Palestinian Medical and Pharmaceutical Journal

The Occurrence and Risk Factors of Acute Kidney Injury Among Patients Who Are Undergoing Cardiac Surgery in Palestine

Eman Alshawish[1,*], Yosouf Dahboor[1]

(Type: Full Article). Received: 30th Sep. 2024, Accepted: 10th Mar. 2025, Published: 1st Oct. 2025,
DOI: https://doi.org/10.59049/2790-0231.10.4.2465

(This article belongs to the Special Issue: Trends in Nursing)

ABSTRACT: Background: Acute kidney injury (AKI) is a sudden and long-lasting loss of kidney function that starts within seven days and causes a quick drop in the Glomerular Filtration Rate (GFR). A rise in serum creatinine and urine output depletion accompanies this. AKI occurs in 1% to 5% of all admissions, and 5% need dialysis, with cardiac surgery being the most common cause after sepsis. AKI increases infection risk, hospitalization length, costs, and mortality rate. This study aimed to measure the occurrence of AKI post cardiac surgery and the relationship between the risk factors and the dynamic predictive scoring system to the occurrence of AKI in cardiac surgery units. **Methodology:** This study adopted an observational prospective quantitative design and included 103 patients who underwent cardiac surgery between August 2020 and September 2021 in three cardiac surgery units in the West Bank in Palestine. The risk factors, serum creatinine, and demographic data were gathered preoperatively. AKI defined by the Kidney Disease Improving Global Outcome (KDIGO) criteria and the dynamic predictive scoring system used to estimate the risk of AKI after cardiac surgery. Statistical Package for the Social Sciences (SPSS version 25) program used for data entry and analysis. **Results:** Of the patients having cardiac surgery at three large hospitals in Palestine's West Bank, 27 (26.2%) had acute kidney injury (AKI), according to diagnostic criteria. AKI stage 1 (19.4%), 4.9% in stage 2, and 1.9% in stage 3. Statistically significant factors for AKI patients were oliguria time, vasopressor usage time > 24 hrs, and high serum creatinine on day 3. Regarding other variables, the results revealed no significant difference between patients with and without AKI (P>0.05). **Conclusion:** The AKI occurrence among patients undergoing cardiac surgery in the West Bank was high. The use of the vasopressor for more than 24 hours was significant in preventing AKI. Applying a predictive scoring system is crucial in predicting, preventing, and managing the problem. Integration of protocols, training workshops, and policies is important in the therapy regimen. We must conduct further experimental studies with a control group and a larger sample.

Keywords: Acute kidney injury; Cardiac surgery; Coronary Artery Bypass Graft (CABG); Risk Factors.

INTRODUCTION

AKI is "a sudden and sustained decrease in kidney function that develops within seven days and leads to a rapid reduction in GFR and is reflected clinically by an elevation in serum creatinine and decreased urine output" [1]. The decrease in GFR results from a reduction in the count of nephrons, a drop in nephron GFR, or both. It results from various etiologies, including specific renal disease and extra-renal pathology [2]. About 1% to 5% of hospital admissions are acute kidney injury (AKI) cases. In the perioperative period, AKI has serious implications for patient outcomes, like the consistent association with increased mortality morbidity and a complicated hospital course with associated cost-effectiveness implications [3].

AKI post-cardiac surgery is the most prevalent cause of AKI in the intensive care unit (ICU) after sepsis [4]. Moreover, the leading cause of AKI in hospitalized patients is surgery [3]. The occurrence of AKI post cardiac surgery occurs in up to 30% [5]. AKI post-cardiac surgery is a common and serious complication encountered in 30–40% of adults and children after CPB. AKI needs dialysis occurs in up to 5% of these cases, in whom the mortality rate approaches 80% [4]. From another point of view, cardiac surgery mortality in non-AKI patients occurs between 1% and 8% [5].

During cardiac surgery, several associated factors for AKI are aortic clamping time, time of cardiopulmonary bypass (CPB), quantity of erythrocyte transfusion, and administration of vasopressors that decrease renal perfusion. These factors motivate the development of AKI. The contribution can be by various mechanisms like induced cycles of ischemia and reperfusion, increased oxidative damage, and increased renal and systemic inflammation [6].

