GMR
The Original

IN HOSPITAL OUTCOMES OF ACUTE KIDNEY INJURY AFTER CORONARY ARTERY BYPASS GRAFT SURGERY AT A TERTIARY CARE HOSPITAL

Dr. Mina Ajmal Sultan[1]*, Dr. Sonia Yaqub[2]

[1] FCPS-II Trainee, Department of Nephrology Medicine, Aga Khan University Hospital, Karachi, Pakistan. Email: minasultan@live.com
[2] MBBS, FCPS, Associate Professor, Department of Nephrology Medicine, Aga Khan University Hospital, Karachi, Pakistan. Email: sonia.yaqub@aku.edu

ABSTRACT

Objective: To determine the frequency of in hospital outcomes of acute kidney injury after coronary artery bypass graft surgery at a tertiary care hospital.
Methods: This cross-sectional research was carried out at the Department of Nephrology at Aga Khan University Hospital, Karachi in a span of six months following ethical approval. Non-probability consecutive sampling was done to select 104 patients. Patients that had undergone coronary artery bypass grafting (CABG) and developed acute kidney injury (AKI) aged 40-80 years were eligible. Data were processed with SPSS v22 and chi-square test was done with p 0.05 considered significant.
Results: The mean age of patients was 66.63 ± 8.62 years. Serum creatinine increased postoperatively from 0.933 ± 0.124 mg/dL to 1.619 ± 0.546 mg/dL and decreased to 1.288 ± 0.478 mg/dL at discharge. Majority of the patients were males (84.6%). Hypertension (92.3%) and diabetes mellitus (59.6%) were prevalent. The most common was hospital stay of 7 days (42.3%). In-hospital outcomes were recovery (67.3%), persistent renal dysfunction (26.9%), and mortality (3.8%). There was a significant association between gender and hospital stay ($p < 0.001$) and no significant association between diabetes and hypertension.
Conclusion: Acute kidney injury related to CABG is a frequent postoperative outcome and is especially susceptible to older males with comorbidities. Most patients recovered, but a significant number either developed chronic kidney disease or die. Close perioperative monitoring and early detection are necessary to enhance renal and overall outcomes.

Keywords: Acute Kidney Injury; Coronary Artery Bypass Grafting; Hospital Mortality; Postoperative Complications; Serum Creatinine.

INTRODUCTION

Coronary artery bypass graft (CABG) surgery has become a very frequent operation with the aim of treating more severe cases of coronary artery disease, but it is not without any severe postoperative adverse effects, and acute kidney injury (AKI) is one of the most severe and clinically important. Post-cardiac surgery AKI is a significant cause of augmented morbidity, protracted stay in the intensive care unit, augmented health care expenditures and augmented short and long-term mortality.

In different populations, AKI has been reported to have a burden after CABG. One of the retrospective cohort studies in a tertiary care hospital in Pakistan revealed the high incidence of AKI following CABG and some of the risk factors that are associated with it, highlighting its continued clinical relevance both locally and globally [1]. Even with the improved surgical and anaesthetic practices, the rates of AKI are still very high, especially among high-risk patients who receive cardiopulmonary bypass.

The recent developments in the field of perioperative management are aimed at the minimization of renal complications based on the optimized approach to perfusion. The concept of goal-directed perfusion has proven to be an exciting one in the reduction of renal hypoperfusion during cardiac surgery. Paediatric cardiac surgery evidence indicates that such measures can greatly decrease AKI incidence through enhanced delivery of oxygen to the body and organ perfusion [2]. In line with this, goal-directed perfusion has been observed to be linked with less postoperative renal injury in systematic studies in adult cardiac surgery populations [3].

The pathophysiology of AKI under CABG is multifactorial. Cardiopulmonary bypass leads to the activation of systemic inflammatory response, haemolysis, oxidative stress and hemodynamic variability all of which contribute to renal ischemia and tubular damage. Cardiopulmonary bypass leads to biochemical changes, which

further impair endothelial dysfunction and inflammatory activation, rendering patients more vulnerable to incurring renal damage [4].

