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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-day readmission post-cardiac surgery imposes higher risks for complications, increased costs, and unfavorable events for the care provider and patient. This study was to determine the unplanned readmission rate, determinants, and most common events within 30 days post-cardiac surgery. Recommendations to prevent or minimize these complications are included.

Methods: Setting and design – a retrospective record review was conducted among all adult patients, who underwent open heart surgery between 2010 and 2020 at King Abdulaziz University Hospital (KAUH), Jeddah, Kingdom of Saudi Arabia.

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, including 53 unplanned readmissions, which was a 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 postoperative LDH and urea were 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.

INTRODUCTION

Over the past several years, considerable attention has been paid to unplanned hospital readmissions (UHR), especially cardiac-related hospital readmissions after cardiac operations, occurring in 8% to 24% of discharged patients [Stanton 1985; Beggs 1996; Zitser-Gurevich 1999; Sabourin 1999]. "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 [Landrum 2006]. Cardiovascular disease (CVD) is now recognized as the leading cause of death and disability worldwide [Mendis 2011]. It is estimated to be responsible for 42% of all mortality [Saquib 2017]. Open heart surgery is crucially important in the therapeutic interventions of a broad range of cardiovascular disorders and involves the care of a patient with higher acuity and complexity [Abdallah 2012]. Subsequently, over 800,000 cardiac surgical operations are performed each year globally [Boeken 2011]. This includes coronary artery bypass grafting (CABG) and valvular surgery, which has been the most common form of surgical intervention performed worldwide [Bharadwaj 2008]. The large numbers of annual cardiac surgical operations indicate that even a small percentage of readmissions can render a high cost to the health care system. Hospital readmissions are expensive and relatively preventable. Lowering hospital readmission rates has been considered an effective method to enhance the quality of care and reduce costs [Keenan 2008]. 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%) [Hannan 2011]. Also, a 2014 prospective study done in the United States reported the overall readmission rate was 18.7%, with female gender, diabetes mellitus, COPD, elevated creatinine, and lower hemoglobin being the top most common risk factors for readmission after cardiac surgery [Iribarne 2014]. Additionally, a recent retrospective observational study in Northern New England revealed that the 30-day readmission rate after cardiac surgery was 12.3% [Trooboff 2019]. Moreover, there is a variation in the most common type of cardiac surgery associated with readmission [Iribarne 2014; Trooboff 2019; Hirji 2020]. Finally, prevention or at least minimizing UHR will effectively help contain early complications, costs, and better patient care. However, due to limited studies worldwide and most specifically in the Middle East and the Kingdom of Saudi Arabia on the topic, further data is required to establish the etiologic spectrum and timing of readmissions to inform the development of targeted quality initiatives. So,

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we aim to assess the frequency and risk factors for unplanned 30-day readmission in patients who had open heart surgery at KAUH between 2010 and 2020.

METHODS

This 10-year retrospective record review was conducted from January-February 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 adult (>18 years) patients, who underwent open heart surgery during the period of 2010–2020 at KAUH. The focus of our study was to first identify the most significant risk factors that led to 30-day readmission after open heart surgeries and then determine their prevalence. Data manually were collected from our hospital information system, Phoenix, using Google Forms. We excluded patients who didn't meet the criteria, like patients below 18 years and those who died 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); preoperative use of aspirin, heparin, thrombolysis, antiplatelet drug or other; type of cardiac intervention (isolated coronary surgery, isolated valvular surgery, or combined (coronary and valvular); priority of surgery (elective or emergency); length of hospitalization (<7 , 7-14, 14-30, >30 days); surgery duration; left ventricular ejection fraction; patient BMI; readmission (yes-no); cause of readmission (surgical site infection "sternal," surgical site infection "saphenous," hemorrhage and hematoma complication, heart failure, myocardial ischemia/acute MI, valvular problem, arrhythmia, HTN, pericardial effusion, aortic dissection, cardiogenic shock, cerebrovascular event (stroke), pneumonia, plural effusion, pulmonary thromboembolism/DVT, GI bleeding and complication, complication of anticoagulation therapy); metabolic disturbance (dehydration, hyponatremia, ketoacidosis, hypoglycemia or 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 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 were presented as medians and interquartile ranges (IQRs). The rate of 30-day unplanned readmission was computed using the one-sample proportion test without continuity correction, and data were 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 (age 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. (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. (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 with 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) No operative characteristics were associated with readmission within 30 days. (Table 4)

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), having a positive history of a cardiovascular disease (OR = 2.38, 95%CI, 1.09 to 5.16, P = 0.029), peripheral vascular disease (OR = 21.73, 95%CI, 1.34 to 351.64, P = 0.030), and malignancy (OR =

Table 1. Demographic and procedural 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 surgery (hours)¥	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

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 5)

DISCUSSION

Despite substantial advances in heart surgery over the last 50 years, early and unplanned hospital readmission after cardiac procedures remains prevalent.