Cardiac surgery, particularly procedures involving cardiopulmonary bypass, can lead to hypoperfusion and reduce the delivery of oxygen, resulting in ischemic injury to the kidneys. Upon reperfusion, the restoration of oxygenated blood can further worsen the injury through the generation of reactive oxygen species and inflammatory cascades [7]. Cardiac surgery triggers a systemic inflammatory response, which activates proinflammatory mediators (cytokines and chemokines) that attract leukocytes to the inflammation site. This inflammation can contribute to endothelial dysfunction, increased vascular permeability, and further kidney injury [8]. Cardiopulmonary bypass and other surgical interventions can lead to increased oxidative stress caused by free radicals, which can damage renal tubular cells and contribute to AKI [9].

Consequently, AKI associated with cardiac surgery has further complications. That is, it increases the risk of acquiring

1 Department of Pediatric Nursing, Maternity and Midwifery, Faculty of Nursing, An Najah National University, Nablus, Palestine.
*Corresponding author email: alshawish@najah.edu

infection, increases the length of the hospitalization period in the intensive care unit as this leads to an increase in the cost of treatment and consumption of resources, and independently increases the mortality rate [10]. Management of AKI post-cardiac surgery is multidisciplinary and mostly relies on prevention, early detection, and early intervention. The treatment regimen includes fluid management, vasopressor administration, avoiding nephrotoxic drugs, diuretic administration, and renal replacement therapy [11]. Therefore, the study aimed to measure the occurrence of AKI post-cardiac surgery and the relationship between the risk factors and the dynamic predictive scoring system to the occurrence of AKI in cardiac surgery units.

MATERIALS AND METHODS

Design and setting: An observational prospective quantitative design study was conducted in the West Bank-Palestine in cardiac surgery units at Al-Arabi Specialized Hospital in Nablus City, Nablus Specialized Hospital in Nablus City, and the governmental Palestine Medical Complex in Ramallah City. These three hospitals receive patients from all over the West Bank. This study was conducted between August 2020 and September 2021.

Population and sample: The population is the patients who underwent cardiac surgery including coronary artery bypass graft (CABG), valve surgery, or a combination of both. The total number of participants was 108, and 5 patients were excluded because one was under 17, three patients had end-stage renal disease, and one had Marfan syndrome. Consecutive sampling was used. The sample size n=103. Calculated manually by estimating the sample size based on proportion by a statistician through this equation:

$n = (z\alpha\ 2 / 2 * (1-p))/ (P *(E)\ 2)$

n= sample size. Z = Z value (from normal distribution curve =1.96 for 95% confidence level), p = AKI incidence from an earlier study; expressed as decimal =37 % from the earlier study. E: The margin of error is considered 0.17.

Exclusion criteria: Age below 18 years old, patients with chronic renal failure and end-stage renal disease, congenital heart disease, patients with congenital and metabolic renal disease, and patients who have urology problems.

Data collection: The tool is divided into four parts; the first part is demographic data, medical history, medications, risk factors, and the dynamic predictive score system preoperative. The second part is on ICU admission post-operative using intraoperative parameters, the dynamic predictive scoring system, and KDIGO criteria. The third part at 24 hrs. is the dynamic predictive score system and KDIGO criteria. The fourth part is the KDIGO checklist criteria from the second to the seventh day of post-operative follow-up.

Participants were interviewed in the preoperative period, and the consent form applied.

Statistical analysis: The researcher used the Statistical Package of Social Science (SPSS- version 25) program for data entry and analysis. Frequency results were used to describe the frequency of specific characters. Statistical tests were used as appropriate such as percentage (%), means and standard deviation (SD), and t-test to assess whether the means of the two groups were statistically different from each other. The Chi-square test was used to figure out whether there were any significant differences among the groups. Finally, a probability value (P-value) less than 0.05 was considered statistically significant.

