AMJ Australasian Medical Journal [AMJ 2020;13(1):32-40]

Which level of preoperative glycated haemoglobin (HbA1c) affect early morbidity and mortality after cardiac surgery?

Yasser F. Elghoneimy[1], Medhat R. Nashy[1], Sharifah A. Othman[2], Norah M. Almarri[2], Asayel A. Alruwaili[2], Assayl R. Alotaibi[2], and Fahad A. Alshammari[2]

1. Division of Cardiac Surgery, department of General Surgery, Imam Abdulrahman bin Faisal University, Dammam, Kingdom of Saudi Arabia
2.College of Medicine, Imam Abdulrahman bin Faisal University, Dammam, Kingdom of Saudi Arabia

RESEARCH

Please cite this paper as: Elghoneimy YF, Nashy MR, Othman SA, Almarri NM, Alruwaili AA, Alotaibi AR, Alshammari FA. Which level of preoperative glycated haemoglobin (HbA1c) affect early morbidity and mortality after cardiac surgery? AMJ 2020;13(1):32–40.
https://doi.org/10.35841/1836-1935.13.1.32-40

Corresponding Author:
Yasser F. Elghoneimy
Division of Cardiac Surgery, Department of General Surgery, Imam Abdulrahman bin Faisal University, Dammam, 34212, Kingdome of Saudi Arabia
Email: Yfarag@iau.ed.sa

ABSTRACT

Background
Diabetics account for 34 per cent of all patients undergoing coronary artery bypass graft (CABG) surgery, and have higher rates of postoperative mortality. Furthermore, they are at risk for ICU admission postoperatively due to complications of hyperglycaemia, which in turn increases hospital mortality.

Aims
The purpose of this study was to evaluate the level of glycated haemoglobin (HbA1c) in patients undergoing cardiac surgery, and to establish it is an independent predictor for postoperative mortality and morbidity.

Methods
This retrospective study was conducted at King Fahd University Hospital. Files of 146 diabetic patients who underwent cardiac surgery in the period between September 2015 to June 2018 were included. One hundred and five patients met the inclusion criteria. Depending on the results of HbA1c preoperatively, patients were divided into 2 groups: Group A, with a HbA1c >=8.5 per cent, accounting for 33 patients, and Group B with a HbA1c <=8.4 per cent accounting for 71 patients.

Results
This study included 79 males and 25 females, with ages ranging in between 17 to 87 years old, with no significant difference between both groups in age and sex. A significant difference was found between Group A and Group B in postoperative mortality (p-value <0.002). No significant difference was found when comparing length of hospital stay, wound infection postoperatively, reoperation, or readmission.

Conclusion
There was a significant difference in mortality postoperativly between the two groups, with patients who had higher HbA1c levels experiencing higher mortality. Since our sample size was small, we recommend that further studies be done in multiple centres.

Key Words
Cardiac surgery, HgA1c, postoperative mortality, hyperglycaemia

What this study adds:

1. What is known about this subject?
Diabetics account for 34 per cent of all patients undergoing coronary artery bypass graft (CABG) surgery, and have higher rates of postoperative mortality. Monitoring and control of HgA1c preoperatively is very important.

2. What new information is offered in this study?
A high preoperative HbA1c level is associated with higher postoperative morbidity, including wound infections and

increased length of hospital stay. Further studies that include a larger sample size are needed.

3. What are the implications for research, policy, or practice?

Since data were obtained from one centre, there was no need to uniform the laboratory units or other values.

Background

Glycated haemoglobin A1c (HbA1c) level is an indicator of the average blood glucose concentrations over the past 3 months. HbA1c may be underestimated due to haemolytic anaemia, renal failure, and drugs (e.g., erythropoietin, vitamin B12). Contrarily, the level of HbA1c may be increased in hypertriglyceridemia, alcoholism, and hyperbilirubinemia.[1]