Clinical research on CABG patients has continuously shown that AKI is still a common complication, especially in patients who are on-pumped. On-pump coronary artery bypass grafting has also been linked to increased cases of postoperative renal dysfunction which has emphasized the effects of extracorporeal circulation on renal functioning [5]. Consequently, much focus has been put on the early detection of vulnerable patients and adoption of renal-protective measures.

In terms of perioperative care, the prevention and early treatment of AKI is crucial. Modern literature focuses on risk stratification, hemodynamic optimization, and prevention of nephrotoxic insults as important preventive interventions in cardiac surgical patients [6]. With these strategies, AKI still takes place, and the necessity to enhance predictive and preventative strategies is obvious.

The existing evidence tends to indicate that cardiac surgery-related AKI depends on various patient-related, surgical and perioperative factors. They are the baseline renal function, length of cardiopulmonary bypass, and intraoperative hemodynamic instability [7]. It has also been observed through observational studies that AKI is linked with poor postoperative outcomes, such as long hospital stay and high mortality [8].

Increased knowledge related to the pathophysiology of cardiac surgery-associated AKI has enhanced preventive measures, which include minimization of inflammatory damage, maximization of renal perfusion and early detection of renal dysfunction [9]. Nonetheless, AKI still presents a considerable prognosis of adverse outcomes after cardiac surgery and presents a considerable clinical challenge [10]. In this respect, the current paper will assess the hospital outcomes of acute kidney injury after the coronary artery bypass graft surgery in a tertiary care hospital with specific interest in its incidence, risk factors, and postoperative outcomes.

METHODS

It was a cross-sectional study that was carried out in the Department of Nephrology at Aga Khan University Hospital, Karachi. The research was carried out in a span of six months following the consent of the synopsis. Before the study began, ethical approval was sought by the Institutional Review Committee with approval no: [CITI new_230201_000041]. All the participants were informed about the study and their consent was taken, and patient data remained confidential throughout the study.

The prevalence of mortality that follows a coronary artery bypass graft surgery complicated by acute kidney injury was used as the sample size with the Raosoft sample size calculator [11] that assumes a margin of error of 7.0% hence the total sample size was 104 patients. The method of sampling was non-probability consecutive. The study included patients of both sexes aged 40-80 years who reported with reduced urine output and generalized edema and had a history of coronary artery bypass graft surgery done in Aga Khan University Hospital. Exclusions included patients who had hypo or hyperthyroidism history, chronic liver disease, chronic renal failure, COPD, stroke, connective tissue disorders as SLE, previous dialysis, nephrotoxic drugs like NSAIDs, or exposure to radioactive contrast. Pregnant women who were sure about their pregnancy through dating scan were also not included.

The patients admitted to the Department of Nephrology were eligible to provide data. Cardiovascular surgeons with a minimum of seven years experience had conducted all the coronary artery bypass graft surgeries. Monitoring of the development of acute kidney injury in patients was done during the hospital stay in the postoperative period according to the definition of operational definition. Aseptic blood sample was used to measure serum creatinine and was sent to the laboratory to be analyzed, and urine output was monitored every 24 hours. The acute kidney injury was defined as an elevation in serum creatinine above 0.3 mg/dL in the next 48 hours compared to baseline or urine production below 0.5 mL/kg/hour during a six-hour period. The outcomes in-hospital were documented as mortality (patient dies in the hospital), recovery (creatinine and urine output returned to normal levels), or persistent dysfunction (patients have high creatinine levels at the end of hospitalization). All data were entered in a pre-designed proforma.

The SPSS version 22.0 was used to analyze data. Categorical variables (gender, residence, comorbid conditions, including diabetes mellitus and hypertension, and in-hospital outcomes), frequencies, and percentages were determined. The continuous variables (age, BMI and length of disease) were presented in the form of mean standard deviation or mode/inter quartile range respectively. The Shapiro-Wilk test was used to determine the normality of continuous data. Effect modifiers like age, gender, residence, hypertension and diabetes mellitus were stratified to control confounding effects. Chi-square test or the Fisher exact test was used after stratification when analyzing categorical variables. The statistically significant p-value was taken as 0.05 and the 95% confidence interval was used for the analysis.

RESULTS

A total of 104 patients who underwent coronary artery bypass grafting (CABG) complicated by acute kidney injury (AKI) were included in the study. The demographic profile, biochemical parameters, hospital stay, and clinical outcomes were analyzed.