RESULTS

Descriptive Analysis and Preoperative Factors

The sample included 103 participants, 88.3% of whom were males. The sample's mean age is 56.0±10.9 years, and the mean body mass index was 28.0±4 kg/m2. The most common surgical procedure was CABG, which was performed in 81 cases (78.6%), followed by valve replacement, performed in 18 cases (17.5%), and the combination of the two, performed in 4 cases (3.9%). While the mean duration of CPB was 88.2±34.1 minutes, the mean duration of the cross-clamp was 54.5±21.5 minutes. The mean preoperative serum creatinine level was 0.89±0.18 mg/dL. Preoperative laboratory tests showed a mean hemoglobin of 13.6±1.5 g/dL. The occurrence of AKI of any degree within the first 48 hours after cardiac surgery was 26.2% AKI occurring in 27 patients, of whom 20 (19.4%) were classified as KDIGO stage 1, while 5 (4.9%) were classified as KGIGO stage 2, and 2 (1.9%) were classified as KDIGO stage 3.

Table (1): preoperative factors:

Variables	Total (n=103)	Patients undergoing cardiac surgery		Statistical test		
		With AKI (n=27)	Without AKI (n=76)	t	c2	P-value
Diagnosis n (%)						
MI	14 (13.6)	5 (18.5)	9 (11.8)		6.222	0.101
IHD	38 (36.9)	7 (25.9)	31 (40.8)			
Unstable angina	34 (33.0)	13 (48.1)	21 (27.7)			
Valve disease	17 (16.5)	2 (7.5)	15 (19.7)			
Years of having DM±SD *(Min-Max)*	2.4±1.4 (0-17)	2.4±1.5 (0-17)	2.3±1.7 (0-15)	-0.120		0.905
Type of surgery n (%)						
CABG	81 (78.6)	25 (92.6)	56 (73.7)		0.054	0.108
Valve surgery	18 (17.5)	2 (7.4)	16 (21.1)			
Both	4 (3.9)	0 (0.0)	4 (5.3)			
DM n (%)						
Yes	35 (34.0)	8 (29.6)	27 (35.5)		0.309	0.578
No	68 (66.0)	19 (70.4)	49 (64.5)			
HTN n (%)						
Yes	57 (55.3)	16 (59.3)	41 (53.9)		0.227	0.633
No	46 (44.7)	11 (40.7)	35 (46.1)			
Years of having HTN±SD *(Min-Max)*	3.7±1.2 (0-15)	3.9±1.6 (0-15)	3.6±1.1 (0-15)	-0.257		0.798
COPD n (%)						
Yes	2 (1.9)	0 (0.0)	2 (2.6)		0.725	0.395
No	101 (98.1)	27 (100.0)	74 (97.4)			
NSAIDs n (%)						
Yes	2 (1.9)	2 (7.4)	0 (0.0)		5.741	0.067
No	101 (98.1)	25 (92.6)	76 (100.0)			

Variables	Total (n=103)	Patients undergoing cardiac surgery		Statistical test		
		With AKI (n=27)	Without AKI (n=76)	t	c2	P-value
Preoperative Hemoglobin (g/dl) ±SD (Min-Max)	13.6±1.5 (9.5-16.9)	13.9±1.1 (12-15.6)	13.5±1.7 (9.5-16.9)	-1.270		0.207
Baseline Creatinine ±SD (Min-Max)	0.89±0.18 (0.5-1.48)	0.88±0.23 (0.5-1.26)	0.9±0.17 (0.6-1.48)	0.491		0.625
eGFR±SD (Min - Max)	89.2±23.2 (24-126)	91.1±23.8 (43-126)	88.5±23.1 (24-125)	-0.492		0.624
Left ventricular ejection fraction± SD (Min-Max)	48±8.1 (30-65)	47.3±7.5 (35-60)	48.2±8.3 (30-65)	0.468		0.641
NYHA score n (%)						
Class 1	19 (18.4)	5 (18.5)	14 (18.4)		1.817	0.611
Class 2	47 (45.7)	10 (37.1)	37 (48.7)			
Class 3	30 (29.1)	9 (33.3)	21 (27.6)			
Class 4	7 (6.8)	3 (11.1)	4 (5.3)			

SD: standard deviation n: number; c2: chi-square test, t: student t-test. *P < 0.05: significant, P ≥ 0.05: not significant

