Frequency and risk factors of Unplanned 30-day readmission after Open heart surgeries: A retrospective study in A tertiary-Care-Center.

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Abstract

Background: Unplanned 30-days readmission post cardiac surgery impose higher risk for complications, increased cost and unfavorable event both for the care provider and the patient. This study is to determine the unplanned readmission rate, determinants and most common events within thirty days post cardiac surgery . Recommendations to prevent or minimize these complications are included. Method **:** Sitting and design: A retrospective record review was conducted among all the adult patients who underwent open heart surgery between January 2020 and December 2021at King Abdulaziz University Hospital (KAUH), Jeddah, Kingdom of Saudi Arabia. methods and material: Using Google Forms, we manually collected data from hospital records. statistical analysis used: binomial logistic regression model (using the backward stepwise method). Regression outcomes were expressed as odds ratios (ORs) and 95%CIs. A p value of < 0.05 indicated statistical significance. Results: Among 400 patients who underwent cardiac surgery, 343 patients were included in the study, 53 unplanned readmission, rate of 16.3% (95%CI, 12.8 to 20.6%). The most frequently reported reasons for readmission were sternal wound infections (7.3%), pleural effusion (2.0%) and heart failure (1.7%). Female gender, high post operative LDH and urea are the most important risk factors. Conclusion: Discharge planning, patient education, and cardiac surgery nurse home visit constitute the most important factors to minimize 30 days of unplanned readmission.

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Introduction:

Unplanned hospital readmission is a subsequent or unscheduled admission to the same specialty through the Accident & Emergency Department within 30 days of the index hospitalization [(5)]. Recently, considerable attention has been paid to unplanned hospital readmissions (UHA) post cardiac surgery because of its significant incidence reported between 8% to 24% of discharged patients[(1–4)]. Prevention or at least minimizing UHA will effectively help in containing early complications, cost and better patient care.

Methadology

This two-year retrospective record review was conducted during Jan-Feb 2022 after receiving approval from the Research Ethical Committee at the College of Medicine, King Abdulaziz University Hospital (KAUH), Jeddah, Kingdom of Saudi Arabia (Reference: 114-22). KAUH is a government tertiary healthcare center that serves all strata of society. We included all the adult (>18 years) patients who underwent Open heart surgery during the period of January 2020 to December 2021 at KAUH. The focus of our study was to first to identify the most significant risk factors that led to 30-day readmission after Open Heart surgeries and then to determine its prevalence. The data were collected manually from our hospital information system, Phoenix, using Google Forms. After excluding patients who didn't met the criteria like patients below 18 years and patients who dies during the operation or within the hospitalization and before discharge we extracted the following variables from (400) patients: medical record number, nationality (Saudi – Non-Saudi) , gender (Male – Female) , age at the time of surgery(18-49, 50-59, 60-69, 70-79, >=80) , any associated co-morbidities (HTN- DM- CHF- Smoking- CVD- PVD- Anemia- hyperlipidemia- Dyslipidemia- Obesity- Malignancies- COPD- Asthma- CKD- thyroid disease - chronic liver disease- Pre-op use of (aspirin, Heparin, Thrombolysis, antiplatelet drug)- Other.), type of cardiac intervention (isolated coronary surgery- isolated valvular surgery- combined (coronary and valvular), priority of surgery , length of hospitalization(<7 , 714, 14-30, >30 days), surgery duration, left ventricular ejection fraction, patient BMI, Readmission , Cause of Readmission (Surgical site infection "Sternal"- Surgical site infection "saphenous"- haemorrhage and haematoma- heart failure- myocardial ischemia, acute MI- valvular problem- arrhythmia- HTN- pericardial effusion- aortic dissection- cariogenic shock- cerebrovascular event (stroke)- pneumonia- plural effusion- pulmonary thromboembolism/ DVT- GI bleeding and complication- complication of anticoagulation therapy- metabolic

disturbance (dehydration, hyponatremia, ketoacidosis, hypoglycemia)- other/unspecified. and preoperative and postoperative lab assessment (Hemoglobin- HCT- INR- PT- APTT- CK- LDH – Troponin- Creatinine- Urea).

