Research Article
Open Access

Cardiac Redo operation, complication rate and risk predictors, a cross sectional study

Abstract

Background: Considering the effect of heart disease and its post-surgical complications on the patient's quality of life, identifying risk predictors for complications after surgery and the patient's clinical course can help us to improve the quality of primary care after surgery, reduce complications and improve the patient's recovery after surgery. This study aims to determine postoperative complication prevalence and related risk predictors.

Material and methods: In this cross-sectional study, the clinical course after cardiac reoperation of patients in the cardiac operating room of Imam Khomeini Hospital during the years 2014-2021was studied. Patients who have had a stroke in the past six months, heart failure, and EF less than 25% were excluded from the study. This study investigates the relationship between preoperative and intraoperative conditions of patients (age, sex, hemoglobin, serum creatinine, blood product transfusion, and pump time) and postoperative complications (death, AKI, bleeding, CVA, and pulmonary complication.

Results: This study examined 461 cardiac reoperation patients with a mean age (44.54±18.35). The most common complications were bleeding (8.24%), death (8.2%), and AKI (19.65$), respectively. In this study, there was a significant difference in terms of age, hemoglobin level, creatinine level, pump time, and blood product transfusion in patients faced with death and AKI compared to uncomplicated patients. Patients with postoperative bleeding received more blood products and had a longer pump time than uncomplicated patients, which was statistically significant.

Conclusion: In this study, there was a significant difference between deceased and uncomplicated patients after cardiac reoperation in terms of age, anemia, pre operative renal failure, and receiving more blood products during surgery. This difference, however, does not necessarily create a causal relationship; but suggests some risk predictors for redo cardiac surgery.

Keywords: cardiac reoperation, Redo surgery, complication, re-sternotomy, cardiopulmonary bypass

Volume 14 Issue 4 - 2022

Seyed Mohammad Hossein Sakhaee,[1] Kianoush Saberi,[2] Mahmood Alemohammad,[2] Hossein Saberi,[3] Shahnaz sharifi[4]

[1]Tehran University of Medical Sciences, Iran
[2]Tehran University of Medical Sciences, Imam Khomeini Hospital complex, Iran
[3]School of medicine, Iran university of medical sciences, Iran
[4]Shahid Beheshti University of Medical Sciences, Iran

Correspondence: Dr. Kianoush Sabari, Imam Khomeini Hospital Complex, Tohid Squre, Tehran, Iran, Tel +989128984844, Email saberikn@yahoo.com

Received: June 22, 2022 | **Published:** July 20, 2022

Introduction

Cardiovascular diseases are the leading cause of death in the group of non-communicable diseases in the world and in Iran.[1] The available treatment for cardiovascular disease is surgery, medication or a combination of both depending on the patient's condition and the severity of the disease.[2] One of the major challenges in heart surgery is cardiac redo operation. Also, as the population ages, the number of patients requiring cardiac reoperation due to heart valve disease increases.[3] Cardiac reoperation has been shown to increase the risk of postoperative mortality and morbidity.[4] Underlying diseases and risk factors are among the major causes of complications after heart surgery. Factors such as age, gender, cardiopulmonary bypass time, renal failure and preoperative drugs.[5] In addition to assessing mortality, it is necessary to assess the clinical course and postoperative complications; because they increase the time of hospitalization. In addition, these studies can also predict the complications of the perioperative time.[6] Hence, the aim of this study was to identify modifiable risk factor or risk predictor in cardiac redo surgery patients.

Method and materials

In this descriptive-analytical cross-sectional study, patients undergoing cardiac redo surgery at Imam Khomeini Hospital (Tehran, Iran) from 2014 to 2021 were studied.

Patients over the age of 16 who have had redo heart surgery at this center were included in this study. Also, patients who had emergency surgery, reoperation more than two times, history of chronic renal failure, stroke in the past six months, or ejection fraction less than 25% were excluded. Age, sex, weight, hemoglobin, creatinine, receiving blood products, time of connection to the pump as independent variables, and postoperative complications including acute kidney injury (AKI), bleeding, Cerebrovascular accident (CVA), pulmonary complication, and mortality were considered as dependent variables. The definition of AKI in this study was according to kidney disease: Improving Global Outcomes (KDIGO) criteria.[7] The presence of any respiratory disorder requiring respiratory support was classified as a pulmonary complication and the presence of any hemorrhage requiring examination was classified as bleeding. Patients with other complications such as tamponade, edema, ICU readmission, need for a pacemaker, and arrhythmia were categorized as other complications.