Comparison Between the Patients with and Without AKI

Table 1. compares the patients, including and excluding AKI. The 27 patient cases with AKI do not have a significant difference from the 76 cases without AKI in terms of the mean age, which was 53.1±12.4 years vs. 57.01±10.1 years (P=0.102). Also, the mean preoperative baseline serum creatinine was 0.88±0.23 mg/dL in the AKI group vs. 0.9±0.17 mg/dL in the non-AKI group, indicating no relationship between variables (P=0.625). Moreover, the mean eGFR was 91.1±23.8 in the AKI group vs. 88.5±23.1 in the non-AKI group, showing no significant relationship between variables (P=0.624); the mean left ventricular ejection fraction was 47.3%±7.5% in the AKI group vs. 48.2%±8.3% in the non-AKI group (P=0.641). The mean duration of CPB was 86±35.5 minutes in the AKI group vs. 88.8±33.8 minutes in the non-AKI group, showing no significant relationship between variables (P=0.733); the mean duration of the cross-clamp was 55.7±24.8 minutes in the AKI group vs. 54.1±20.4 minutes in the non-AKI group, demonstrating no significant relationship between variables (p=0.740); the mean duration of mechanical ventilation time was higher in the AKI group, 16.4±30.6 hours vs. 12.6±26.1

hours in the non-AKI group, showing no significant relationship between variables (P=0.539). Red blood cell transfusion was higher in the AKI group at 0.8±2.1 units vs. 0.7±1.5 units, indicating no significant relationship between variables (P=0.733).

Vasopressor administration in the first 24 hrs was used in 51 patients; 31.37% (n=16) developed AKI. In contrast, 21.15% (n=11) out of 52 patients who did not receive vasopressors developed AKI, indicating no significant relationship between variables (P=0.238). In contrast, Vasopressor administration for more than 24 hrs showed a significant relationship with AKI occurrence; it was used in 27 patients, and 11.1% (n=3) of them developed AKI. In contrast, 88.9% (n=24) out of 76 who did not receive vasopressor developed AKI (P=0.038).

Table (2): Dynamic predictive scoring system results.

		Total (n=103)	Patients undergoing cardiac surgery		Statistical test		
			With AKI (n=27)	Without AKI (n=76)	t	c^2	P-value
Preoperative dynamic predictive score	**Dynamic predictive score system ± SD (Min-Max)**	2.7±0.9 (1-5)	2.6±0.8 (1-4)	2.7±0.9 (1-5)	0.708		0.481
	The dynamic predictive score system						
	Low	4 (3.9)	1 (3.7)	3 (3.9)		0.372	0.337
	Medium	78 (75.7)	23 (85.2)	55 (72.4)			
	High	21 (20.4)	3 (11.1)	18 (23.7)			
Dynamic predictive score on ICU admission	**Dynamic predictive score system ±SD (Min-Max)**	3.5±1.7 (1-12)	3.4±2 (2-12)	3.5±1.7 (1-12)	0.296		0.768
	The dynamic predictive score system						
	Low	84 (81.6)	24 (88.9)	60 (78.9)		0.233	0.264
	Medium	17 (16.5)	2 (7.4)	15 (19.7)			
	High	2 (1.9)	1 (3.7)	1 (1.3)			
Dynamic predictive score at post operation on 24 hrs	**Dynamic predictive score system± SD (Min-Max)**	4.1±1.7 (2-13)	3.9±2.1 (2-13)	4.2±1.6 (2-13)	- 0.0803		0.424
	Dynamic predictive score system n (%)						
	Low	75 (72.8)	22 (81.5)	53 (69.7)		0.267	0.281
	Medium	26 (25.2)	4 (14.8)	22 (28.9)			
	High	2 (2.0)	1 (3.7)	1 (1.4)			

We also found no significant difference between the patients with and without AKI in association with the dynamic predictive scoring system over the three phases as shown in Table 2.

