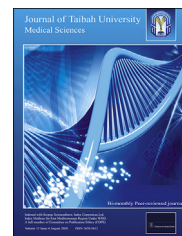Taibah University

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Original Article

Thirty-day readmission rates and associated risk factors after coronary artery bypass grafting

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الملخص

أهداف البحث: تهدف هذه الدراسة إلى قياس نسب إعادة التنويم للمرضى بعد عملية الشريان التاجي خلال ٣٠ يوم، ودراسة العوامل المؤدية لذلك. وذلك نظرا لارتفاع تكلفة الرعاية الصحية الناتجة عن إعادة تنويم المرضى.

طرق البحث: أجريت دراسة حشدية رجعية تم فيها مراجعة السجلات الطبية لمرضى عملية الشريان التاجي وذلك خلال فترة من ١ يناير ٢٠١٦ إلى ٣١ يناير ٢٠١٩ في مدينة الملك عبد العزيز الطبية، الرياض، المملكة العربية السعودية. تم استخراج البيانات عن طريق نظام بيست كير. وتم حساب الترددات والنسب المئوية للمتغيرات النوعية بينما تم حساب المتوسط والانحراف المعياري للمتغيرات الكمية. كما تم استعمال الانحدار اللوجستي ثنائي الحدود والانحدار اللوجستي متعدد الحدود لاكتشاف العوامل المساهمة في إعادة التنويم.

النتائج: تكونت العينة من ٥٣٤ مريضا وأظهرت النتائج أن ١٦.١٪ من المرضى أُعيد تنويمهم خلال ٣٠ يوم. في تحليل الانحدار اللوجستي متعدد الحدود، تم اثبات أن كل من داء السكري ودواء الأميودارون ودواء الستاتين ودواء أملوديبين والربو وارتفاع شحوم الدم تعتبر كعوامل خطورة في زيادة قابلية التنويم في المستشفى خلال ٣٠ يوم بعد عملية الشريان التاجي.

الاستنتاجات: داء السكري ودواء الأميودارون ودواء الستاتين ودواء أملوديبين والربو وارتفاع شحوم الدم كانت عوامل خطورة في زيادة قابلية التنويم في المستشفى خلال ٣٠ يوم بعد عملية الشريان التاجي. يجب أخذ هذه العوامل بعين الاعتبار من أجل تحديد استراتيجيات فاعلة لخفض نسب التنويم بعد إجراء العملية مما يخفف عبء مالي كبير لتكلفة الرعاية الصحية.

الكلمات المفتاحية: جراحة القلب؛ عملية الشريان التاجي؛ المملكة العربية السعودية؛ مدى الانتشار؛ اعادة التنويم

Abstract

Objectives: Coronary artery bypass grafting (CABG) is among the most frequently performed cardiac surgical procedures. However, it is associated with high readmission rates for a plethora of causes, which can substantially increase healthcare costs. This study aimed to assess the rates and associated risk factors of 30-day readmissions for CABG patients.

Methods: We conducted this retrospective cohort study at King Abdulaziz Medical City. The study targeted adult patients who underwent CABG between January 1, 2016, and January 31, 2019. Data were extracted from the BEST Care system. Frequencies and percentages were generated for categorical variables. Mean and standard deviation were calculated for quantitative variables. Bivariable and multivariable logistic regressions were used to detect readmission risk factors.

Results: Among 534 adult patients, the overall 30-day readmission rate was 16.1% (n = 86). The multivariable logistic regression analysis showed that diabetes mellitus ($P = .002$), amiodarone use ($P = .04$), statin use ($P = .04$), amlodipine use ($P = .006$), asthma ($P < .001$), and hyperlipidemia ($P = .04$) were significantly correlated with 30-day readmission.

Conclusions: Our study showed an estimated 16.1% 30-day readmission rate after CABG. Diabetes mellitus, asthma, hyperlipidemia, and use of medications such as amiodarone, statins, and amlodipine were associated with readmission. Further studies are needed to develop tailored and practical strategies to reduce CABG readmissions and mitigate patient and health care facility burdens.