Microsoft Excel v16.0 was used to organize the data and then Statistical analysis was performed using the Statistical Package for the Social Sciences (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp) and R version 4.1.1. Frequencies and percentages were utilized as descriptive statistics for the categorical variables, and numerical data was presented as medians and interquartile ranges (IQRs). The rate of 30day unplanned readmission was computed using the one-sample proportion test without continuity correction, and data was expressed as proportion and the respective 95% confidence interval (95%CI). The independent risk factors for readmission were assessed by constructing a binomial logistic regression model (using the backward stepwise method). The readmission status (no versus yes) was used as a dependent variable, and the collected demographic and clinical data were entered as independent variables. Regression outcomes were expressed as odds ratios (ORs) and 95%CIs. A p value of < 0.05 indicated statistical significance.

Results

Demographic, clinical and procedural characteristics of patients:

The records of 343 patients were analyzed in the current study. The majority of patients were males (79.6%), and non-Saudis (88.0%). Elderly patients (aged 60 years or older) represented 50.15% of the sample. Regarding the procedural characteristics, elective surgeries were performed in 86.3% of patients. A high proportion of patients underwent isolated coronary surgeries (77.6%), while isolated valvular and combined surgeries represented 21.6% and 0.9% of procedures, respectively. Other procedural and demographic characteristics and listed in Table 1. Focusing on the clinical history of patients, the most commonly reported conditions at baseline included anemia (62.1%), hypertension (61.5%) and diabetes mellitus (58.9%, Figure 1).

Thirty-day readmission rate and the reasons for readmission:

Among the included patients, 56 patients were readmitted within 30 days after surgeries, with an unplanned readmission rate of 16.3% (95%CI, 12.8 to 20.6%). The most frequently reported reasons for readmission were sternal wound infections (7.3%), pleural effusion (2.0%) and heart failure (1.7%). More details about the reasons of readmission are depicted in Figure 2.

Factors associated with the 30-day readmission:

Based on the preoperative characteristics, univariate association analysis showed that a significantly higher proportion of readmitted patients were females (35.7% versus 17.4% of non-readmitted females, p = 0.002). Furthermore, readmission was associated with a positive history of a peripheral vascular disease (PVD in 3.6% versus no PVD in 0.3%, p = 0.018, Table 2). Concerning the laboratory parameters, readmitted patients had significantly higher postoperative LDH concentrations compared to non-readmitted patients (median = 421.0, IQR = 333.0 to 469.0 versus median = 354.0, IQR = 290.0 to 436.0, respectively, p = 0.007, Table 3).

Risk factors for the 30-day readmission

A logistic regression model was constructed to reveal the independent risk factors for the 30-day readmission after open heart surgeries. The final model explained 25.2% of the variance in readmission, and it correctly classified 87.0% of cases. Results indicated that the following variables were independent risk factors for readmission within 30-days: the female gender (OR = 3.71, 95%CI, 1.64 to 8.37, p = 0.002), peripheral vascular disease (OR = 21.73, 95%CI, 1.34 to 351.64, p = 0.030), and malignancy (OR = 6.16, 95%CI, 1.14 to 33.24, p = 0.034), as well as high postoperative Hb (OR = 1.33, 95%CI, 1.01 to 1.76, p = 0.043), and postoperative urea concentrations (OR = 1.19, 95%CI, 1.09 to 1.30, $p < 0.0001$, Table 4.

Table 1: *Demographic and proc* edural characteristics of patients

Parameter	Category	Frequency	Percent
Gender	Male	273	79.6
	Female	70	20.4
Nationality	Non-Saudi	302	88.0
	Saudi	41	12.0
Age categories (years)	18-49	66	19.2
	50-59	105	30.6
	60-69	106	30.9
	70-79	58	16.9
	80 or older	8	2.3
BMI*	Median, IQR	26.1	24.2-29.4
BMI categories*	Underweight	12	3.5
	Healthy	102	29.7
	Overweight	148	43.1
	Obese	71	20.7
LVEF on admission	Median, IQR	48.0	40.0-57.0
Type of intervention	Isolated coronary surgery	266	77.6
	Isolated valvular surgery	74	21.6
	Combined (coronary and valvular)	3	0.9
Priority of surgery	Elective	296	86.3
	Emergency	47	13.7
Duration of the surgery (hrs.)¥	Median, IQR	245.0	218.0-281.0
Length of hospitalization	<7 days	94	27.4
	7-14 days	182	53.1
	14-30 days	55	16.0
	>30 days	12	3.5

