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# Early Hospital Readmissions after Coronary Artery Bypass Graft Surgery

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## Abstract

***Background-*** Risk factors for 30-day hospital readmission following coronary artery bypass grafting (CABG) have not been established. Recent studies have reported readmission rates after CABG ranging from 7.1% to 21%, and causes of readmission have varied in different studies. This study was conducted to evaluate probable risk factors of increased morbidity following CABG surgery during the first 30 postoperative days.

***Methods-*** A total of 545 patients who had undergone CABG were followed prospectively for 30 days after surgery. The patients were contacted by telephone to determine readmission. If re-hospitalized in the first 30 days after surgery, the patients were visited and data were collected and analysed.

***Results-*** Sixteen out of 545 patients were readmitted. The overall 30-day hospital readmission rate was 2.9%. The most common reason for readmission was sternal infection. There were no significant differences between readmitted and non-readmitted cases in demographic and clinical variables.

***Conclusion-*** Unlike other studies in which some factors like female gender and length of hospital stay were risk factors for 30-day hospital readmission after CABG, our data did not show these as predictors of re-hospitalization ***(Iranian Heart Journal 2006; 7 (1): 25-30).***

**Key words:** coronary artery bypass grafting ■ hospital readmission ■ risk factors

Coronary artery bypass graft (CABG) surgery is a procedure increasingly performed in patients with coronary heart disease. It is one of the most common major elective operative procedures in the United States.[1] Today many non-surgical methods like interventional cardiology have decreased the rate of CABG, but surgery is still the main procedure to revascularize left main coronary artery and three-vessel coronary diseases.

Decreasing hospital readmissions after CABG is associated with diminished mortality and morbidity, although little is known of the true 30-day readmission rate following cardiac operations.[9]

The first four-to-eight weeks after CABG operation is the recovery period, which is an important and critical time for patients and is accompanied with higher risks of complications and hospital readmission.

On the other hand, the costs of medical interventions are of economic and strategic concern for many hospitals.

Efforts to decrease the cost of providing complete healthcare for CABG patients must include reducing readmission rates following CABG. Many studies have reported readmission rates ranging from 7.1% to 20.9%. [1-5]

An understanding of the risk factors for increasing readmission rate is essential toward the selection of appropriate strategies to reduce the risks.

This study was performed to evaluate probable risk factors of increased morbidity following CABG surgery during the first 30 postoperative days.

## Methods

This study included 550 consecutive patients who had undergone isolated primary CABG between January 2001 and January 2002 at the two cardiac surgery departments in Kerman Medical Sciences University and Yazd University of Medical Sciences under similar conditions. Patients who died while in the hospital (n=4) and surviving patients who had not been discharged by postoperative day 30 (n=1) were excluded from this analysis. The final cohort included 545 patients.

One surgeon in each centre operated on all the patients in this study. A balanced anaesthetic technique was utilized for all the cases. Medical data were extracted from hospital records. Data collected included; sex, age, history of diabetes mellitus (DM), myocardial infarction (MI), hypertension (HTN), peripheral vascular disease (PVD), baseline preoperative left ventricular ejection fraction (LVEF), serum creatinine (Cr) and postoperative atrial fibrillation (AF). All the patients were personally called by the authors every week after discharge. If the admission was due to any reasons relevant to their surgery such as CHF, unstable angina, infection, etc., the patient was labelled as a case in

this study.

Statistical analysis was performed using SPSS-10 software. Categorical and dichotomous variables were compared using Pearson Chi Square test or Fisher's exact test. Student's t- test was used for quantitative variables. Multivariable logistic regression was performed to control potential confounding factors or effect modification. Statistical significance was defined as a 2-sided P value of less than 0.05.

## Results

A total of 545 patients with CABG were included. Preoperative clinical characteristics are shown in Table I.