DISCUSSIONS

In this study, the occurrence of acute kidney injury (AKI) among patients undergoing cardiac surgery was 27 cases (26.2%) and 76 (73.8%) normal cases according to diagnostic criteria,19.4% stage 1, 4.9% in stage 2 and 1.9% stage 3 defined by KDIGO criteria. Shi et al., in their meta-analysis study, found that AKI occurrence was in 5% to 33% of pediatric cardiac surgery and 1% to 30% of adult cardiac surgery. [12] Ng et al. 2016 reported the incidence of AKI post-cardiac surgery was 29.7% in Singapore [13]. This study result was higher than the 16.4% and 15.7% reported by Andersson et al. in 1993 [14], Kumada et al. In Japan in 2017 [15] In a row, Machado et al., in 2014 in Brazil, among 918 patients found that 43 % developed AKI post-cardiac surgery, 35% were classified as stage 1, 27% as stage 2, and 5% as stage 3 using KDIGO criteria [16]. Alshaiji et al. in 2024 in Bahrain found AKI Occurrence post cardiac surgery was 35% using KDIGO criteria [17]. The only published study in Palestine by Qadan et al. in 2023 found that 32.1% developed AKI post cardiac surgery using RIFLE criteria [18]. These two studies have higher occurrences than this study. Moreover, there are no published studies in the Middle East except the previously mentioned studies about AKI post cardiac surgery. Gameiro J. et al. 2018 in a systemic review study found a superiority of KDIGO diagnostic criteria over AKIN and RIFLE criteria in accuracy, mortality prediction, and occurrence. Among the studies reviewed, the occurrence of AKI in the KDIGO group was higher than in the AKIN and RIFLE groups [19]. The earlier finding by Gameiro J. et al. may reflect the occurrence in this study found in the upper range as KDIGO criteria were used in this study. The difference in the occurrence of AKI is related to different AKI definitions used by researchers and to differences in setting and treatment regimens. Moreover, the lack of protocols and policies for AKI management and diagnosis in the health care system in Palestine might contribute to the increase in this problem.

In this study, the mean age of patients identified with AKI post-cardiac surgery was smaller than the non-AKI group age and showed no significant relationship between age and occurrence of AKI (p-value 0.102). Moreover, Gangadharan et al.in 2018, Zakkar et al. in 2016, and Lagney et al. in 2015 in their studies demonstrated no significant relationship between age and AKI post cardiac surgery [20–22]. In contrast, studies by Ng et al. in 2016, Kim et al. in 2015, and Jiang et al. in 2016 found that age is associated with AKI post-cardiac surgery [13,23,24].

The percentage of the male group was larger than the female group. The gender is not statistically significantly different among AKI occurrence post cardiac surgery in this study (p-value 0.919). This may be related to the small sample of female gender. The impact of gender on the risk assessment of AKI is still not clear. Che et al. in 2010, Khan et al. in 2017, and Xie et al. in 2017 in their retrospective studies showed that males are at more risk of developing AKI post cardiac surgery [25–27]. While other retrospective studies conducted by Machado et al. 2014 and Heise et al. in 2009 found that females are at more risk of developing AKI post cardiac surgery [16,28]. In contrast. Ferreiro et al. in 2017 and Fang et al. in 2010 in their studies have proven that gender is not a risk of AKI post-cardiac surgery [29,30]. Therefore, gender needs further investigations for the impact on the development of AKI post cardiac surgery.

Diabetes Mellitus (DM) has no relationship with the occurrence of AKI post cardiac surgery as shown by results (p-value 0.578), many previous studies showed that there was no relationship between DM and the occurrence of AKI post cardiac surgery [13,16,21,31,32]. In contrast, Lagney et al.2015 found that there is a significant relationship between variables [22]. Most earlier studies have found that DM is not a risk factor for AKI post Cardiac surgery.

Hypertension (HTN) has no association with AKI post cardiac surgery according to this study's results (p-value 0.798). In addition, previous studies reported that HTN had no relationship to AKI occurrence post cardiac surgery [13,23,31,32]. However, Jiang et al. 2016 and Lagney et al. 2015 reported an association between HTN and AKI post cardiac surgery in their studies [22,24].