The mean age of patients was 66.63 ± 8.62 years. The mean pre-CABG serum creatinine was 0.933 ± 0.124 mg/dL, which increased postoperatively to 1.619 ± 0.546 mg/dL, and decreased to 1.288 ± 0.478 mg/dL at discharge.

Table 1 presents the baseline demographic profile and comorbid conditions of the study population. The majority of patients were male, and a high proportion had hypertension and diabetes mellitus.

Table 1: Baseline demographic and clinical characteristics of study participants

Variable	n (%)
Male	88 (84.6%)
Female	16 (15.4%)
Diabetes Mellitus (Yes)	62 (59.6%)
Hypertension (Yes)	96 (92.3%)

Table 2 shows the mean biochemical parameters at different time points along with hospital stay distribution. A rise in serum creatinine was observed postoperatively, followed by partial improvement at discharge. The most common hospital stay duration was 7 days.

Table 2: Biochemical parameters and hospital stay duration

Variable	Mean ± SD / n (%)
Age (years)	66.63 ± 8.62
Pre-CABG Creatinine (mg/dL)	0.933 ± 0.124
Post-CABG Creatinine (mg/dL)	1.619 ± 0.546
Discharge Creatinine (mg/dL)	1.288 ± 0.478
Hospital stay (7 days)	44 (42.3%)

Table 3 summarizes the clinical outcomes of patients following CABG-associated acute kidney injury. The majority of patients recovered, while a smaller proportion developed persistent renal dysfunction or died during hospitalization.

Table 3: In-hospital outcomes of study participants

Outcome	n (%)
Resolved	70 (67.3%)
Persisting renal dysfunction	28 (26.9%)
Death	4 (3.8%)

Table 4 shows the association of gender, diabetes mellitus, hypertension, and hospital stay with in-hospital outcomes. A statistically significant association was observed for gender and hospital stay, while no significant association was observed for diabetes mellitus and hypertension.

Table 4: Association of clinical variables with in-hospital outcomes (Chi-square test)

Variable	χ^2 value	df	p-value
Gender vs Outcome	23.890	3	0.000
Diabetes Mellitus vs Outcome	10.470	6	0.106
Hypertension vs Outcome	1.695	3	0.638
Hospital Stay vs Outcome	76.595	36	0.000

DISCUSSION

This current paper has examined 104 patients who experienced acute kidney injury (AKI) after coronary artery bypass grafting (CABG) with an emphasis on the perioperative alterations in renal functions, outcomes, and other clinical variables. In general, the results are in line with the existing body of literature that characterizes cardiac surgery-related AKI as a common and clinically significant complication.

Our cohort had a mean age of 66.63 +8.62 years indicating an older surgery population. This is in line with the fact that cardiac surgery-related AKI is more prevalent in the elderly because of the diminished renal reserve and increased comorbidity burden. Qiao et al. [12] also indicate that aging is also among the most stable risk factors of AKI following cardiac surgery, which adds to the susceptibility of perioperative physiological stress.

The observed increase in postoperative serum creatinine (0.933 + 0.124 mg/dL to 1.619 + 0.546 mg/dL) and subsequent partial recovery at the time of discharge is a characteristic pattern of acute tubular damage and subsequent partial recovery. According to Kellum et al. [13], AKI is a dynamic process, which is usually reversible in the early phases, but incomplete recovery in a substantial portion of patients depending on the extent and duration of insult.

The fact that most of the patients are male and that hypertension and diabetes mellitus are the most common in our study population is in line with known cardiovascular risk profiles in CABG cohorts. Scott [14] emphasizes that comorbidities like hypertension and diabetes are the causes of endothelial dysfunction and poor renal perfusion, which predispose to postoperative renal injury, but may depend on the perioperative care and the complexity of surgery.

Clinically, the majority (67.3%) of the patients did not develop chronic renal failure and 26.9% recovered and 3.8% of patients died. Similar results are documented by Salve et al. [15], who note that whereas a considerable number of patients recover postoperative AKI in the early stages, a considerable percentage develops permanent renal dysfunction, especially in case of multifactorial or delayed recognition injury.