It is an important indicator for outcomes in cardiac surgery, as evidenced by the increased incidence of cardiovascular accidents (7.5 per cent) in patients with high HbA1c undergoing cardiac surgery.[2] The prevalence of diabetic patients who undergo coronary artery bypass grafting (CABG) is reported to be as high as 34 per cent, resulting in higher rates of postoperative morbidity, mortality, and ICU stay due to complications arising from hyperglycaemia.[3] Clinicians should optimize levels of HbA1c preoperatively when assessing the risk of cardiovascular complications. Intervention to improve glycaemic control in patients with HbA1C >8 per cent is strongly advised to improve surgical outcomes, with a target preoperative HbA1c of 6.0 per cent to 8.0 per cent.[4]

The purpose of this study was to evaluate the levels of HbA1c in patients undergoing cardiac surgery, and to establish HbA1c level as an independent predictor for postoperative mortality and morbidity.

Methods

This retrospective study was conducted at King Fahd University Hospital. Files of 146 diabetic patients who underwent cardiac surgery between September 2015 to June 2018 were included. All diabetic patients who underwent cardiac surgery and had preoperative HbA1c levels available on-file were included.

One hundred and four patient met the inclusion criteria and were included. Patients were divided into two groups based on their preoperative HbA1c levels: Group A (HbA1c >=8.5 per cent) which consisted of 33 patients, and Group B (HbA1c <=8.4 per cent) which consisted of 71 patients.

All patients were subjected to a full preoperative assessment, and their operative and post-operative data were recorded. Parameters used to compare the two groups were: preoperative and postoperative creatinine, length of hospital stay, postoperative mortality, wound infection, reoperation, and rate of readmission.

Statistical analysis

1. Data entry was done using Microsoft Excel, and analysis was done with the Statistical Package for Social Sciences software (SPSS) version 23.
2. A P-value of less than 0.05 was considered statistically significant, with a confidence interval of 95 per cent.

Ethical considerations

The ethical approval to conduct this study was obtained from the Institutional Review Board of Imam Abdulrahman bin Faisal University.

Results

A hundred and five diabetic patients who underwent cardiac surgery were included in this study and were divided into two groups based on their preoperative HbA1c levels. Group A accounted for patients with HgA1c levels above or equal to 8.5 per cent and consisted of 33 patients. While group B accounted for patients with HgA1c levels below or equal to 8.4 per cent, consisting of 71 patients.

Group A comprised of 25 males and 8 females (75.8 per cent and 24.2 per cent respectively), while group B consisted of 54 males and 17 females (76 per cent and 24 per cent respectively). Ages in both groups ranged between 17 to 87 years old, with a mean and standard deviation of 58.27±7.6 in group A, and 56±12.48 in group B. There was no statistically significant difference between both groups in age and sex, as shown in Table 1 and Figure 1.

Table 1: Socio-demographic Characteristics

Socio-demographic data	Group A (no=33)		Group B (no=71)		P-value
	No	%	No	%	
Sex					
Male	25	75.8	54	76	0.95
Female	8	24.2	17	24	
Age (years)					
Mean±SD	58.27±7.6		56±12.48		0.3
Median	58		56		
Range	35		70		

Maximum	73	87	
Minimum	38	17	

Figure 1: Age (Groups A and B)

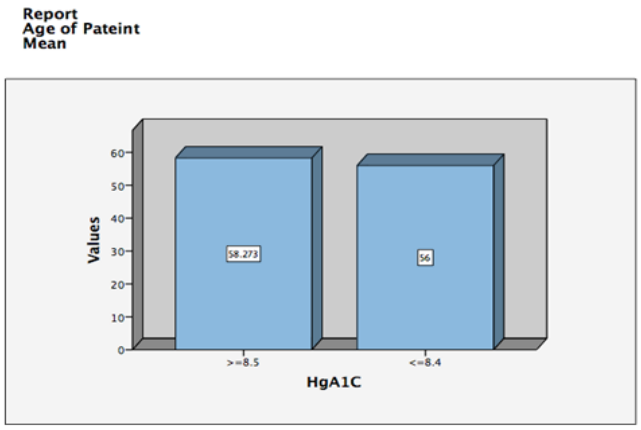


Table 2 compares the preoperative and postoperative renal function in the two groups.

There was no statistically significant difference in preoperative creatinine between, as shown in Table 3.