**Data was retrieved for 333 patients; ¥Data was retrieved for 341 patients; IQR: interquartile range; LVEF: Left ventricular ejection fraction; Data was expressed as frequencies and percentages unless otherwise stated*

Table 2: Analysis of the demographic and clinical factors associated with readmission within 30 days after open heart surgeries.

Parameter Category 30-day Readmission P

No (n=287) Yes (n=56)

Gender	Male	237 (82.6)	36 (64.3)	**0.002**
	Female	50 (17.4)	20 (35.7)	
Nationality	Non-Saudi	255 (88.9)	47 (83.9)	0.299
	Saudi	32 (11.1)	9 (16.1)	
Age	18-49	52 (18.1)	14 (25.0)	0.649
	50-59	89 (31.0)	16 (28.6)	
	60-69	92 (32.1)	14 (25.0)	
	70-79	48 (16.7)	10 (17.9)	
	80 or older	6 (2.1)	2 (3.6)	
BMI	Underweight	12 (4.3)	0 (0.0)	0.128
	Healthy	82 (29.4)	20 (37.0)	

Gender	Male	237 (82.6)	36 (64.3)	**0.002**
	Overweight	129 (46.2)	19 (35.2)	
	Obese	56 (20.1)	15 (27.8)	
Smoking		73 (25.4)	13 (23.2)	0.726
Hypertension		172 (59.9)	39 (69.6)	0.172
Diabetes mellitus		168 (58.5)	34 (60.7)	0.762
Chronic heart failure		6 (2.1)	2 (3.6)	0.502
Peripheral vascular disease		1 (0.3)	2 (3.6)	**0.018**
Anemia		179 (62.4)	34 (60.7)	0.815
Hyperlipidemia		11 (3.8)	1 (1.8)	0.446
Dyslipidemia		36 (12.5)	9 (16.1)	0.474
Obesity		59 (20.6)	15 (26.8)	0.300
Malignancy		4 (1.4)	3 (5.4)	0.055
Asthma		3 (1.0)	1 (1.8)	0.999
Chronic kidney disease		12 (4.2)	3 (5.4)	0.694
Thyroid disease		5 (1.7)	3 (5.4)	0.101
Chronic liver disease		3 (1.0)	1 (1.8)	0.512
Preoperative medication use*		75 (26.1)	15 (26.8)	0.919
LVEF on admission	Median (IQR)	48.0 (40.0-57.0)	48.0 (40.0-58.0)	0.660

*Data was expressed as frequencies and percentages unless otherwise stated; *Medication use included the preoperative use of at least one of the following drugs: Aspirin, Heparin, thrombolytic drugs or antiplatelet drugs*

Table 3: Analysis of the preoperative and postoperative laboratory parameters associated with readmission within 30 days after open heart surgeries.

Parameter	**30-day Readmission**	**30-day Readmission**	**30-day Readmission**	**30-day Readmission**	**P**	**P**	**P**
	No (n=287)	**No (n=287)**	**Yes (n=56)**	**Yes (n=56)**			
Preoperative							
Hb	12.9 (11.2-14.1)	12.9 (11.2-14.1)	12.8 (10.9-14.5)	12.8 (10.9-14.5)	0.927	0.927	0.927
HCT	38.8 (33.8-42.4)	38.8 (33.8-42.4)	38.2 (33.9-43.2)	38.2 (33.9-43.2)	0.934	0.934	0.934
PT	12.1 (11.5-12.8)	12.1 (11.5-12.8)	11.9 (11.4-12.9)	11.9 (11.4-12.9)	0.356	0.356	0.356
APTT	32.8 (29.9-37.0)	32.8 (29.9-37.0)	31.6 (29.3-36.9)	31.6 (29.3-36.9)	0.399	0.399	0.399
CK	101.0 (65.0-256.0)	101.0 (65.0-256.0)	91.0 (59.0-260.0)	91.0 (59.0-260.0)	0.573	0.573	0.573