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% [Hannan 2011]. On the other hand, a separate study in Florida, United States, was 23% [Case 2020]. 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 outcomes. For this reason, we are concerned with identifying the possible risk factors and causes of readmission.

Predictors for hospital readmission after cardiac surgery:

- Female – 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 research conducted in the United States [Case 2020], indicating strong associations between females and readmission (P-value 0.0406). Hence, it could conceivably be hypothesized that the female gender is at higher risk of readmission than males, necessitating close monitoring and appropriate home care after discharge.

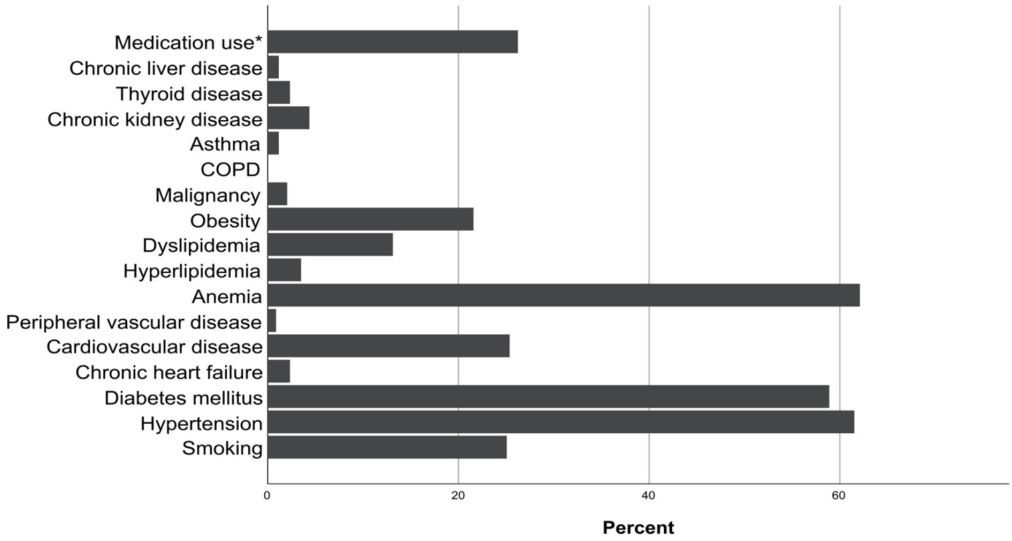

Figure 1. The percentages of chronic conditions and other parameters of the clinical history of patients. *Medication use included the preoperative use of at least one of the following drugs: aspirin, heparin, thrombolytic drugs, or antiplatelet drugs.