This study's results reflect no significant relationship between preoperative Hgb level and AKI post cardiac surgery (p-value 0.207). in contrast, Preoperative Hgb value has an association with AKI post cardiac surgery according to Ng et al. study in 2016 [13]. However, Chen et al. 2016 and Lagney et al. (2015) found no significant relationship between preoperative Hgb and AKI occurrence post cardiac surgery [22,31]. Most of the reviewed studies did not include preoperative Hgb levels in their studies.

The results showed that there is no significant relationship between the usage of Non-steroidal anti-inflammatory drugs (NSAIDs) except Aspirin and AKI post cardiac surgery (p-value 0.067), because of the small sample subjected they used NSAIDs, only 2 participants used NSAIDs and both developed AKI post-operation. Tang et al. (2020) found that parecoxib has a significant relation to the occurrence of AKI postcardiac surgery [33]. In addition, Guan et al. (2019) confirmed that there is a relationship between NSAIDs usage and the occurrence of AKI post cardiac surgery [34]. In contrast, Xie et al. 2017 found no relationship between the occurrence of AKI and NSAIDs [35].

In This study, red blood cells (RBCs) transfusion is not associated with the occurrence of AKI post cardiac surgery (P value 0.771). in addition, Kim et al. 2015 and Neyra et al. 2019 found no association between AKI post Cardiac surgery and RBCs transfusion [23,32]. While Jiang et al. and Ng et al. in 2016 found a significant relationship between RBC transfusion and AKI occurrence post cardiac surgery [13,24].

This study found no relation between preoperative baseline serum creatinine and the occurrence of AKI post-cardiac surgery with a P value of (0.625). In contrast, previous studies reported in their results that baseline serum creatinine (SCr) has no association with the occurrence of AKI post cardiac surgery [23,32]. While another five studies found that baseline SCr is significant in the occurrence of AKI post cardiac surgery [21,22,24,31,36].

This study found no relation between the CPB duration and AKI post-cardiac surgery, with a P value of 0.733 and a mean of 88.2 min. Chen et al., in 2016, found the mean of CPB time to be 117.3 min, and Lagny et al., in 2015, found the mean of CPB time to be 85 min; the previously mentioned studies found that CPB time is not associated with AKI post cardiac surgery [22,31]. However, Machado et al., in 2014, found a CPB time mean of 90 min in the non-AKI group vs (100-110 min) in the AKI group and found. Kim et al., in 2015, found that CPB time of more than 180 min is associated with AKI post-cardiac surgery; these two studies found that CPB time is associated with AKI post-cardiac surgery [16,23]

Usage of vasopressors less than 24 hrs post cardiac surgery showed no significant relationship between usage of vasopressors and the occurrence of AKI in the study sample (p-value 0.238). Usage of vasopressors for more than 24 hrs showed a significant relationship to the occurrence of AKI post cardiac surgery with a p-value (0.038), which showed a lower occurrence of AKI in the vasopressor group. In Chen et al., (2016) study, they showed that 10.8% of the study sample received inotropes and found no relation between the usage of inotropes and AKI post cardiac surgery [31].

The AKI group's Mechanical ventilation (MV) time was longer than the non-AKI group. However, results showed no significant relationship between MV time and AKI occurrence. Gao Xuxia et al. in 2020 found that MV of more than 96 hrs is a risk factor for AKI post-cardiac surgery [37]. Moreover, Heringlake et al. 2014 found that an increase in postoperative mechanical ventilation time from 4 hrs to more than 16 hrs increases the incidence of AKI post-cardiac surgery for 3.5 folds [38]. While Chen et al., in 2016, found that MV time is not associated with the occurrence of AKI post-cardiac surgery however, the AKI group time was much higher than the non-AKI group (58.4±11.8 vs. 22.8±2.6 hrs), but in the same study found that 8.2%of study population received MV and has relation between usage of MV and occurrence of AKI post cardiac surgery [24,31].

The dynamic predictive scoring system in this study has no relation to the occurrence of AKI post-cardiac surgery as it measured three times: preoperative, ICU admission, and on 24 hr post-cardiac surgery with a p-value of 0.481 in the preoperative period, 0.768 on ICU admission and 0.424 on 24 hr post cardiac surgery. This scoring system was developed in 2016 by Jiang et al., as they found that the dynamic predictive scoring system for AKI is suitable for the prediction of AKI occurrence post-cardiac surgery with an area under the receiver operating characteristic (AUROC) value of 0.74 preoperatively, 0.75 on ICU admission and 0.82 on 24 hrs post cardiac surgery [24].