We gathered information of patients from the archives of Imam Khomeini Hospital. The variables were recorded in the patients' files by the treating physicians and hospital staff. Ethical considerations and the method of conducting this study were reviewed by the ethics committee in the research center of Imam Khomeini Hospital Complex and approved by the code of ethics IR.TUMS.IKHC.REC.1400.154.

Sample size

With information about the mean and standard deviation of creatinine (one of the important laboratory indicators in this study) in alive and deceased patients after surgery, using G-POWER software,

the sample size was estimated to be 388 people. Assuming the compensation of missing items, ten percent was added to this volume. The sample size was estimated 427 people.

Statistical analysis

The Patient data were encoded. Collected data were statistically analyzed using Graphpad prism Software v. 9. Frequency was used to provide a descriptive report of qualitative variables and mean and standard deviation and interquartile range (IQR) were used for quantitative variables. To analyze data; First, the normal distribution was checked. T-test was used for normally distributed data and Mann-Whitney U test was used for abnormally distributed data. A chi-squared test was used to evaluate the qualitative data. Correlation with $p < 0.05$ was considered significant.

Results

This study aimed to investigate the prevalence of complications after cardiac reoperation in Imam Khomeini Hospital. To investigate the factors affecting the prevalence of complications, pre-operative and intra-operative factors were also assessed. In this study, 461 patients were included based on the inclusion criteria. Information was extracted from patients' files. Demographic information of patients and the prevalence of their underlying risk factors are provided in Table 1. Table 2 shows the prevalence of complications as well as the age and sex distribution of patients in each group. In a statistical study, a significant correlation was found between age and AKI, CVA, pulmonary complication, and mortality. Information about the distribution and statistical analysis of variables pre- and intra-operation are detailed in Table 3 & 4. Figure 1 shows the distribution of values of three quantitative variables including hemoglobin, creatinine, and pump connection time with a box diagram.

Table 1 Characteristics of patients undergoing redo surgery

Variable	
Preoperative	
Age (yrs.)	44.54 ± 18.35
Female	208 (45%)
Weight (Kg)	67.65 ± 15.98
Risk Factor	
Hypertension	102 (22%)
Diabetes Miletus	57 (12%)
Hyperlipidemia	57 (12%)
Hypothyroidism	9 (2%)
Years since initial surgery	12.53 ± 9.56

Table 2 Post-Operative Complication incidence in study population. Correlation of age and gender with post-operative complication occurrence also represented here

Complication	**Incidence**	**Age (yrs.)**			**Gender**		
		Mean ± SD	**P.Value**	**sig**	**Female**	**P.Value**	**sig**
Death	38 (8.2%)	51.1 ± 19.3	0.005	**	39 %	0.594	ns
AKI	92 (19.65%)	56.9 ± 15.8	<0.001	****	43 %	0.921	ns
Pulmonary complication	30 (6.5%)	61.4 ± 13.8	<0.001	****	50 %	0.538	ns
CVA	20 (4.33%)	57.8 ± 15.1	0.0003	***	60 %	0.169	ns
Bleeding	38 (8.24%)	49.1 ± 18.7	0.058	ns	42 %	0.819	ns
Other	13 (2.81%)	61.5 ± 19.4	0.088	ns	62 %	0.218	ns
No complication	245 (53.14 %)	43.2 ± 17.8			44 %		

CVA, Cerebral vascular accident; AKI, Acute Kidney Injury; Non-significant (ns) t-test, Mann-Whitney U test and Chi-squared test, as appropriate.