Table 3: Preoperative Creatinine

	Group A (no=33)	Group B (no=71)	P-value
Preoperative Creatinine			
Mean± SD	1.15+0.49	1.13+0.81	0.971
Median	1.03	0.99	
Maximum	2.75	7	
Minimum	0.6	0.3	

There was no statistically significant difference in length of hospital stay in the two groups. Median length of stay was 14 days in group A and 12 days in group B, as can be seen in Figure 2 and Table 4.

Figure 2: Length of Stay

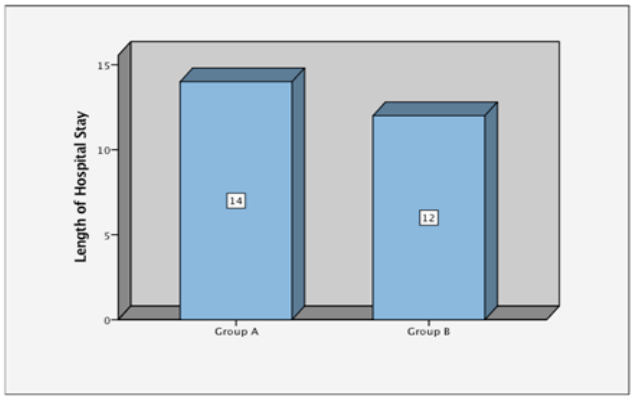


Table 4: Length of Stay

	Group A (no=33)	Group B (no=71)	P-value
Hospital stay (days)			
Mean± SD	17.42+14.1	17.11+19.46	0.31
Median	14	12	
Range	82	135	
Maximum	84	140	
Minimum	2	5	

Table 5 shows the correlation between HgA1c and mortality, showing 4 instances of mortality in group A compared to zero in group B. (Figure 3)

Table 5: Difference in mortality

		HgA1c		P-value
		Group A	Group B	
Mortality	yes	4	0	0.002
	no	29	71	
Total		33	71	

Figure 3: Mortality Count

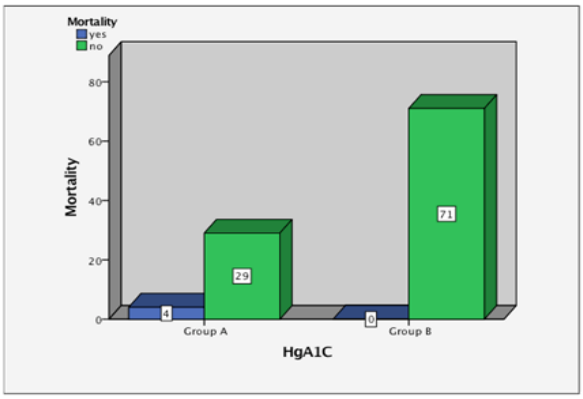


Table 6 shows the frequency of postoperative wound infection in relation to Hb1Ac levels, with no significant statistical difference in between. Four patients from Group B developed wound infection postoperatively compared to only one patient in Group A (Figure 4).

Table 6: Correlation between HgA1C and postoperative wound infection

		HgA1c		P-value
		Group A	Group B	
Wound Infection	yes	1	4	0.56
	no	32	67	
Total		33	71	