Our results of transient increase in creatinine is also backed by the results of Ortega-Loubon et al. [16] who characterize CABG-linked AKI as a continuum of mild reversible dysfunction to severe persistent injury which is usually due to ischemia-reperfusion injury, inflammatory response, and cardiopulmonary bypass-related factors. Kamla et al. [17] also point out that changes in postoperative renal biomarkers, even minor ones, can be the signs of the presence of subclinical kidney injury that can precondition the development of long-term renal dysfunction. This advocates the significance of early diagnosis and follow up in patients undergoing cardiac surgery.

Our cohort with high comorbidity rates is aligned with the results described by Harky et al. [18], who revealed that hypertension and diabetes were frequent causes of postoperative AKI because of chronic microvascular damage and impaired renal autoregulatory capability.

Jabayeva et al. [19] also indicated that diabetes mellitus and hypertension are high predictors of cardiac surgery-related AKI incidence in prospective observational data, but the strength of the association could be affected by perioperative optimization and the selection of patients. On the contrary, these comorbidities were not statistically significant in our study, which might indicate successful perioperative care or variability of samples.

The relationship between the long stay in hospital and poor outcomes in our study is inline with the literature. Huang et al. [20] reiterate that postoperative morbidity like AKI has a close association with extended hospital stays and morbidity post-CABG, which is indicative of both the severity of illness and slowing of recovery.

Lastly, McIlroy [21] points out that even with the available research, it is difficult to predict AKI following cardiac surgery, and that effective risk-stratification tools are yet to be developed. This reinforces our results, with some variables exhibiting noteworthy relationships and conventional risk factors like diabetes and hypertension not always determining results in our cohort.

Strengths and Limitations: The research was carried out at one facility and used a relatively small sample (n = 104), which restricts the external validity. It is also not useful in establishing causal relationships due to its observational design. The evaluation of renal function was done with serum creatinine alone, which can overlook early/subclinical AKI. Other vital intraoperative variables like bypass time and hemodynamic instability were not studied in detail. Also, no long-term follow-up was provided after discharge, and it was restricted to assess the persistent or progressive renal dysfunction. Results might also have been affected by residual confounding.

Nevertheless, the study offers real-world information about CABG-related AKI including serial evaluation of renal functionality (preoperative, postoperative, and discharge). It also measures clinical events and correlations with important comorbidities, which can provide valuable information regarding patient risk profiles and recovery patterns.

Recommendations: To enhance generalizability and outcome measures, future researchers ought to consider bigger and multicentred populations with long-term follow-up. Early AKI detection should be incorporated with sensitive biomarkers (e.g., NGAL, cystatin C). Intraoperative variables need to be evaluated in detail to determine risk factors that can be modified. Predictive risk model development could be useful in the early detection and prevention of AKI in CABG patients.

CONCLUSION

CABG-related AKI is widespread and can be reversible, yet, a considerable percentage of patients acquire chronic renal failure. The essential concept is to recognize early, monitor closely and optimize the perioperative care to enhance outcomes and lessen renal complications.

REFERENCES

1. Abbasi MSR, Sultan K, Manzoor R, Nizami AA, Ullah N, Mushtaq A, et al. Assessment of renal function and prevalence of acute kidney injury following coronary artery bypass graft surgery and associated risk