Parameter	30-day Readmission	30-day Readmission	30-day Readmission	30-day Readmission	P	P	P
LDH	242.0 (181.0-329.0)	242.0 (181.0-329.0)	244.0 (169.5-369.0)	244.0 (169.5-369.0)	0.896	0.896	0.896
Troponin	0.4 (0.0-4.4)	0.4 (0.0-4.4)	0.1 (0.0-6.5)	0.1 (0.0-6.5)	0.655	0.655	0.655
Creatinine	86.0 (72.0-104.0)	86.0 (72.0-104.0)	82.0 (70.8-109.0)	82.0 (70.8-109.0)	0.992	0.992	0.992
Urea	4.8 (4.0-6.0)	4.8 (4.0-6.0)	5.1 (4.0-7.6)	5.1 (4.0-7.6)	0.196	0.196	0.196
Postoperative							
Hb	Hb	9.8 (9.0-10.6)	9.8 (9.0-10.6)	10.1 (9.3-10.9)	10.1 (9.3-10.9)	0.382	
HCT	HCT	29.6 (27.2-31.9)	29.6 (27.2-31.9)	30.1 (27.9-33.3)	30.1 (27.9-33.3)	0.375	
PT	PT	13.7 (12.9-14.6)	13.7 (12.9-14.6)	13.6 (12.6-14.9)	13.6 (12.6-14.9)	0.363	
APTT	APTT	32.7 (29.4-36.9)	32.7 (29.4-36.9)	34.1 (28.7-40.2)	34.1 (28.7-40.2)	0.645	
CK	CK	448.0 (302.0-673.0)	448.0 (302.0-673.0)	450.5 (321.5-681.5)	450.5 (321.5-681.5)	0.768	
LDH	LDH	354.0 (290.0-436.0)	354.0 (290.0-436.0)	421.0 (333.0-496.0)	421.0 (333.0-496.0)	**0.007**	
Troponin	Troponin	6.6 (3.4-14.3)	6.6 (3.4-14.3)	8.4 (3.7-14.9)	8.4 (3.7-14.9)	0.404	
Creatinine	Creatinine	91.5 (72.3-111.0)	91.5 (72.3-111.0)	98.6 (78.8-117.5)	98.6 (78.8-117.5)	0.081	
Urea	Urea	4.8 (3.9-6.0)	4.8 (3.9-6.0)	5.0 (3.9-8.0)	5.0 (3.9-8.0)	0.169	

Data was expressed as median (interquartile range)

Table 4: Results of the multivariate regression analysis to assess the risk factors for the 30-day readmission after open heart surgeries.

Variables	OR (95% CI)	p value
Female (vs Male)	3.71 (1.64-8.37)	**0.002**
Peripheral vascular disease	21.73 (1.34-351.64)	**0.030**
Malignancy (yes vs no)	6.16 (1.14-33.24)	**0.034**
Postoperative Hb (per unit)	1.33 (1.01-1.76)	**0.043**
Postoperative LDH (per unit)	1.00 (1.00-1.00)	0.058
Postoperative Urea (per unit)	1.19 (1.09-1.30)	$<$ **0.0001**

OR: odds ratio; bold values indicate statistical significance at $p < 0.05$. The results were based on backward stepwise logistic regression analysis, which included the baseline demographic variables, clinical history of patients, and procedural variables, as well as pre- and post-operative laboratory parameters.