Figure 4: Rate of postoperative wound infection in relation to HbA1c

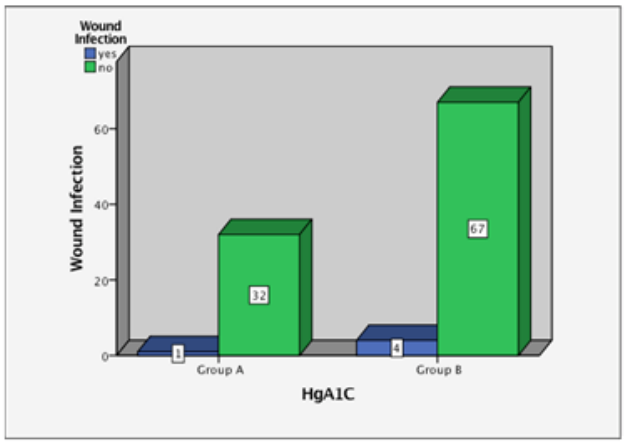
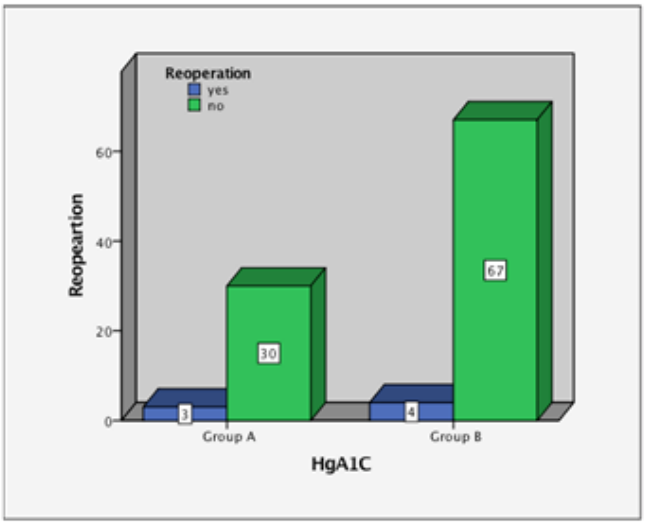


Table 7 and Figure 5 compare rates of reoperation in the two groups, with no statistically significant difference. Three patients in Group A had to undergo reoperation compared to four from Group B.

Table 7: Rate of Reoperation

		HgA1c		P-value
		Group A	Group B	
Reoperation	yes	3	4	0.51
	no	30	67	
Total		33	71	

Figure 5: Number of patients who underwent reoperation in the two groups:

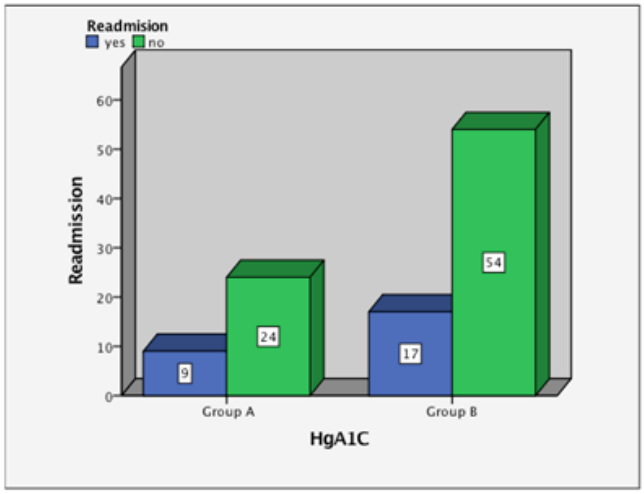


There was no significant statistical difference when comparing rates of readmission in Groups A and B. Nine and 17 patients were readmitted after discharge from Groups A and B, respectively. (Table 8, Figure 6)

Table 8: Rate of readmission and HbA1c levels

		HgA1c		P-value
		Group A	Group B	
Readmission	yes	9	17	0.71
	no	24	54	
Total		33	71	

Figure 6: Number of patients who were readmitted in both groups:



There was no significant difference when comparing postoperative creatinine level in Groups A and B.

Table 9: Postoperative creatinine:

	Group A (no=33)	Group B (no=71)	P-value
Postoperative Creatinine			
Mean± SD	1.18+0.59	1.23+0.63	0.74
Median	1	1.03	
Maximum	2.58	3.9	
Minimum	0.51	0.41	

Discussion

There was no significant difference when comparing the two groups included in our study with regards to postoperative creatinine. A study conducted in Dhahran in the period between 2005–2008 showed that out of 293 patients undergoing cardiovascular surgery, 29 per cent developed acute kidney injury postoperatively.[5] The pathophysiology of AKI following cardiac surgery is not yet well explained.[5] However, multiple risk factors contributing

to the development of acute kidney injury have been identified, such as female sex, age, diabetes, preoperative chronic kidney disease, peripheral vascular disease, congestive heart failure, renal insufficiency, and emergent surgery.[6]