Table 3 Correlation of pre-operative laboratory findings with post-operative complication occurrence

Complication	**Hemoglobin (mg/dl)**				**Creatinine (g/dl)**		
	<10 (%)	**10-12 (%)**	**Chi-square**	**P.Value**	**2 ≤ (%)**	**Chi-square**	**P.Value**
Death	21.0	47.3	7.31	0.006	13.1	6.29	0.012
AKI	30.4	46.7	34.49	<0/001	13.0	10.05	0.002
Pulmonary complication	6.6	30.0	1.42	0.492	6.6	0.62	0.430
CVA	30.0	35.0	5.62	0.018	10.0	1.86	0.173
Bleeding	7.8	42.1	0.0002	0.988	7.8	1.44	0.230
Other	0.0	38.4	1.08	0.298	7.6	0.54	0.464
No complication	8.9	39.1			3.6		

CVA, Cerebral vascular accident; AKI, Acute Kidney Injury; Chi-squared test used here.

Citation: Sakhaee SMH, Saberi K, Alemohammad M, et al. Cardiac Redo operation, complication rate and risk predictors, a cross sectional study. *J Anesth Crit Care Open Access.* 2022;14(4):116–120. DOI: 10.15406/jaccoa.2022.14.00520

Table 4 Correlation of intra-operative interventions with post-operative Complication occurrence

Complication	Pump Time			Blood Product Pack Cell		Platelet		Fresh frozen Plasma	
	Received %	Prolonged (180≤)	P.Value	Received %	P.Value	Received %	P.Value	Received %	P.Value
Death	86.8	57.5	<0/001	97.3	<0.001	78.9	0.001	84.2	0.001
AKI	91.3	34.5	<0/001	88.0	<0.001	72.8	0.000	86.9	<0.001
Pulmonary complication	86.6	26.9	0.064	83.3	0.035	73.3	0.015	76.6	0.024
CVA	85.0	52.9	<0/0001	85.0	0.058	75.0	0.030	75.0	0.084
Bleeding	86.8	36.3	0.001	100.0	<0.001	100.0	<0.001	100.0	<0.001
Other	84.6	9.0	0.686	76.9	0.345	61.5	0.409	53.8	0.929
No complication	88.9	13.3		64.0		49.8		55.1	

CVA, Cerebral vascular accident; AKI, Acute Kidney Injury; t-test, Mann-Whitney U test and Chi-squared test, as appropriate.

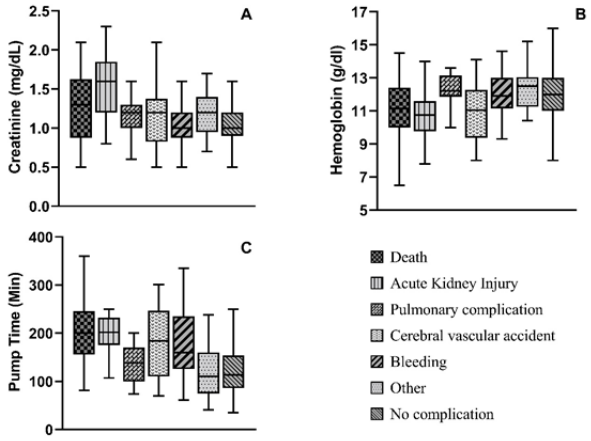

Figure 1 Tukey Box plot shows median, interquartile range and distribution of each group.

Discussion

This study investigated the prevalence of various complications of patients after cardiac reoperation and their possible predisposing factors in patients undergoing cardiac surgery in Imam Khomeini Hospital. The single center assessment is likely to cause similar conditions in surgeries. In a 2010 study by Park et al., 2,555 patients were considered candidates for cardiac reoperation at Rochester mayo clinic. An initial 18950 sternotomy was performed at the time of the study. The prevalence of reoperation in the study center was 3.5%. The mortality rate in primary surgery patients was 4.3%, in secondary surgery 8.5%, and in third surgery 11.4%. The number of heart surgeries (re-sternotomy) was a statistically significant independent risk factor for mortality.[8] The study by Launcelott et al. Showed similar results in 1521 cardiac reoperation patients. The risk of death was related to the frequency of sternotomies. The mortality rate in reoperation was 9.7%, which was significantly higher than 3.4% in the first surgery.[9] A study by Salehi et al. in Imam Khomeini hospital reported 8.8% mortality in reoperation.[10] The mortality rate in these studies is consistent with the current study (8.2%). However, in the study of O'Brien et al., Which reviewed data from 495 patients undergoing cardiac reoperation, the death rate was 2.9%.[11] In the study of Lytle et al., Mortality was 11% in primary surgery, 15% in reoperation, and 45% in third to fifth surgery.[12] These differences can be due to different patient conditions, risk factors, underlying diseases, surgical procedures, or emergency or non-emergency surgeries.

