropriate, categorical or binary variables were compared using Pearson  $\chi^2$  or Fisher's exact tests. All variables included in the model were analyzed via Multivariate logistic regression to control for potential confounding or effect modification. Statistical significance was defined as a 2-sided *P* value of less than 0.05.

#### 4. Results

A total of 545 were included in this study. Demographic characteristics and clinical data are shown in (Table 1).

A standardized follow-up identified a 30-day readmission rate of 2.9% (16/545). Surgical site infection was the leading cause, accounting for half of readmissions. Other causes of re-admission were cardiac causes (37.5%) (MI, unstable angina, and arrhythmia), stroke (6%), and diabetic ketoacidosis (6%). Preoperative risk factors (sex, DM, HTN, MI, LVEF) and bypass use showed no significant association with readmission (Table 2).

Multivariable analysis revealed no significant association between readmission and a broad range of pre-operative factors, including demographics (sex), medical history (DM, HTN, MI), baseline cardiac function LVEF, and the surgical approach (use of cardiopulmonary bypass). Additionally, no significant correlations were observed with preoperative serum creatinine levels, age, or length of stay in the ICU (Table 3).

Multivariable logistic regression analysis revealed no independent preoperative risk factor significantly associated with early readmission (Table 4).

#### 5. Discussion

Predicting early readmission following CABG surgery remains a complex challenge. Our prospective cohort study, examining a national heart institute population in Egypt, identified a 30-day readmission rate of 2.9% (16/545) with surgical site infection [6] as the leading etiology. Multivariable logistic regression analysis revealed no independent preoperative risk factor significantly associated with early readmission. This finding contributes to the ongoing debate regarding early readmission

predictors. While Stanton *et al.* reported a higher 6-month readmission rate (24%), with angina pectoris as the primary cause in their study, their findings also suggest a potential link between prolonged ICU stay and subsequent readmission [7].

While retrospective studies like that by Hannan *et al.* [1] provide valuable insights, their generalizability can be limited. Their analysis of over 33 000 patients in New York State identified a higher early readmission rate (16.5%) compared with our prospective cohort study (2.9%). Their findings also highlight significant hospital variations (8.3%–21.1%) and potential patient-related risk factors (age, sex, BMI, race) that warrant further investigation in a prospective setting to establish causality. Examining risk factors for early readmission following isolated CABG surgery, Beggs *et al.* [8] (1996) reported a 30-day readmission rate of 13.8%. Their retrospective analysis identified potential predictors including large body surface area, involvement of the posterior descending artery, preoperative anemia (hematocrit <30%), postoperative arrhythmia, and prolonged ICU stay. However, the retrospective nature of their study limits generalizability. Further prospective research is warranted to confirm causality and explore these factors in more diverse populations.

Stewart *et al.* [5] conducted a study that revealed a 16% rehospitalization rate within 30 days following CABG. The primary diagnosis associated with these rehospitalizations was post-CABG AF. Interestingly, the study found that females had a readmission rate that was more than double that of males. Additionally, there was an inverse relationship observed between the rate of readmission and the length of hospital stay [5,9]. Li *et al.* [3] conducted a study aiming to identify the factors contributing to the variation in early rehospitalization rates among hospitals in California. The study examined hospital-related factors, such as the hospital's ownership (private or public), the presence of teaching programs, and the number of beds, as well as patient-related factors. The findings of the study, which included 119 hospitals, revealed that the readmission rates ranged from 0 to 26.9%. The most prevalent causes of readmission were cardiac complications, infections [10], and digestive system complications. Interestingly, the study emphasized that patient-related factors, including age, DM, and sex, had a more significant influence on readmission rates compared with variables at the hospital level.

In our study, we had a lower readmission rate compared with previous studies and this can be attributed to the lower mean of age ( $55 \pm 10.3$ ) in our patient's population compared with other studies with a higher mean of age [4,11–13]. Another cause

is the exclusion of admissions to the emergency department (ER) this relieved the bias that would be raised by physicians running the ER due to lower orientation by cardiac surgical patients which might result in unwanted rehospitalizations. Moreover, the complexity of the procedure has been reported to be associated with a higher readmission rate compared with isolated CABG [4].

A lower incidence of AF in our study (7%) could be another cause of a lower readmission rate compared with other studies that have a higher post-CABG AF [13]. The lower AF rate may be attributed to the lower age in our study.

Even though female sex and diabetics are described as major risk factors for early rehospitalization in some studies [1,2,4,14,15], we believe that females have been referred to the ER more than men. This bias additionally exists for patients with diabetes as compared with non-diabetics and unwanted readmissions can be raised [5]. Surgical site infection [16] was the principal cause (50%) of rehospitalizations in our patient's cohort and that was a very high incidence compared with other studies [17], other mentioned causes in our study have been reported by many researchers [2,5,15,17,18].

### 5.1. Conclusions

An Egyptian national heart institute conducted a prospective cohort study on early readmission after isolated CABG surgery. While the study observed a lower-than-expected 30-day readmission rate (2.9%), preoperative risk factors showed no significant association with readmission in multivariable analysis. This is likely due to the study's limitations: a single center, younger patients ( $n = 545$ ), and isolated CABG procedures. Notably, surgical site infection was a major cause of readmission (50%), highlighting the importance of infection control. Future multicenter studies with larger, more diverse cohorts and complex procedures are needed to confirm these findings and generalize them to broader surgical settings.

### 5.2. Limitations

This single-center study with a limited sample size and focus on isolated CABG procedures necessitates multicenter research with broader patient cohorts and exploration of post-operative factors for generalizable causal inferences.

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This research is not funded or granted.



## Author contribution

All authors have been actively contributed in all study steps.

## Institutional Review Board (IRB) Approval Number

IHC00082.

## Conflict of interest

There are no conflicts of interest.

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