Prolonged postoperative hospital and ICU stay is associated with high risk for both early and in-hospital mortality.[7] Odds ratios for in-hospital mortality were 1.071 and 1.033 for ICU and hospital stays respectively. The daily observed mortality rate after 30 postoperative days in the ICU was 25.6 per cent.[7]

Early mortality is defined as death within 30 days of cardiac surgery, and should be used as a benchmark of isolated CABG procedures.[8] The course of early mortality after cardiac surgery differs across interventions and continues up to 120 days.[8] A prolonged follow up period must be considered as to not miss these patients.[8] No statistically significant differences were found between mortality and prolonged ventilation, prolonged stay, mediastinitis, and bleeding related exploration.[9]

In our present study, there was no statistically significant difference in hospital stay between group A and B.
However, group A had a longer hospital stay (median 14) than B, which may be explained by the larger number of patients in group A.

This study did not show a statistically significant correlation between HgA1c and wound infections. Studies in the literature showed that reduced levels of perioperative hyperglycaemia were associated with lower rates of deep sternal wound infections.[10-12] Moreover, a retrospective study done in the United States reported that medically treated diabetes was associated with deep sternal wound infection, especially in bilateral internal thoracic artery grafting.[13]

It is important to consider the type of cardiac surgery that maximizes and improves the long-term survival in diabetic patients. Bilateral internal thoracic artery grafting had a 21 per cent lower mortality rate, and was recommended for those patients undergoing CABG. However, it was more associated with deep sternal wound infections compared to single internal thoracic artery grafting.[13]

No significant difference was found when correlating HbA1c and the rate of reoperation. In comparison, a retrospective study from Italy found that diabetics undergoing CABG were at a higher risk for reoperation, along with other adverse effects including prolonged ICU stay, renal and lung complications.[14] Age, BMI, chronic obstructive pulmonary disease, gender or diabetes were not associated with risk of reoperation.[15] The risk of reoperation due to bleeding or cardiac tamponade were not significant.[16] Also, postoperative blood product transfusion was considered an independent predictive factor for reoperation.[17,18]

Reoperation was associated with mediastinitis, especially where the duration of primary operation was prolonged. The most common causes of reoperation were stabilization of the sternum (46 per cent) and postoperative bleeding (36 per cent).[15]

In diabetic patients, the main complication after cardiac surgery is bleeding and deep sternal wound infection (DSWI).[19] Diabetic patients undergoing CABG had a higher risk for reoperation, prolonged ICU stay, renal dysfunction, and blood transfusion.[20]
There was no statistically significant difference between patients who were treated with insulin versus patients who did not receive insulin therapy.[19]

Significant predictive factors for reoperation in postoperative patients are decreased ejection fraction, high EuroSCORE, operations other than the primary procedure (isolated CABG), prolonged duration on cardiopulmonary bypass, low BMI, diabetes mellitus, smoking, emergency setting and preoperatively elevated s-creatinine.[19,21] In our study, only a minimal number of patients underwent reoperation between groups A and B, with no statistically significant difference observed.

Our study did not show a significant correlation between HbA1c and readmission. However, according to a retrospective study conducted in the United States and Canada, readmission after cardiac surgery was associated with pharmacologically treated diabetes (p-value<0.001).[22] This finding is also similar to other studies in the literature which found that diabetes was one of the predictive factors for early readmission.[23-27] However, a retrospective study done in US analysed data from 3132 patients who had invasive cardiovascular procedures, and concluded that elevated levels of blood glucose were not associated with 30-day readmission, but increased risk of in-hospital mortality.[28]

In the literature, many factors were associated with increased rate of ICU readmission.[29-32] Patients with higher mortality rate had ICU readmission 23 times more than usual patients.[29,31,33] More than 21 per cent required more

than one admission.[30] The rate of ICU readmission reach up to 33.3 per cent in patients who underwent CABG, and 16 per cent in patients who had a stay in the ICU of less than 3 days.[29,31,32,34] Patients who were readmitted to the ICU within 30 days of the operation were found to have poor left ventricular function, congestive cardiac failure, ventricular arrhythmias, unstable angina, peripheral vascular disease, renal dysfunction, higher body mass index, chronic obstructive airway disease, and sternal dehiscence. These patients were also found to have Parsonnet scores of more than 10, high APACHE III scores and a EuroSCORE of more than 9, along with prolonged bypass duration and a cross-clamp time of more than 80 minutes.[29,31]