factors: a retrospective cohort study at a tertiary care hospital in Islamabad, Pakistan. Medicine (Baltimore). 2023;102(42):e35482. doi:10.1097/MD.0000000000035482
2. Long F, Zhang Y, Luo M, Liu T, Qin Z, Wang B, Zhou Y, Zhou R. Goal-directed perfusion to reduce acute kidney injury after pediatric cardiac operation. Ann Thorac Surg. 2025 Apr;119(4):891–898. doi:10.1016/j.athoracsur.2024.10.015.
3. Gao P, Liu J, Zhang P, Bai L, Jin Y, Li Y. Goal-directed perfusion for reducing acute kidney injury in cardiac surgery: a systematic review and meta-analysis. Perfusion. 2023 Apr;38(3):591–599. doi:10.1177/02676591211073783.
4. Ferreira LO, Vasconcelos VW, Lima JdS, Vieira Neto JR, da Costa GE, Esteves JdC, de Sousa SC, Moura JA, Santos FRS, Leitão Filho JM, et al. Biochemical changes in cardiopulmonary bypass in cardiac surgery: new insights. J Pers Med. 2023;13(10):1506. doi:10.3390/jpm13101506.
5. Iqbal T, Ali M, Ali N, Hayat M, Tariq A, Latif R. Acute kidney injury after on-pump coronary artery bypass grafting surgery. J Saidu Med Coll. 2025;15(1):38–43. doi:10.52206/jsmc.2025.15.1.930
6. Cheruku SR, Raphael J, Neyra JA. Acute kidney injury after cardiac surgery: prediction, prevention and management. Anesthesiology. 2023;139(6):880–898. doi:10.1097/ALN.0000000000004734
7. von Groote T, Sadjadi M, Zarbock A. Acute kidney injury after cardiac surgery. Curr Opin Anaesthesiol. 2024;37(1):35–41. doi:10.1097/ACO.0000000000001320
8. Mohrag M, Abdulrasak M, Borik W, et al. Risk factors and outcomes of acute kidney injury after cardiac surgery: a retrospective observational study. J Clin Med Res. 2024;16(8):5220. doi:10.14740/jocmr5220
9. Yu Y, Li C, Zhu S, et al. Diagnosis, pathophysiology and preventive strategies for cardiac surgery-associated acute kidney injury. Eur J Med Res. 2023;28:45. doi:10.1186/s40001-023-00990-2
10. Scurt FG, Bose K, Mertens PR, Chatzikyrkou C, Herzog C. Cardiac surgery-associated acute kidney injury. Kidney360. 2024 Jun 1;5(6):909–926. doi:10.34067/KID.0000000000000466.
11. Raosoft Inc. (2004). Sample Size Calculator. Available at: http://www.raosoft.com/samplesize.html
12. Qiao C, Zhou J, Wei C, Cao J, Zheng K, Lv M. Cardiac surgery-associated acute kidney injury: a decade of research trends and developments. Front Med. 2025;12:1572338. doi:10.3389/fmed.2025.1572338.
13. Kellum JA, Romagnani P, Ashuntantang G, et al. Acute kidney injury. Nat Rev Dis Primers. 2021;7:52. doi:10.1038/s41572-021-00284-z
14. Scott JP. Commentary: Acute kidney injury and mortality after pediatric cardiac surgery: a relationship in need of intervention. JTCVS Open. 2020 Aug 17;4:88–89. doi:10.1016/j.xjon.2020.08.006.
15. Salve G, Gananjay G, et al. Newer insights into acute kidney injury following congenital cardiac surgery using staging criteria and biomarker analysis. Med Res Arch. 2025;13(2). doi:10.18103/mra.v13i2.6321.
16. Ortega-Loubon C, Tamayo E, Jorge-Monjas P. Cardiac surgery-associated acute kidney injury: current updates and perspectives. J Clin Med. 2022;11(11):3054. doi:10.3390/jcm11113054.
17. Kamla CE, Meersch-Dini M, Palma LMP. Kidney injury following cardiac surgery: a review of our current understanding. Eur J Drug Metab Pharmacokinet. 2025;50:337–348. doi:10.1007/s40256-024-00715-8.
18. Harky A, Joshi M, Gupta S, Teoh WY, Gatta F, Snosi M. Acute kidney injury associated with cardiac surgery: a comprehensive literature review. Braz J Cardiovasc Surg. 2020;35(2):211–224. doi:10.21470/1678-9741-2019-0122.
19. Jabayeva N, Li T, Kuanyshbek A, Zhailauova A, Amanzholova A, Bekishev B, et al. Cardiac surgery-associated acute kidney injury, incidence, and predictors: a prospective observational single-center study. J Clin Med Kaz. 2024;21(4):21–25. doi:10.23950/jcmk/14965
20. Huang C, Qiu J, Fang X. Prediction of acute kidney injury after coronary artery bypass grafting from preoperative serum uric acid. J Cardiothorac Vasc Anesth. 2024 Oct;38(10):2247–2253. doi:10.1053/j.jvca.2024.04.018.
21. McIlroy DR. Predicting acute kidney injury after cardiac surgery: much work still to be done. Br J Anaesth. 2021 Dec;127(6):825–828. doi:10.1016/j.bja.2021.09.005.