In this study, mortality was significantly associated with patients' age (median 58 versus 45 for uncomplicated patients). In the Launcelott study, the risk of death in reoperation patients increased significantly in Older patients.[9] High-risk procedures such as reoperation have higher morbidity and mortality in elderly patients.[13] Older people usually have a number of comorbidities, so the risk of surgery is part of the overall risk.[14] By examining the underlying factors, a better understanding of the role of comorbidities and the distinct role of the aging process in increasing the risk of postoperative complications can be found.

In this study, we examined two preoperative factors, hemoglobin (an indicator of anemia) and creatinine (an indicator of kidney failure), and two intraoperative factors: blood product receiving and pump connection time.

In the present study, in cardiac reoperation patients there was a significant relationship between lower hemoglobin levels and mortality, AKI, and CVA. Low hemoglobin has been shown to be an independent risk factor for increased mortality in patients with heart disease.[15] Preoperative anemia can be considered a contraindication to any elective major surgery.[16,17] Carson et al. showed an exponential relationship between decreased hemoglobin concentration and 30-day mortality and complications in the presence of cardiovascular disease, whereas in healthy patients undergoing surgery, this relationship was linear.[18]

The results of the present study showed a significant correlation between preoperative renal failure (creatinine greater than or equal to 2 mg/dL) with mortality and AKI occurrence. The results of this study are consistent with previous studies in this field. In Leontyev et al.'s study, preoperative renal impairment was defined as having a serum creatinine level greater than 200 umol/L, and in Fukunaga's study, renal impairment was defined as having a creatinine level higher than 1.5 mg/dL.[19,20] In a study by Launcelott et al., Creatinine levels above 176 umol/L or 2mg/dL were evaluated as indicators of renal failure. In this study, renal failure or high creatinine was a significant risk factor for postoperative mortality.[9] In a study by Fernando et al., They evaluated the results of heart surgery in patients with chronic kidney disease (creatinine above 200 umol/L) or dialysis. The results of this study in 545 patients showed cardiac reoperation as an independent risk factor for perioperative death.[21] The study by Keeling et al. Also identified renal failure as an independent factor in mortality.[22]

Citation: Sakhaee SMH, Saberi K, Alemohammad M, et al. Cardiac Redo operation, complication rate and risk predictors, a cross sectional study. *J Anesth Crit Care Open Access*. 2022;14(4):116–120. DOI: 10.15406/jaccoa.2022.14.00520

The results of the present study show that receiving blood products in patients undergoing cardiac surgery, as well as patients undergoing primary heart surgery, increases the risk of death and postoperative complications. Patients with bleeding, respiratory failure, CVA, AKI, or death received significantly more blood products than patients without complications.

Studies have investigated the optimal balance between the risks of anemia - an independent risk factor for complications and mortality after heart surgery - and those associated with RBC transmission in surgery.[23] Muñoz et al. Believe that blood transfusions are still dangerous and should not be overlooked.[16] Blood transfusions during heart surgery increase heart failure, respiratory complications, stroke, postoperative infections, cost, and increased mortality.[24-27] In the study of Kulier et al., Patients with low preoperative Hb had a higher rate of postoperative side effects; But at the same Hb level, the side effects increase significantly with red blood cell transfer. There is a direct relationship between the number of units of erythrocytes injected and the occurrence of adverse outcomes.[28] In Koch et al.'s study of 11,963 patients undergoing CABG, after risk adjustment, RBC transmission dose-dependently increased risk for postoperative complications, including mortality, renal failure, long-term ventilation, infection, Cardiac complications, and associated neurological events.[25] Ferraris et al. examined more than 470,000 surgical patients and found no significant risk of transfusion for high-risk patients. On the other hand, low-risk patients are about ten times more likely to have adverse consequences after a blood transfusion.[29]