Most of the literature concludes that older age, female gender, NYHA class III/IV, high BMI >30kg/m^2, EuroSCORE II >3.9 per cent, non-elective surgery, long duration of surgery >4h, bypass time >103min, mechanical ventilation >530min, pre-operative renal failure, re-exploration for hematoma, low cardiac output, ventricular arrhythmias, myocardial infarction, use of inotropic or balloon pump support, blood loss and transfusion wound infection or sternal dehiscence, postoperative renal failure, and cerebrovascular complication are considered independent factors for readmission to ICU after CABG.[29-31,33,34]

The most common indications for ICU readmission are respiratory failure, cardiac arrest, renal failure gastrointestinal complications, sepsis, and deep sternal infection.[29,30] Upon ICU discharge, non-use of beta-blockers, low haemoglobin, high oxygen requirement, and high respiratory rate were reported as risk factors for ICU readmission.[29] The Bounce Back After Transfer (BATS) score was created to determine the risk of ICU re-admission. Patients with a score <5 are considered low risk, 5–10 moderate risk, and >10 are at a high-risk.[34] Patients experienced ICU re-admission at a rate of 3.0 per cent, 10.4 per cent, and 42 per cent, respectively.[34]

However, there was a significant difference between the 2 groups, 4 patients in group A had high levels of HA1C in which they were associated with postoperative mortality (p-value=0.002). Reports in the literature show a four-fold increase in mortality especially with coronary artery bypass surgeries when the HbA1c level is more than 8.6 per cent.[35,36] However, a retrospective study conducted in Turkey reported that high levels of HbA1c more or equal to 7 per cent were not considered an independent factor in predicting mortality in cardiac surgery patients.[36] A similar retrospective study done at Duke University in the United States concluded that elevated levels of HbA1c have no positive correlation with 30-day mortality in cardiac surgery patients, yet controlling peri-operative glucose levels would positively affect and predict mortality in those patients.[37]
In general, several studies suggested the use of continuous insulin infusion for perioperative control of hyperglycaemic patients, since elevated levels of glucose were associated with several adverse outcomes in cardiac surgeries. These include increased postoperative morbidity, mortality, length of hospitalization, and recurrent attacks of ischemia, affecting the long-term survival and the prognosis of the patient.[12]

Conclusion

Our study shows that there is a significant difference in postoperative mortality in the two groups studied, with higher mortality in Group A, which included patients with HgA1c levels >=8.5. However there was no statistically significant difference in preoperative and postoperative creatinine level, length of hospital stay, wound infection, risk of reoperation and readmission. As this study was conducted in a low volume centre, it is limited by a small sample size. We recommend that further studies be conducted in larger centres to increase the accuracy and validity of the results.

References

1. Ralston S, Penman I, Strachan M, et al. (n.d.). Davidson's principles and practice of medicine. 22nd ed.
2. Biskupski A, Waligórski S, Kowalik B, et al. Glycated hemoglobin HbA 1c – a new risk marker for the outcome of cardiac surgery?. Polish Journal of Cardio-Thoracic Surgery. 2014;1:7–11.
3. Schmeltz L, DeSantis A, Thiyagarajan V, et al. Reduction of Surgical Mortality and Morbidity in Diabetic Patients Undergoing Cardiac Surgery with a Combined Intravenous and Subcutaneous Insulin Glucose Management Strategy. Diabetes Care. 2007;30(4):823–828.
4. Cavero-Redondo I, Peleteiro B, Álvarez-Bueno C, et al. Glycated haemoglobin A1c as a risk factor of cardiovascular outcomes and all-cause mortality in diabetic and non-diabetic populations: a systematic review and meta-analysis. BMJ. 2017.
5. Alkhunaizi AM E. Acute kidney injury after cardiac surgery in eastern Saudi Arabia. - PubMed - NCBI. [online] Ncbi.nlm.nih.gov. Available at: https://www.ncbi.nlm.nih.gov/pubmed/21796967 [Accessed 20 Aug. 2019].
6. Bellomo R, Kellum JA, Ronco C. Defining and classifying acute renal failure: from advocacy to consensus and validation of the RIFLE criteria. Intensive Care Med.