Keywords: Cardiac surgery; Coronary artery bypass grafting; KSA; Prevalence; Readmissions

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Introduction

Coronary artery bypass grafting (CABG) is a surgical procedure in which a section of a blood vessel is grafted into the coronary artery to bypass the blocked section of its circulation.[1] With a reported annual rate of 4,00,000 procedures and an average incidence of 62 per 100,000 citizens in western European countries,[2,3] CABG is among the most common cardiac surgical procedures performed. Severe blockages in the coronary circulation are the main indication for CABG, notably when medical treatment or percutaneous coronary intervention (PCI) fails to clear the arterial blockage.[3] CABG can involve a variety of complications that increase morbidity and mortality. According to a study conducted in Bologna, Italy, the risk of stroke post-CABG varies across studies is 0−5.2%. Strokes can cause disability and increase the risk of death by up to 6-fold.[4]

Globally, CABG has a high rate of short-term readmissions.[5,6] Readmissions can burden both the healthcare system and the patient, especially when the average cost of readmission equals US $14,674.70.[6] Many global studies have discussed the rates and risk factors of short-term readmissions. In fact, some developed evidence-based strategies that adequately address these risk factors.[6] However, no peer-reviewed study conducted in KSA to date has used hospital population-based data to identify the rates and readmissions of CABG or develop strategies to lower them despite it being a region with a high prevalence of heart disease. Thus, due to a lack of local studies discussing the subject, the present study aimed to assess the 30-day readmission rate and associated risk factors for adult patients undergoing CABG. Assessing and managing the risk factors to adequately lower readmission rates could remove or at least mitigate an enormous burden on both patients and health care facilities.

Materials and Methods

Study design and participants

This retrospective cohort study was conducted at King Abdulaziz Medical City (KAMC). Inclusion criteria were used to select all adult patients who underwent CABG at KAMC with a complete medical history between January 1, 2016, and January 31, 2019. The exclusion criteria were: those who had undergone CABG and follow-up outside KAMC and those readmitted for reasons not directly related to the CABG procedure. Finally, 534 patients were included.

Data collection method

The patients' medical records were accessed in the BEST Care system. All adult patients who underwent CABG surgery and met the inclusion criteria were enrolled. The primary outcome variable was 30-day readmission. The variables were grouped according to age, sex, body mass index (BMI), length of hospital stay, any comorbidities, discharge medications used, and non-routine discharge. The research team retrospectively analyzed all of the included medical records.

Statistical analysis

The data were managed in Microsoft Excel 2010 (Microsoft Ltd., USA) and were analysed using SPSS version 20.0 (IBM Corporation, NY, USA). Frequencies and percentages were generated for categorical variables, while mean and standard deviation were calculated for quantitative variables. Bivariable and multivariable logistic regression analyses were used to investigate factors that were significantly associated with 30-day readmission.

In the bivariable logistic regression analysis, a backward elimination method was used to eliminate the less relevant variables. The significant variables were detected, and those variables with values of $P \leq .20$ were included in the final multivariable logistic regression analysis. For the multivariable analysis, the binary logistic regression equation was used. A 5% significance level was set as the basis to reject the null hypothesis. The Hosmer and Lemeshow test was used to assess model fitness at a 5% level of significance.

Results

Baseline characteristics

Of the 534 adult patients, 85.6% (n = 457) were male and 14.4% (n = 77) were female. Overall, 97.8% (n = 522) were routinely discharged. The all-cause mortality rate during the index admission was 2.2% (n = 12). Among the population, 9.7% (n = 52) were ≤50 years old, 31.1% (n = 166) were 51−60 years old, 36.0% (n = 192) were 61−70 years old, and 23.2% (n = 124) were ≥71 years old. The mean patient age was 62.7 ± 10.2 years for men and 62.7 ± 9.2 years for women. Overall, 1.7% (n = 9) were categorized as underweight, 17% (n = 91) were of normal weight, 37.8% (n = 202) were overweight, and 43.4% (n = 232) were obese. The mean BMI was 28.7 ± 5.2 kg/m^2 for the men and 31.8 ± 5.2 kg/m^2 for the women. Length of stay was <1 week for .1% (n = 6), 1−2 weeks for 48.9% (n = 261), 3−4 weeks for 38.6% (n = 206), 5−8 weeks for 9% (n = 48), and >8 weeks for 2.4% (n = 13). The mean length of stay was 19.1 ± 17.3 (7−234) days overall, 18.4 ± 16.5 (range, 7−234) days for the men, and 22.9 ± 20.8 (range, 8−147) days for the women. The overall 30-day readmission rate was 16.1% (n = 86); of the cohort, .7% (n = 4) had >1 readmission during the 30-day period (Table 1).