In a study by Madhavan et al., they examined the effect of pump time on CABG complications, 1960 patients were assessed. This study showed that a long cardiopulmonary bypass (CPB) time (more than 180 minutes) had a predictive effect on mortality. It is also associated with longer ICU times and the need for longer mechanical respiration and intubation.[30] In a meta-analysis study by Kowalewski et al. In 2016, the results of 100 RCT studies examined OFF-Pump CABG (OPCAB) and On-Pump CABG (CABG). The results showed that OPCAB was associated with a significant reduction in stroke compared to CABG. The benefits of OPCAB in preventing death and myocardial infarction depend on the patient's risk profile. Therefore, OPCAB is strongly recommended for high-risk patients.[31]

A study by Djedovic et al. Compared revascularization with and without CPB in elderly patients. Patients who did not receive CPB had lower levels of mechanical respiration, length of ICU stay, and postoperative bleeding.[32] In a study by Miana et al., they identified Long CPB time in cardiac reoperation as an independent risk factor for bleeding.[33]

In Mangano et al. study to evaluate renal failure after myocardial revascularization, they proposed some independent risk factors to predict renal failure. The effects of all of these independent risk factors are exacerbated when the CPB lasts 180 minutes or more.[34] The current study also showed an increased risk of developing renal failure, death, bleeding, and CVA in patients receiving long-term CPB. These results about redo cardiac surgery are similar to primary heart surgery. In the present study, the mean pump time in the death group (207.9 min), AKI (200/6 min), bleeding (174.7 min), and CVA (203.2 min) minutes was significantly higher than the uncomplicated group (121.9min). Also, in these groups, the frequency of patients with prolonged pump time (above 180 minutes) is significantly higher than the uncomplicated group.

Conclusion

The results of this study could be used to determine the risk of performing cardiac redo operation to anesthesiologists and cardiologists. According to the results of this study, cardiac reoperation in Imam Khomeini hospital has acceptable mortality and morbidity rate.There was a significant difference between deceased and uncomplicated patients after cardiac reoperation in terms of age, anemia, pre operative renal failure, and receiving more blood products during surgery. This difference, however, does not necessarily create a causal relationship; but suggests some risk predictors for redo cardiac surgery. Balancing blood transfusions and anemia and also efforts to reduce bypass time should be considered in the surgical treatment plan.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet.* 2020;396(10258):1204–1222.
2. Kandaswamy E, L Zuo. Recent Advances in Treatment of Coronary Artery Disease: Role of Science and Technology. *Int J Mol Sci.* 2018;19(2):424.
3. Colkesen Y. Predictors of in–hospital mortality following redo cardiac surgery: Single center experience. *Interv Med Appl Sci.* 2015;7(3):102–107.
4. Imran Hamid U. Incidence and outcome of re–entry injury in redo cardiac surgery: benefits of preoperative planning. *Eur J Cardiothorac Surg.* 2015;47(5):819–823.
5. Cordeiro AL. Physiological Changes from Walking and Time of Stay after Heart Surgery. International Journal of Cardiovascular Sciences. 2015;28.
6. Reddy HG. Analyzing "failure to rescue": is this an opportunity for outcome improvement in cardiac surgery? The Annals of thoracic surgery. 2013;95(6):1976–1981.
7. Khwaja A. KDIGO clinical practice guidelines for acute kidney injury. *Nephron Clin Pract.* 2012;120(4):179–184.
8. Park CB. Identifying patients at particular risk of injury during repeat sternotomy: analysis of 2555 cardiac reoperations. *J Thorac Cardiovasc Surg.* 2010;140(5):1028–1035.
9. Launcelott S. Predicting in–hospital mortality after redo cardiac operations: development of a preoperative scorecard. *Ann Thorac Surg.* 2012;94(3):778–784.
10. Salehi M. Resternotomy, a single–center experience. *Asian Cardiovasc Thorac Ann.* 2017;25(1):13–17.
11. O'Brien M.F. How to do safe sternal reentry and the risk factors of redo cardiac surgery: a 21-year review with zero major cardiac injury. Journal of cardiac surgery. 2001;17(1):4–13.
12. Lytle BW. Reoperations for valve surgery: perioperative mortality and determinants of risk for 1,000 patients, 1958–1984. *Ann Thorac Surg.* 1986;42(6):632–643.
13. Fukunaga N. Redo valvular surgery in elderly patients aged > 75 years. *J Heart Valve Dis.* 2014;23(2):228–234.
14. Porizka M. Postoperative Outcome of High–Risk Octogenarians Undergoing Cardiac Surgery: A Multicenter Observational Retrospective Study. *Ann Thorac Cardiovasc Surg.* 2017;23(4):188–195.