2007;33:409–413.
7. Mazzeffi M, Zivot J, Buchman T, et al. In-hospital mortality after cardiac surgery: Patient characteristics, timing, and association with postoperative length of intensive care unit and hospital stay. Ann Thorac Surg [Internet]. 2014;97(4):1220–5. Available from: http://dx.doi.org/10.1016/j.athoracsur.2013.10.040
8. Siregara S, Groenwold RHH, de Mol BAJM, Speekenbrink RGH, Versteegh MIM, Bruinsma GJBB, et al. Evaluation of cardiac surgery mortality rates: 30-day mortality or longer follow-up? Eur J Cardio-thoracic Surg. 2013;44(5):875–83.
9. Atik FA. Quality improvement program decreases mortality after cardiac surgery. J Thorac Cardiovasc Surg. 2009;138(1):253–4.
10. Gatti G, Perrotti A, Reichart D, et al. Glycated hemoglobin and risk of sternal wound infection after isolated coronary surgery. Circ J. 2017;81(1):36–43.
11. Lazar HL, Chipkin SR, Fitzgerald CA, et al. Tight glycemic control in diabetic coronary artery bypass graft patients improves perioperative outcomes and decreases recurrent ischemic events. Circulation. 2004;109(12):1497–1502. doi: 10.1161/01.CIR.0000121747.71054.79.
12. Navaratnarajah M, Rea R, Evans R, et al. Effect of glycaemic control on complications following cardiac surgery: literature review. J Cardiothoracic Surg. 2018;13(1).
13. Raza S, Sabik J, Masabni K, et al. Surgical revascularization techniques that minimize surgical risk and maximize late survival after coronary artery bypass grafting in patients with diabetes mellitus. J Thoracic Cardiovasc Surg. 2014;148(4):1257–1266.e9.
14. Morricone L, Ranucci M, Denti S, et al. Diabetes and complications after cardiac surgery: comparison with a non-diabetic population. Acta Diabetologica. 1999;36(1-2):77–84.
15. Bitkover CY, Vaage J, Ga B. Postoperative mediastinitis in cardiac surgery — microbiology and. Eur J Cardio-Thoracic Surg. 2002;21:825–30.
16. Biskupski A, Waligórski S, Kowalik B, et al. Glycated hemoglobin HbA1c- A new risk marker for the outcome of cardiac surgery? Kardiochirurgia i Torakochirurgia Pol. 2014;11(1):7–11.
17. Lopes CT, Brunori EHFR, Santos VB, et al. Predictive factors for bleeding-related re-exploration after cardiac surgery: A prospective cohort study. Eur J Cardiovasc Nurs. 2016;15(3):e70–7.
18. Colson PH, Gaudard P, Fellahi JL, et al. Active bleeding after cardiac surgery: A prospective observational multicenter study. PLoS One. 2016;11(9):1–14.
19. Raza S, Sabik JF, Masabni K, et al. Surgical revascularization techniques that minimize surgical risk and maximize late survival after coronary artery bypass grafting in patients with diabetes mellitus. J Thorac Cardiovasc Surg [Internet]. 2014;148(4):1257–1266.e9. Available from: http://dx.doi.org/10.1016/j.jtcvs.2014.06.058
20. Morricone L, Ranucci M, Denti S, et al. Diabetes and complications after cardiac surgery: Comparison with a non-diabetic population. Acta Diabetol. 1999;36(1–2):77–84.
21. Kubota H, Ohura N. Deep sternal wound infection after cardiac surgery. 2018;1–6.
22. Lribarne A, Chang H, Alexander J, et al. Readmissions after cardiac surgery: Experience of the national institutes of health/Canadian institutes of health research cardiothoracic surgical trials network. Ann Thorac Surg. 2014;98(4):1274–1280.
23. Hannan E. Predictors of readmission for complications of coronary artery bypass graft surgery. JAMA. 2003;290(6):773.
24. Hannan E, Zhong Y, Lahey S, et al. 30-Day Readmissions After Coronary Artery Bypass Graft Surgery in New York State. JACC Cardiovasc Interv. 2011;4(5):569–576.
25. Stewart R, Campos C, Jennings B, et al. Predictors of 30-day hospital readmission after coronary artery bypass. Ann Thorac Surg. 2000;70(1):169–174.
26. Nabagiez J, Shariff M, Khan M, et al. Physician assistant home visit program to reduce hospital readmissions. J Thorac Cardiovasc Surg. 2013;145(1):225–233.
27. Espinoza J, Camporrontondo M, Vrancic M, et al. 30-day readmission score after cardiac surgery. Clin Trials Regul Sci Cardiol. 2016;20:1–5.
28. Lee L, Emons M, Martin S, et al. Association of blood glucose levels with in-hospital mortality and 30-day readmission in patients undergoing invasive cardiovascular surgery. Curr Med Res Opin. 2012;28(10):1657–1665.
29. Chung DA, Sharples LD, Nashef SA. A case-control analysis of readmissions to the cardiac surgical intensive care unit. Eur J Cardio-thoracic Surg [Internet]. 2002;22(2):282–6. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L34831871%0Ahttp://dx.doi.org/10.1016/S1010-7940(02)00303-2
30. Kolat P, Guttenberger P, Ried M, et al. ICU readmission after cardiac surgery-still a matter of concern? Thorac Cardiovasc Surg. 2018.
31. Alex J, Shah R, Griffin SC, et al. Intensive care unit readmission after elective coronary artery bypass grafting. Asian Cardiovasc Thorac Ann. 2005;13(4):325–