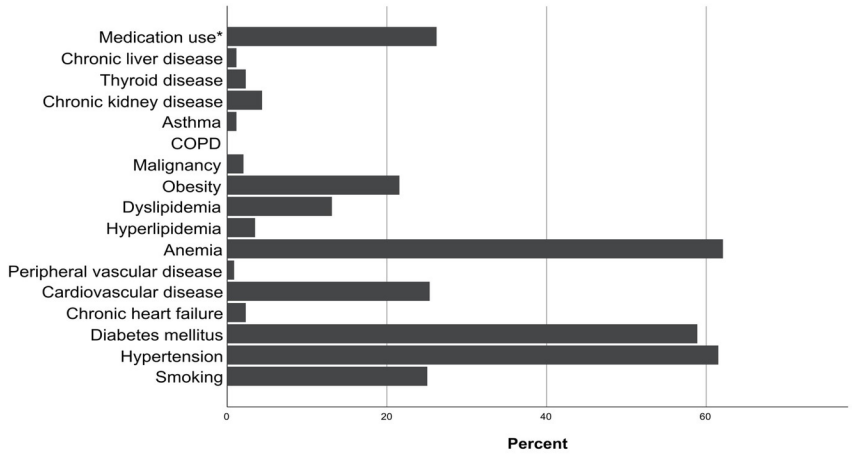

Figure 1: the percentages of chronic conditions and other parameters of the clinical history of patients. *Medication use included the preoperative use of at least one of the following drugs: Aspirin, Heparin, thrombolytic drugs or antiplatelet drugs.

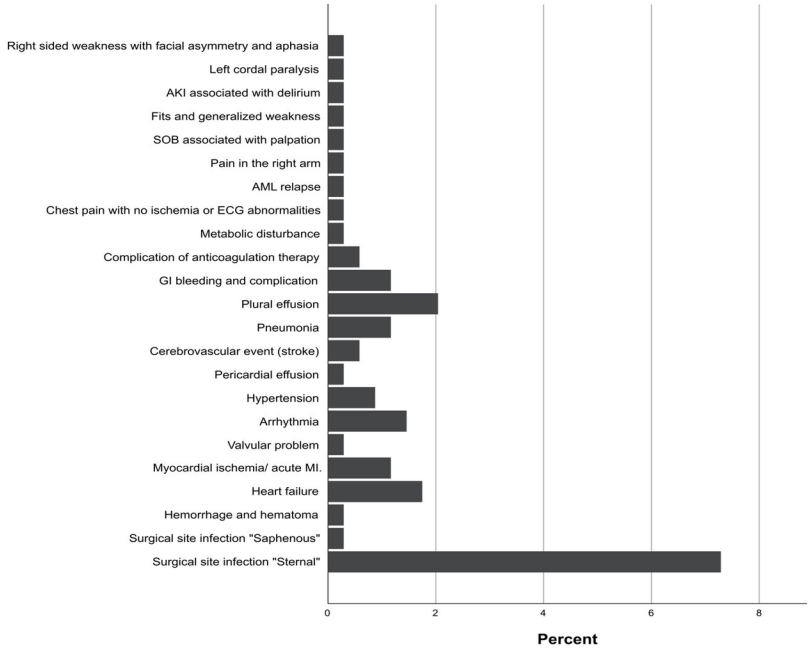

Figure 2: the percentage distribution of the reasons for readmission within 30 days after open heart surgeries. Other reasons (n=8) included the following conditions (each in one patient): AML relapse, AKI associated with delirium, SOB associated with palpation (no other details), fits and generalized weakness, left cordal paralysis, chest pain with no ischemia or ECG abnormalities, pain in right arm, and right sided weakness with facial asymmetry and aphasia.

Discussion

Despite substantial advances in heart surgery over the last fifty years, early and unplanned hospital readmission after cardiac procedures remains prevalent. Cardiovascular disease (CVD) is now recognized as the leading cause of death and disability worldwide [(6)]. and is estimated to be responsible for 42% of all mortality[(7)]. Open heart surgery is crucially important in the therapeutic interventions of a broad range of cardiovascular disorders, and it involves the care of a patient with higher acuity and complexity[(8)]. Subsequently, over 800,000 cardiac surgical operations are performed globally each year [(9)]. This includes coronary artery bypass grafting (CABG) and valvular surgery, which has been the most common form of surgical intervention performed worldwide [(10)]. The large numbers of annual cardiac surgical operations indicate that even a small percentage of readmissions can explicit a high cost to the health care system. Lowering hospital readmission rates has been considered an effective method to enhance the quality of care and reduce costs[(11)]. Nevertheless, a retrospective cohort study in the United States between January 1, 2005, and November 30, 2007, showed that the 30-day readmission rate after cardiac surgery ranged from 8.3% to 21.1%, with the most common reasons for readmission being postoperative infection (16.9%) and heart failure (12.8%)[(12)]. Iribarne and colleagues in a prospective study reported that the overall rate of readmission was 18.7% with female gender, diabetes mellitus, COPD, elevated creatinine, and lower hemoglobin being the top most common risk factors for re-admission after cardiac surgery[(13)]. Additionally, a recent retrospective observational study done in Northern New England revealed that the 30-day readmission rate after cardiac surgery was 12.3%[(14)]. Moreover, there is a variation of the most common type of cardiac surgery associated with readmission[(13–15)]. Lowering readmission rates is an important goal of all care providers for future quality improvement and cost contaiment. However, due to limited studies worldwide and most specifically in the Middle East and the Kingdom of Saudi Arabia on this topic, further data is required to establish the etiologic spectrum and risk factors of 30-day cardiac surgery readmissions .