**Table I. Patient characteristics**

| Variables | Frequency | Percent |
|---|---|---|
| Sex | | |
| Female | 152 | 27.9 |
| Male | 393 | 72.1 |
| Age (year) | | |
| <70 | 498 | 91.4 |
| =>70 | 47 | 8.6 |
| Diabetes mellitus | 132 | 24.2 |
| Myocardial infarction | 115 | 21.1 |
| Hypertension | 184 | 33.8 |
| Peripheral vascular disease | 1 | 0.2 |
| Serum creatinine   mg/dl | | |
| <1.4 | 500 | 91.7 |
| ≥1.4 | 45 | 8.3 |
| LVEF % | | |
| <40 | 186 | 34.1 |
| ≥40 | 359 | 65.9 |
| Post- CABG Atrial fibrillation | 39 | 7.2 |
| Off- pump bypass | 43 | 7.9 |
| LOS ICU days | | |
| <5 days | 498 | 91.4 |
| ≥5 days | 47 | 8.6 |
| | mean | SD |
| Los days | 3.1 | 1.7 |

LVEF: left ventricular ejection fraction, LOS: length of ICU stay, CABG: coronary artery bypass grafting.

Of these, sixteen cases (2.9%) were readmitted to the hospital within 30 days of CABG (Fig. 2).

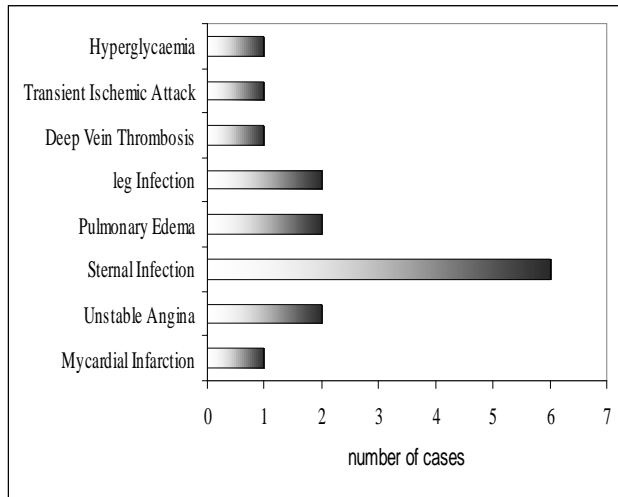Readmission diagnoses are listed in Fig. 1.

**Fig. 1.** Frequency of readmission diagnoses.

The most common reason for readmission was sternal infection. History of DM, MI, and HTN, gender of patients, AF and using cardiopulmonary bypass did not cause any significant difference between readmitted and non-readmitted patients (Table II).

No significant differences were observed in the mean of age, serum Cr, LVEF and post-surgical length of ICU stay (LOS) between readmitted and non-readmitted patients (Table III). Multiple logistic regressions, controlling all of the measured patient characteristics, demonstrated that none of the variables were a significant predictor for readmission (Table IV).

**Table III. Mean of continuous characteristics in readmitted and non-readmitted patients**

| Variable | Readmission | Mean | SD | P-value |
|---|---|---|---|---|
| Age | No | 55.4 | 10.3 | P=0.798 |
| | Yes | 56.1 | 10 | |
| Cr | No | 0.94 | 0.5 | P=0.327 |
| | Yes | 1.5 | 2.2 | |
| LVEF | No | 41.1 | 10.5 | P=0.219 |
| | Yes | 37.8 | 12.5 | |
| LOS | No | 3.14 | 1.8 | P=0.92 |
| | Yes | 3.18 | 1.6 | |

Left ventricular ejection fraction (LVEF), serum creatinine (Cr), and length of ICU stay (LOS)