Comorbidities

The most prevalent comorbidity was diabetes mellitus, identified in 75.3% (n = 402), followed by hypertension (67.8% [n = 362]), dyslipidaemia (34.8% [n = 186]), and chronic kidney disease (6.2% [n = 33]) (Table 2).

Table 1: Patients' baseline characteristics (N = 534).

Variable	Category	n (%)
Sex	Male	457 (85.6)
	Female	77 (14.4)
Age, years, mean ± SD	62.5 ± 9.9 (range, 31−87)	
Age, years	≤50	52 (9.7)
	51−60	166 (31.1)
	61−70	192 (36.0)
	≥71	124 (23.2)
Overall body mass index, kg/m^2, mean ± SD	29.2 ± 6.0 (range, 17.0−94.4)	
Body mass index group	Underweight (≤18)	9 (1.7)
	Normal weight (18.5−24.9)	91 (17.0)
	Overweight (25−29.9)	202 (37.8)
	Obese (≥30)	232 (43.4)
Number of 30-day readmissions per patient	None	442 (82.8)
	1	82 (15.4)
	2	4 (.7)
Mortality rate	Routinely discharged	522 (97.8)
	Deceased	12 (2.2)
Overall length of hospital stay, weeks	19.1 ± 17.3 (range, 7−234)	
Length of hospital stay, weeks	<1	6 (.1)
	1−2	261 (48.9)
	3−4	206 (38.6)
	5−8	48 (9.0)
	>8	13 (2.4)
Male patients only		
Age, years, mean ± SD	62.7 ± 10.2 (range, 21−87)	
Body mass index, kg/m^2, mean ± SD	28.7 ± 5.2 (range, 17−54)	
Length of stay, weeks	18.4 ± 16.5 (range, 7−234)	
Female patients only		
Age, years, mean ± SD	62.7 ± 9.2 (range, 39−83)	
Body mass index, kg/m^2, mean ± SD	31.8 ± 5.2 (range, 18−49)	
Length of stay, weeks	22.9 ± 20.8 (range, 8−147)	

Discharge medications

The most common prescribed discharge medications were aspirin (90.1% [n = 481]), statins (88.2% [n = 471]), clopidogrel (73.8% [n = 394]), and furosemide (37.8% [n = 202]) (Table 3).

Table 2: Overall patient comorbidities (N = 534).

Comorbidity	n (%)
Diabetes mellitus	402 (75.3)
Hypertension	362 (67.8)
Dyslipidaemia	186 (34.8)
Chronic kidney disease	33 (6.2)
Smoking	24 (4.5)
Hyperlipidaemia	19 (3.6)
Hypothyroidism	24 (4.5)
Hyperparathyroidism	14 (2.6)
End-stage renal disease	9 (1.7)
Asthma	15 (2.8)
Decompensated heart failure	2 (.4)
Dyspnoea	2 (.4)
Psoriasis	3 (.6)
Anaemia	5 (.9)
Epilepsy	3 (.6)
Vitiligo	2 (.4)
Hepatitis	3 (.6)
Rheumatoid arthritis	18 (3.4)

Bivariable analysis

The variables diabetes mellitus ($P = .002$), amiodarone use ($P = .03$), statin use ($P = .04$), amlodipine use ($P = .012$), asthma ($P < .001$), and hyperlipidaemia ($P = .03$) were significantly correlated with readmission within 30 days on the bivariable analysis (Table 4).

Multivariable logistic regression

The binary logistic regression equation was used. Diabetes mellitus ($P = .002$), amiodarone use ($P = .04$), statin use ($P = .04$), amlodipine use ($P = .006$), asthma ($P < .001$), and hyperlipidaemia ($P = .04$) were significant predictors of readmission within 30 days (Table 5).