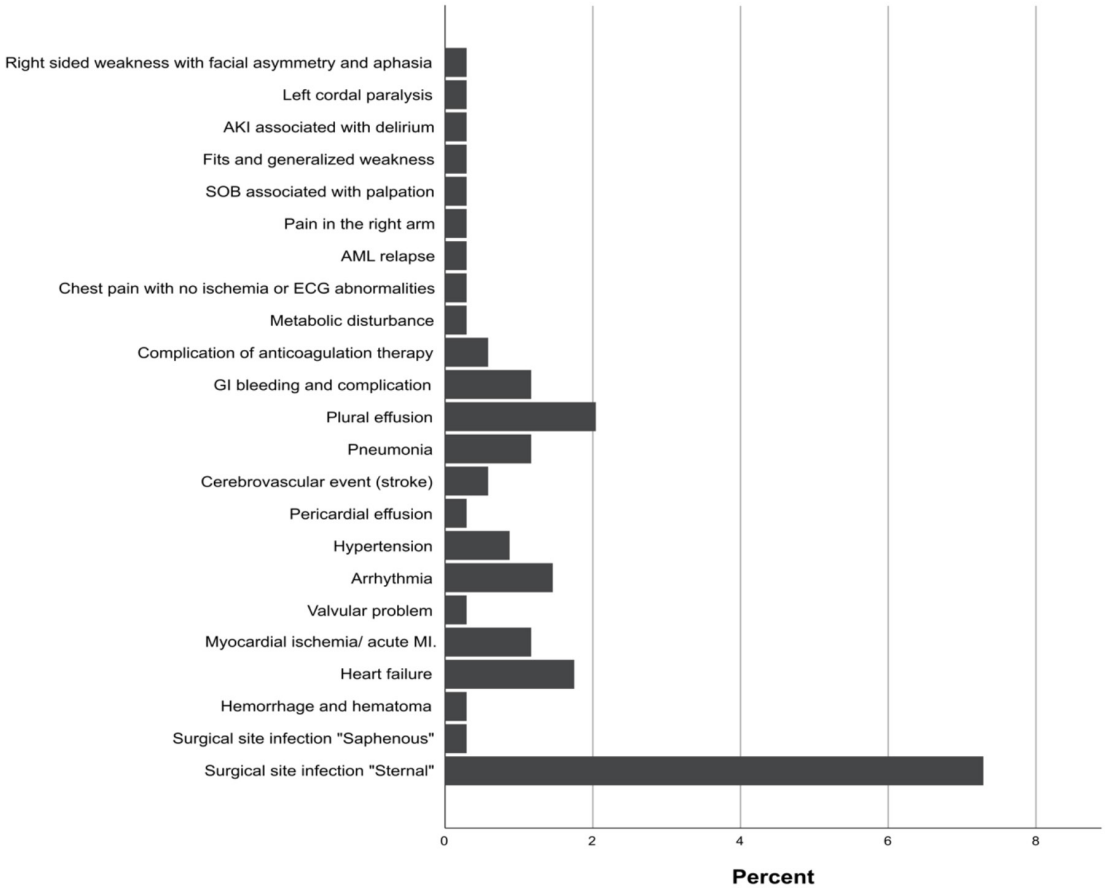

Figure 2. Reasons for readmission within 30 days after open heart surgeries. Other reasons (N = 8) included the following conditions (each in one patient): AML relapse, AKI associated with delirium, SOB associated with palpation (no other details), fits and generalized weakness, left cordal paralysis,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

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

Parameter	Category	30-day Readmission No (*N* = 287)	30-day Readmission Yes (*N* = 56)	*P*
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)	
	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
Cardiovascular disease	-	70 (24.4)	17 (30.4)	0.348
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
COPD	-	0 (0.0)	0 (0.0)	NA
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 drug

- Cardiovascular disease – our findings broadly support prior studies done in the U.S. and Serbia [Benuzillo 2018; Li 2012; Redžek 2015], which have noted the significance of cardiovascular disease in correlation with a risk factor for readmission. This result may be explained by the fact that cardiovascular instability is accountable for half of the postoperative complications, where these types of patients are very susceptible to hypoxia, anemia, and the negative effects of certain anesthetics.
- Peripheral vascular disease – 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 [Hannan 2011], where they found a strong relationship with a P-value of 0.0002. We believe that because these patients already have weak and damaged vessels, these types of invasive procedures put more stress on the vessels and make the patients more prone to develop complications and subsequently, readmissions.

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

Parameter	30-day Readmission No (*N* = 287)	30-day Readmission Yes (*N* = 56)	*P*
Preoperative			
Hb	12.9 (11.2-14.1)	12.8 (10.9-14.5)	0.927
HCT	38.8 (33.8-42.4)	38.2 (33.9-43.2)	0.934
PT	12.1 (11.5-12.8)	11.9 (11.4-12.9)	0.356
APTT	32.8 (29.9-37.0)	31.6 (29.3-36.9)	0.399
CK	101.0 (65.0-256.0)	91.0 (59.0-260.0)	0.573
LDH	242.0 (181.0-329.0)	244.0 (169.5-369.0)	0.896
Troponin	0.4 (0.0-4.4)	0.1 (0.0-6.5)	0.655
Creatinine	86.0 (72.0-104.0)	82.0 (70.8-109.0)	0.992
Urea	4.8 (4.0-6.0)	5.1 (4.0-7.6)	0.196
Postoperative			
Hb	9.8 (9.0-10.6)	10.1 (9.3-10.9)	0.382
HCT	29.6 (27.2-31.9)	30.1 (27.9-33.3)	0.375
PT	13.7 (12.9-14.6)	13.6 (12.6-14.9)	0.363
APTT	32.7 (29.4-36.9)	34.1 (28.7-40.2)	0.645
CK	448.0 (302.0-673.0)	450.5 (321.5-681.5)	0.768
LDH	354.0 (290.0-436.0)	421.0 (333.0-496.0)	0.007
Troponin	6.6 (3.4-14.3)	8.4 (3.7-14.9)	0.404
Creatinine	91.5 (72.3-111.0)	98.6 (78.8-117.5)	0.081
Urea	4.8 (3.9-6.0)	5.0 (3.9-8.0)	0.169