In this study, we aimed to explore the readmission rate and its associated risk factors. Among patients admitted for open-heart surgery, the readmission rate in our study was 16.3%. Similarly, a retrospective study gathered in New York, United States, showed the readmission rate was 16.5% [(12)]. On the other hand, a separate study in Florida, United States, was 23% [(16)]. Subsequently, despite the variation between the population, the readmission rates are still within the same ranges. Moreover, over the past years, cardiac surgeries have been improving regarding patient overall outcome. For this reason, we are concerned with identifying the possible risk factors and causes of readmission.

Significant Predictor for Hospital Readmission After Cardiac Surgery included female gender, peripheral vascular disease, malignancy, postoperative Hb and urea. Females had a significant relationship with 30-day readmission following open-heart surgery, according to our study (P-value 0.002). This supports the findings of Case and colleagues[(16)] indicating strong associations between females and readmission (P-value 0.0406) necessitating close monitoring and appropriate home care after discharge. In this study, there is a significant relation between peripheral vascular disease and 30 days readmission with a (P-value of 0.030), which correlates with the study done in New York [(12)]. Malignancy was found to be significantly associated with readmission rate ($p = 0.034$), This outcome is contrary to Chan and colleagues reporting no difference in the rate of hospital readmission in patients with malignancy ($p=0.19$)[(20)]. Cancer patients poor overall health and their vulnerability to complications might be the cause. One of the significant relations in our study is the high postoperative hemoglobin and the relationship with 30-day readmission after open-heart surgery, with a P-value of 0.043. This could be because of higher blood viscosity and decrease flow. Iribarne and colleagues found that high postoperative hemoglobin was a protective parameter for the risk of readmission[(13)]. Post-op Urea have a significant link with increased rates of readmission ($p < 0.0001$). This was also consistent with earlier observation, carried out in Serbia, which reported that post-op Urea concentrations were related to higher readmission rate [(19)].

Causes for unplanned early readmission were sternal wound infections, pleural effusion, heart failure, and Arrhythmia respectively. Sternal wound infection is a preventable complication once its risk factors, precautions and safety measures are followed [(21,22)]. Several studies showed similar results [(12,16,23,24)]. In a

retrospective study done in Denmark [25], 25% of the patients who underwent valve surgery were readmitted within 30-days of discharge because of pleural/pericardial effusion followed by atrial fibrillation/flutter. Readmission due to atrial fibrillation in our study was significantly lower than the Denmark study. Most of the postoperative pleural effusion is secondary to residual post surgical bleeding, excessive transfusion or diaphragmatic palsy or paralysis[26]

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Conclusion:

This study has demonstrated that short-term readmissions following open heart surgery remain a persistent challenge. Identification of the high risk patients for readmission and formulating a clinical risk score including the predictive factors prior to discharge is crucial to minimize or prevent the unfavorable event. Implementation of prevention strategy including patient education of the performed procedure and expected complications, discharge planning, cardiac surgery nurse home visits, close appointment of the first postoperative visit and contact numbers of surgical team.

Limitation

The main limitations included being single center study, retrospective small volume. Large multicenter prospective studies are needed to delineate this unfavorable event and provide preventive measures.

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