Table 3: Discharge medications (N = 534).

Medication	n (%)
Amiodarone	44 (8.2)
Furosemide	202 (37.8)
Aspirin	481 (90.1)
Statin	471 (88.2)
Apixaban	22 (4.1)
Warfarin	45 (8.4)
Amlodipine	56 (10.5)
Heparin	14 (2.6)
Clopidogrel	394 (73.8)

Table 4: Results of bivariable logistic regression analysis.

Variable	B	P	Odds Ratio	95% Confidence Interval	
				Lower	Upper
Gender	.210	.548	1.234	.621	2.450
Age	−.018	.156	.982	.958	1.007
Height	−.486	.349	.615	.222	1.701
Weight	−.012	.388	.988	.961	1.015
Body mass index	.019	.572	1.019	.954	1.088
Length of stay	.006	.410	1.006	.992	1.021
Diabetes mellitus	−1.278	.002	.279	.122	.636
Hypertension	−.101	.750	.904	.487	1.679
Dyslipidaemia	−.497	.070	.608	.355	1.041
Hypothyroidism	−1.638	.123	.194	.024	1.559
End-stage renal disease	−.752	.411	.471	.078	2.838
Amiodarone	−.863	.033	.422	.191	.933
Statin	−1.315	.037	.268	.078	.924
Amlodipine	−.872	.012	.418	.211	.829
Asthma	−2.599	.000	.074	.019	.287
Hyperlipidaemia	−1.260	.028	.284	.092	.874
Model Fitness Test					
Hosmer and Lemeshow Test					

Step	Chi-square		df		P
1	4.212		8		.838

Table 5: Results of multivariable logistic regression analysis.

Variable	B	P	Odds Ratio	95% Confidence Interval	
				Lower	Upper
Age	−.018	.157	.982	.959	1.007
Diabetes mellitus	−1.245	.002	.288	.130	.638
Dyslipidaemia	−.471	.075	.624	.372	1.049
Hypothyroidism	−1.633	.110	.195	.026	1.444
Amiodarone	−.821	.037	.440	.203	.953
Statin	−1.271	.038	.281	.084	.933
Amlodipine	−.948	.006	.387	.198	.758
Asthma	−2.509	.000	.081	.021	.310
Hyperlipidaemia	−1.161	.038	.313	.105	.935
Model Fitness Test					
Hosmer and Lemeshow Test					

Step	Chi-square		df		P
1	5.044		8		.753

Discussion

The study aimed to assess the 30-day readmission rates and associated predictors of patients who underwent CABG procedures at the KAMC. The results revealed a readmission rate of 16.1% after the index admission. The estimated rate was similar to those reported elsewhere, including 16.1%, 8.9%, 16.9%, 12.2%, 16%, and 9.2% in the United States[5–10]; 14.4% and 15.2% in Australia[11,12]; 12.0% in Korea[13]; and 10.7% in Taiwan[14]. In our region, the Middle East, one study conducted in Lebanon

reported a readmission rate of 9.8%, similar to those described in global studies.[15]

Although the CABG procedure has been in use since the 1960s,[16] it has not been thoroughly explored in the Middle East. Few efforts have been made to enhance it to achieve the most desirable short- and long-term outcomes.

Unlike a previous American multicentre study that found patients with a BMI >40 kg/m^2 were at higher risk of readmission,[7] the current study did not find a significant association between any BMI group and risk for readmission in the final analysis. Additionally, the present study found no association between age and an increased likelihood of readmission. The results are inconsistent with many American multiple centre studies that included more abundant populations.[7,17,18] On the other hand, the findings are similar to those reported in a single-centre American study with a similarly sized population that reported no association between age and 30-day readmission rate.[19]

Moreover, the current study found that length of hospital stay was not associated with 30-day readmission, contradicting an Australian multicentre study reporting that a longer length of stay was a potential predictor for 30-day readmission[12] and an American multicentre study that reported that length of stay was associated with a higher risk of readmission.[7]