9.
32. Oliveira EL de, Westphal GA, Mastroeni MF. Demographic and clinical characteristics of patients undergoing coronary artery bypass graft surgery and their relation to mortality. Rev Bras Cir Cardiovasc. 2012;27(1):52–60.
33. Kinduris Š. A case-control study of readmission to the intensive care unit after cardiac surgery. Med Sci Monit. 2013;19:148–52.
34. Magruder JT, Kashiouris M, Grimm JC, et al. A Predictive Model and Risk Score for Unplanned Cardiac Surgery Intensive Care Unit Readmissions. J Card Surg. 2015;30(9):685–90.
35. Tennyson C, Lee R, Attia R. Is there a role for HbA1c in predicting mortality and morbidity outcomes after coronary artery bypass graft surgery?: Table 1:. Interact Cardiovasc Thorac Surg. 2013;17(6):1000–1008.
36. Aydinli B, Demir A, Ozmen H, et al. Can pre-operative HbA1c values in coronary surgery be a predictor of mortality? Turk J Anaesthesiol Reanim. 2018;184–190.
37. van den Boom W, Schroeder R, Manning M, et al. Effect of A1C and glucose on postoperative mortality in noncardiac and cardiac surgeries. Diabetes Care. 2018;41(4):782–788.

PEER REVIEW

Not commissioned. Externally peer reviewed.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

FUNDING

None

ETHICS COMMITTEE APPROVAL

Institutional Review Board committee of Imam Abdulrahman bin Faisal University

Table 2: Preoperative and postoperative renal function tests

Renal function tests		Preoperative urea nitrogen	Preoperative Creatinine	Postoperative urea nitrogen	Postoperative Creatinine
Group A	Mean	21.2424	1.1509	22.7333	1.1813
	Std. Deviation	11.44288	0.4972	10.4219	0.5921
	Median	18	1.03	20	1
	Minimum	10	0.6	11	0.51
	Maximum	58	2.75	50	2.58
Group B	Mean	17.9009	1.1361	21.1909	1.23
	Std. Deviation	11.60122	0.80994	12.17042	0.63
	Median	15.5	0.995	18	1.03
	Minimum	0.9	0.3	5	0.41
	Maximum	80	7	82	3.9