CONCLUSION

The incidence of acute kidney injury (AKI) among patients undergoing cardiac surgery is elevated (26.2%) and the highest percentage in stage 1 (19.4%), followed by 4.9% in stage 2, and the lowest group was stage 3. The results showed no relation between the occurrence of AKI among patients undergoing cardiac surgery and sociodemographic data such as address, gender, age, and BMI (P>0.05). The results showed no association between the occurrence of AKI among patients undergoing cardiac surgery and clinical data were studied (Diagnosis, Years of having diabetes mellitus, Type of surgery, DM, HTN, Years of having HTN, COPD, and NSAIDs)

The results showed no association between patients with and without AKI about hemoglobin, creatinine, GFR, left ventricular ejection fraction, and dynamic predictive score (P>0.05). The oliguria time was statistically significant among patients with AKI compared to those without AKI. There is no relation between AKI regarding CPB time, mechanical ventilation time, Cross clamp time, Packed RBCs, serum creatinine, dynamic predictive score system, intra-aortic balloon pump usage, valve and CABG, kidney disease (without RRT), CPB application previous, cardiac surgery, hypotension, and vasopressors usage up to 24 hrs. vasopressor time more than 24 hr has a relation to AKI post cardiac surgery. The occurrence of AKI in the vasopressor >24 hr group was lower than in the non-vasopressor group.

Patients have AKI not associated with erythrocyte transfusion, dynamic predictive score system, oliguria time, serum creatinine, LCOS, hypotension, and urine output Serum creatinine on day 3 was higher statistically significant among patients with AKI compared to those without AKI. No relation between the incidence of AKI and days, urine output, and oliguria time.

Abbreviation

AKI	Acute kidney injury
AKIN	Acute Kidney Injury network
AUROC	Area under the receiver operating characteristic
CABG	Coronary artery bypass graft
COPD	Chronic obstructive pulmonary disease
CPB	Cardio-pulmonary bypass
DM	Diabetes mellites
GFR	Glomerular filtration rate
HTN	Hypertension
Hr	Hour
Hgb	Hemoglobin
ICU	Intensive care unit
IHD	Ischemic heart disease
KDIGO	Kidney Diagnosis Improving Global Outcome
LCOS	Low cardiac output syndrome
MI	Myocardial infarction
MV	Mechanical ventilation
SCr	Serum creatinine
NSAIDs	Non-steroidal anti-inflammatory drugs
RIFLE	Risk, injury, failure, loss, end-stage
RRT	Renal replacement therapy
RBCs	Red blood cells

Disclosure Statement

- **Ethics approval and consent to participate:** This study was approved by An-Najah National University IRB committee under the number Mas. July/2020/22 and approved by the administration of the Ministry of Health, Al-Arabi specialized, and Nablus specialized hospitals. The names of participants were hidden to ensure anonymity and confidentiality. Before conducting the study, informed consent was obtained from each patient, and they were informed that the research was voluntary, confidential, and purely for academic purposes. Our study rigorously adheres to the ethical principles established by the Declaration of Helsinki, ensuring compliance with its standards throughout the research process.
- **Consent for publication:** NA
- **Availability of data and materials:** The corresponding author will provide the data supporting the study's findings upon a reasonable request.
- **Author's contribution:** Each of the authors played a substantial role in this research, including contributions to the conception, study design, data acquisition, analysis, and interpretation. Additionally, they were involved in drafting, revising, and critically reviewing the article. Furthermore, all authors provided final approval for the manuscript's publication, selected the journal for submission, and committed to being accountable for all aspects of this research.

- **Funding:** This research paper was conducted without external funding or financial support.

- **Conflicts of interest:** The investigators declare that there is no conflict-of-interest statement.

- **Acknowledgements:** The investigator would like to thank all participants for their cooperation during the study.

References

1] Bellomo R, Kellum JA, Ronco C. Acute kidney injury. The Lancet. 2012 Aug 25;380(9843):756–66.