**Table II. Relationships between readmission risks and some of the main potential risk factors; number of (%) readmissions**

| Variable | | | |
|---|---|---|---|
| | **Readmission** | | |
| Sex | No | Yes | P value |
| Male | 384(97.7%) | 9(2.3%) | P=0.163 |
| Female | 145(95.4%) | 7(4.6%) | |
| DM | | | |
| No | 404(97.8%) | 9(2.2%) | P=0.064 |
| Yes | 125(94.6%) | 7(5.4%) | |
| MI | | | |
| No | 416(96.7%) | 14(3.3%) | P=0.392 |
| Yes | 113(98.2%) | 2(1.8%) | |
| HTN | | | |
| No | 351(97.2%) | 10(2.8%) | P= 0.791 |
| Yes | 178(96.7%) | 6(3.3%) | |
| Pump | | | |
| No | 40(93%) | 3(7%) | P=0.124 |
| Yes | 489(97.4%) | 13(2.6%) | |
| AF | | | |
| No | 493(97.4%) | 13(2.6.%) | P=0.09 |
| Yes | 36(92.3%) | 3(7.7%) | |

**Table IV. Logistic regression analysis of 30-day readmission**

| Variable | Odds Ratio | P-Value | 95% CI |
|---|---|---|---|
| Female gender | 1.9 | 0.245 | 0.64-5.6 |
| Age≥70 | 2.1 | 0.283 | 0.54-8.2 |
| DM | 2.4 | 0.111 | 0.81-7 |
| HTN | 0.88 | 0.834 | 0.28-2.7 |
| MI | 0.62 | 0.55 | 0.13-3 |
| Pump-on | 0.26 | 0.06 | 0.6-1.1 |
| Cr>1.4 | 1.8 | 0.46 | 0.4-9.4 |
| A.F. | 2.4 | 0.2 | 0.6-9.4 |
| L.O.S>5 days | 0.95 | 0.965 | 0.11-8.1 |
| L.V.E.F<40% | 2.13 | 0.18 | 0.7-6.5 |

Diabetes mellitus (DM), myocardial infarction (MI), hypertension (HTN), left ventricular ejection fraction (LVEF), serum creatinine (Cr), postoperative atrial fibrillation (AF), length of ICU stay (LOS)
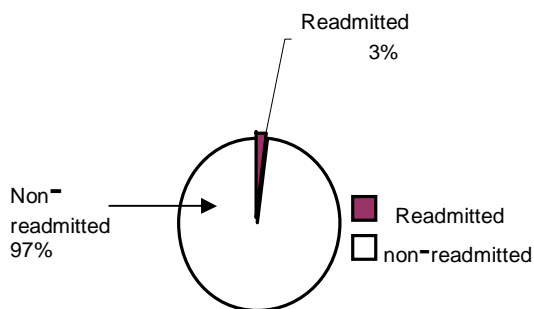
**Fig. 2.** Percentage of readmitted patients.

## Discussion

The known risk factors for readmission during the recovery phase after CABG are controversial. There were no significant predictors for re-hospitalization after CABG in our study. At least five studies have investigated readmission rates and predictors among CABG patients, but they have identified different predictors.[1, 9]

Stanton et al. determined hospital readmission rate of 24% among survivors six months after CABG. Only cardiac chest pain was the most common cause of readmission. 8.2% of the cases had been readmitted during the first month. These patients had stayed significantly longer in ICU.[1]

Beggo and co-workers in 1996 evaluated related factors to re-hospitalization within thirty days of discharge after CABG. Overall re-hospitalization rate was 13.8%. They demonstrated body surface area >2.8, posterior descending artery stenosis and CCU admission before surgery as preoperative factors and hematocrit less than 30%, arrhythmia after bypass and length of stay more than seven days as postoperative factors for readmission of patients after CABG.[5]

In a study similar to ours, Stewart and colleagues clarified predictors of 30-day hospital readmission after CABG. Sixteen percent were readmitted to hospital within 30 days after CABG. In their study atrial fibrillation was the most common readmission diagnosis. The most significant finding of this study was that women were readmitted more than twice as often as men within 30 days of CABG. Length of stay was inversely associated with the 30-day rehospitalization.[6,16]

In this study we tried to determine risk factors related to readmission to the hospital after CABG operation. These factors have been studied in previous works.[3,6] The risk factors include, age, diabetes before operation, post-CABG AF, EF of less than 40% before operation, serum creatinine of more than 1.4mg/dl, renal insufficiency before operation, myocardial infarction before operation and the number of days of stay in the ICU before the first discharge.