Data was expressed as median (interquartile range)

Table 4. Analysis of the operative parameters associated with readmission within 30 days after open heart surgeries

Parameter	Category	30-day Readmission No (*N* = 287)	30-day Readmission Yes (*N* = 56)	*P*
Type of intervention	Isolated coronary surgery	221 (77.0)	45 (80.4)	0.681
	Isolated valvular surgery	63 (22.0)	11 (19.6)	
	Combined (coronary and valvular)	3 (1.0)	0 (0.0)	
Priority of surgery	Elective	249 (86.8)	47 (83.9)	0.573
	Emergency	38 (13.2)	9 (16.1)	
Length of hospitalization	<7 days	78 (27.2)	16 (28.6)	0.165
	7-14 days	158 (55.1)	24 (42.9)	
	14-30 days	43 (15.0)	12 (21.4)	
	>30 days	8 (2.8)	4 (7.1)	
Duration of surgery	Median (IQR)	245.0 (219.0-280.0)	244.5 (206.0-294.0)	0.988

Data was expressed as frequencies and percentages unless otherwise stated

Table 5. 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
Cardiovascular disease (yes vs. no)	2.38 (1.09-5.16)	0.029
Peripheral vascular disease (yes vs. no)	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

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 postoperative laboratory parameters. OR, odds ratio; bold values indicate statistical significance at $P < 0.05$.

- Malignancy – malignancy was found to be significantly associated with the readmission rate ($P = 0.034$). This outcome is contrary to that of those who found there is no difference in the rate of hospital readmission in terms of malignancy ($P = 0.19$) [Chan 2012]. A possible interpretation for this is that malignancy is not the direct consequence of readmission. However, a result of cancer patients' poor overall health and their vulnerability to complications might be the cause.
- Postoperative hemoglobin – one of the significant relations in our study is the high postoperative hemoglobin and relationship with 30-day readmission after open heart surgery, with a P-value of 0.043. In contrast to another study [Iribarne 2014], they found that high postoperative hemoglobin was a protective parameter for the risk of readmission. It is controversial among the studies, so this calls for further investigation into this risk factor. But from our point of view, we believe that abnormal deviation from the normal baseline of any hemodynamic parameter will reflect on a patient's health and make them more predisposed to developing complications and thus readmission.
- Postoperative urea – one of the most noticeable findings to emerge from the analysis is that postoperative urea concentrations have a significant link with increased rates of readmission ($P < 0.0001$). This also was consistent with earlier observation carried out in Serbia, which reported that postoperative urea concentrations were related to readmission rate [Redžek 2015]. It is therefore likely that such connections exist between a high level of urea concentration and poor outcomes in delaying the rate of recovery progression.
- Reason for readmission – 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 [Al-Ebrahim 2020; Al-Ebrahim 2022]. Several studies showed similar results [Hannan 2011; Case 2020; Abdelnabey 2014; Shah 2019]. In a retrospective study done in Denmark [Weiss 2020], 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 in the Denmark study. Valvular surgeries were the least conducted surgeries in our data. There is a strong relation between valvular surgery and the readmission rate due to atrial fibrillation. Most of the postoperative pleural effusion is secondary to residual post-surgical bleeding, excessive transfusion or diaphragmatic palsy, or paralysis [Al-Ebrahim 2019].

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

CONCLUSION

In summary, this study aimed to assess the prevalence and risk factors for unplanned 30-day readmission in patients, who had open heart surgery between 2010 and 2020 at KAUH, Jeddah, Saudi Arabia. This study has demonstrated that short-term readmissions following open heart surgery remain a persistent challenge. According to our findings, we noticed that the female gender, having a positive history of cardiovascular disease, peripheral vascular disease, malignancy, and high postoperative hemoglobin and urea concentrations all were significantly associated with the risk of readmission. Moreover, the most commonly reported reasons for readmission were sternal wound infection, pleural effusion, and heart failure. Finally, 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 include patient education of the performed procedure and expected complications, discharge planning, cardiac surgery nurse home visits, the close appointment of the first postoperative visit, and contact numbers of the surgical team.

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