15. Peterson PN. Association of longitudinal measures of hemoglobin and outcomes after hospitalization for heart failure. *Am Heart J.* 2010;159(1):81–89.

16. Muñoz M. 'Fit to fly': overcoming barriers to preoperative haemoglobin optimization in surgical patients. *Br J Anaesth.* 2015;115(1):15–24.

17. Spahn D, K Zacharowski. Non–treatment of preoperative anaemia is substandard clinical practice. 2015, Oxford University Press.

18. Carson JL. Effect of anaemia and cardiovascular disease on surgical mortality and morbidity. *Lancet.* 1996;348(9034):1055–1060.

19. Leontyev S. Redo Aortic Valve Surgery: Early and Late Outcomes. *Ann Thorac Surg.* 2011;91(4):1120–1126.

20. Fukunaga N, R Sakata, T Koyama. Short-and long-term outcomes following redo valvular surgery. *J Card Surg.* 2018.33(2):56–63.

21. Fernando M. Outcomes of cardiac surgery in chronic kidney disease. *J Thorac Cardiovasc Surg.* 2014;148(5):2167–2173.

22. Keeling WB. Outcomes following redo sternotomy for aortic surgery. *Interact Cardiovasc Thorac Surg.* 2012.15(1):63–68.

23. Loor G. Implications and management of anemia in cardiac surgery: Current state of knowledge. *J Thorac Cardiovasc Surg.* 2012.144(3):538–546.

24. Vivacqua A. Morbidity of bleeding after cardiac surgery: is it blood transfusion, reoperation for bleeding, or both? The Annals of thoracic surgery. 2011;91(6):1780–1790.

25. Koch CG. Morbidity and mortality risk associated with red blood cell and blood–component transfusion in isolated coronary artery bypass grafting. *Crit Care Med.* 2006;34(6):1608–1616.

26. Surgenor SD. Intraoperative red blood cell transfusion during coronary artery bypass graft surgery increases the risk of postoperative low–output heart failure. *Circulation.* 2006;114(1_supplement):43–48.

27. Horvath KA. Blood transfusion and infection after cardiac surgery. *Ann Thorac Surg.* 2013;95(6):2194–201.

28. Kulier A. Impact of preoperative anemia on outcome in patients undergoing coronary artery bypass graft surgery. *Circulation.* 2007;16(5):471–479.

29. Ferraris VA. Blood transfusion and adverse surgical outcomes: the good and the bad. *Surgery.* 2015;158(3):608–617.

30. Madhavan S. Cardiopulmonary bypass time: every minute counts. *J Cardiovasc Surg (Torino).* 2018;59(2):274–281.

31. Kowalewski M. Off–pump coronary artery bypass grafting improves short–term outcomes in high–risk patients compared with on–pump coronary artery bypass grafting: Meta–analysis. *J Thorac Cardiovasc Surg.* 2016;151(1):60–77.

32. Djedovic S. Surgical revascularization in elderly patients with and without cardiopulmonary bypass. *Med Arch.* 2013;67(5):351–353.

33. Miana LA. Risk factors for postoperative bleeding after adult cardiac surgery. *Brazilian Journal of Cardiovascular Surgery.* 2004; 19280–286.

34. Mangano CM. Renal dysfunction after myocardial revascularization: risk factors, adverse outcomes, and hospital resource utilization. The Multicenter Study of Perioperative Ischemia Research Group. *Ann Intern Med.* 1998;128(3):194–203.

Citation: Sakhaee SMH, Saberi K, Alemohammad M, et al. Cardiac Redo operation, complication rate and risk predictors, a cross sectional study. *J Anesth Crit Care Open Access.* 2022;14(4):116–120. DOI: 10.15406/jaccoa.2022.14.00520