The present study found no correlation between sex and risk of readmission. These findings are inconsistent with those of an American study that reported a similar readmission rate of 16%.[19] The finding was also inconsistent with that of a study in Australia[12] but similar to that of a study in Korea that reported no significant correlation between sex and readmission.[13]

Regarding comorbidities, in the multivariable analysis, the present study identified diabetes mellitus as a predictor of 30-day readmission. Similarly, an American study reported that patients with diabetes were more likely to be readmitted.[7] On the other hand, our study found no significant correlation between chronic renal failure and 30-day readmission, which contradicts the results of an American study that identified chronic renal failure as a predictor.[8] Moreover, complementing our negative findings, a study with a similarly sized population found no significant relationship between hypertension and the likelihood of readmission after CABG.[19] However, a South Korean study that compared readmission rates for CABG and PCI found that hypertension can be a predictor of post-CABG readmission. On the other hand, this same study reported that hyperlipidaemia can be a predictor of readmission, as demonstrated here.[20]

Addressing risk factors can markedly reduce the readmission rates. For instance, a study conducted at the Intermountain Medical Center (Murray, UT, USA) that aimed to reduce 30-day readmission rates after CABG formed a three-stage reduction strategy that was divided into pre-procedure, during hospitalization, and post-procedure phases. The pre-procedure strategy used the Society of Thoracic Surgeons risk calculator, European System for Cardiac Operative Risk Evaluation, 5-m walk test, and dysphagia screening test to detect patients at high risk for readmission. The strategies used during hospitalization involved not discharging the patient if their weight was >3 kg above the admission weight

or they had no bowel movements were absent, were not yet at step 5 of the cardiac rehabilitation program, had increased oxygen needs, had a haematocrit <22, had an irregular heart rhythm, or had a heart rate <120 beats/min. The post-procedure strategy included assigning physician assistants to monitor patients discharged to skilled nursing facilities and encouraging surgeons to visit these facilities and educate the staff about readmissions. After implementing the triple-aim reduction strategy, the initial readmission rate of 8.9% decreased by 64%−5.5%.[6]

There were some limitations to this study. First, the data registered in the BEST Care system may be incomplete. Second, the research team could not directly observe the cases; as such, they had to rely on other individuals for accurate recordkeeping. Third, because this was a retrospective study, selection bias may have been unavoidable. In terms of strengths, the current study is the first of its kind in KSA and encourages further exploration of readmission rates and risk factors for CABG patients and other patient populations. In addition, the study included only unplanned readmissions. This is especially important given that tertiary centres such as KAMC are more likely to experience planned readmissions for surgical procedures such as CABG.

Conclusion

Our findings suggest that the estimated 30-day readmission rate was similar to those reported in other countries. Diabetes mellitus, asthma, hyperlipidaemia, and the use of drugs such as amiodarone, statins, and amlodipine were associated with a higher risk of readmission. These risk factors must be considered in the development of effective strategies for reducing readmission rates after CABG. Such actions would remove or at least mitigate the enormous financial burden readmission inflicts on patients and health care facilities.

Recommendations

Post-CABG readmission is a complex dilemma that requires a plethora of interventions in the preoperative, perioperative, and post-discharge surgery periods. The formation of a multi-aim framework for the development of practical strategies for reducing readmissions is recommended. Further studies are necessary to better detect the underlying factors that increase patient risk of readmissions after CABG. Furthermore, a risk scoring system that is specifically tailored to this region's CABG population should be developed and used to ensure the best possible outcomes.

Source of funding

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

The study was approved by the Institutional Review Board of King Abdullah International Medical Research Center, Ministry of National Guard Health Affairs, Riyadh, KSA (approval number RC19/262/R). Patient confidentiality was ensured, and the patients' data were collected and used by the research team only. Serial numbers were used instead of medical record numbers to ensure anonymity. Due to the retrospective nature of the study and the use of anonymized patient data, the requirement for informed consent was waived.

Authors contributions

MAG, SAJ, and NAS developed the idea and designed the methods. LKS, IFS, and EAS acquired and analysed the data and interpreted and presented the results. MAG, SAJ, and NAS wrote the manuscript. LKS, IFS, and EAS critically revised the final manuscript for important intellectual content. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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