The first difference between this work and previous studies is the age of patients. In other studies, the average age of the patients who had undergone operation is reported to be 65±10.6 years, whereas the average age of our patients was 55±10.3 years (Table I). This could be attributed to the severity of the disease in Iran and the age of onset of disease, which is ten years lower than that in the rest of the world.[6,15]

The other difference that we encountered in our study is the lower rate of AF rhythm after the CABG operation (Table I). According to the literature, the rate of AF rhythm after the CABG operation is about 27%. In our study, however, we found a rate of 7%.

The reason for this difference might be the lower age of our patients.[15] The lower rate of AF rhythm cannot be attributed to the better EF because more than 30% of our patients had an EF of less than 40%, whereas in most of the studies in the western countries, the rate is about 24%.[11-13] Different studies have mentioned different risk factors for readmission including female sex, diabetes, AF rhythm after surgery, body surface area of more

than 2.8, stenosis of PDA branch, hematocrit of less than 30 before the operation and number of days in the ICU.[5]

Most studies show a rate of 7-21% for readmission. Only one study shows a rate of 3.6%. In different studies, therefore, different risk factors have been mentioned for readmission. In our study, from 545 patients who had an operation, only 16 were re-hospitalized in the first month, and the rate of readmission was about 2.9%. The rate of readmission in our study is lower than that in most studies. Perhaps the first reason to explain this is the younger age of our patients compared to the patients in western countries.[15] For example, only 8.6% of our patients were older than 70 years, whereas this rate in other countries is about 37% (Table I). The other reason for the lower rate of readmission in our patients might be their lower rate of AF rhythm. AF rhythm has been implicated as one of the reasons for re-hospitalization. According to the statistics, there is also a difference between the major reason for readmission in our study and western countries. Studies in the USA have implicated AF rhythm as the major reason for re-hospitalization after the CABG operation.[11]

In our study, sternum infection was the main cause of readmission (37%). However in a study in the USA, this complication was the cause of only 7% of readmissions, and in another study it was the third cause of readmission.[17]

Overall, in this study we were not able to find a definitive risk factor for readmission to the hospital. Some studies have considered the female sex and diabetes as the major risk factors for re-hospitalization.[8] The authors, however, believe that following surgery, women refer more often to their physician or the emergency room compared to men. This could be the reason for the higher rate of their re-hospitalization. This bias also exists for diabetic patients, as compared to non-diabetics; they also refer more often to

their physicians and emergency department. The physicians have more sensitivity toward the diabetics, and they might readmit them without any definite indication.[6] One of the strong points of this study was that all of the patients who had undergone surgery in Yazd and Kerman were included. The other strong point was that almost all (98%) re-hospitalizations were in the same center where the operation was performed, whereas in other studies, only up to 50% of the patients were re-hospitalized in the center where the surgery was done. The other point that needs to be mentioned is that in this study, only the primary CABG was studied and patients with redo CABG, CABG+MVR, CABG+AVR, CABG+VSD, and CABG+ASD were excluded.

Considering that none of the risk factors showed a significant relationship to re-hospitalization, other factors such as the surgeon's skills and patient care after surgery might be the reasons for readmission. Proving this, however, requires a broad and multi-center study.

## Conclusion

In this survey, no relationship was found between significant risk factors such as sex, CHF, diabetes, etc, and readmission during the first month after CABG. It may be necessary to do a vast study in cooperation with more centers in order to find such a relationship. The interesting point in this survey was the low rate of readmitted patients in comparison with other studies, the only explanation for which could be the lower age of our patients.

## Acknowledgements

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