2] Radi ZA. Symposia Review Kidney Pathophysiology, Toxicology, and Drug-Induced Injury in Drug Development. Int J Toxicol. 2019;38(3):215–27.

3] Calvert S, Shaw A. Perioperative acute kidney injury. Perioperative Medicine. 2012 Dec 4;1(1):6.

4] Sethi SK, Goyal D, Yadav DK, Shukla U, Kajala PL, Gupta VK, et al. Predictors of acute kidney injury post-cardiopulmonary bypass in children. Clin Exp Nephrol. 2011 Aug;15(4):529–34.

5] Vives M, Hernandez A, Parramon F, Estanyol N, Pardina B, Muñoz A, et al. Acute kidney injury after cardiac surgery: Prevalence, impact and management challenges. Int J Nephrol Renovasc Dis. 2019;12:153–66.

6] Kang W, Wu X. Pre-, intra-, and post-operative factors for kidney injury of patients underwent cardiac surgery: A retrospective cohort study. Medical Science Monitor. 2019;25:5841–9.

7] Leballo G, Chakane PM. Cardiac surgery-associated acute kidney injury: Pathophysiology and diagnostic modalities

and management. Vol. 31, Cardiovascular Journal of Africa. Clinics Cardive Publishing (PTY)Ltd; 2020. p. 205–12.
8] Verma SK, Molitoris BA. Renal Endothelial Injury and Microvascular Dysfunction in Acute Kidney Injury. Semin Nephrol. 2015 Jan 1;35(1):96–107.
9] Wang Y, Bellomo R. Cardiac surgery-associated acute kidney injury: Risk factors, pathophysiology and treatment. Vol. 13, Nature Reviews Nephrology. Nature Publishing Group; 2017. p. 697–711.
10] Rao SN, Shenoy M P, Gopalakrishnan M, Kiran B A. Applicability of the Cleveland clinic scoring system for the risk prediction of acute kidney injury after cardiac surgery in a South Asian cohort. Indian Heart J. 2018 Jul 1;70(4):533–7.
11] Gameiro J, Fonseca JA, Outerelo C, Lopes JA. Acute kidney injury: From diagnosis to prevention and treatment strategies. Vol. 9, Journal of Clinical Medicine. MDPI; 2020.
12] Shi Q, Hong L, Mu X, Zhang C, Chen X. Meta-analysis for outcomes of acute kidney injury after cardiac surgery. Medicine (United States). 2016;95(49):e5558.
13] Ng RRG, Tan GHJ, Liu W, Ti LK, Chew STH. The association of acute kidney injury and atrial fibrillation after cardiac surgery in an asian prospective cohort study. Medicine (United States). 2016;95(12).
14] Andersson LG, Ekroth R, Bratteby LE, Hallhagen S, Wesslén Ö. Acute Renal Failure after Coronary Surgery - A Study of Incidence and Risk Factors in 2009 Consecutive Patients. Thorac Cardiovasc Surg. 1993 Aug 30;41(04):237–41.
15] Kumada Y, Yoshitani K, Shimabara Y, Ohnishi Y. Perioperative risk factors for acute kidney injury after off-pump coronary artery bypass grafting: a retrospective study. JA Clin Rep. 2017 Dec;3(1).
16] Machado MN, Nakazone MA, Maia LN. Acute kidney injury based on KDIGO (Kidney Disease improving global outcomes) criteria in patients with elevated baseline serum creatinine undergoing cardiac surgery. Braz J Cardiovasc Surg. 2014 Jul 1;29(3):299–307.
17] Faisal Alshaiji A, Kumar Motwani S, Saunders H, Sathyan S, Nagendra Banovath S, Bukamal N, et al. Journal of the Bahrain Medical Society Cardiac Surgery Associated Acute Kidney Injury-Incidence, Risk Factors, Outcomes, and Risk Score Validation from a Single Centre in Bahrain. Vol. 36, J Bahrain Med Soc. 2024.
18] Qadan L, Eid Aburuz M, Ahmed FR, Alaloul F. The Open Nursing Journal Higher Body Mass Index and Prolonged Cardiopulmonary Bypass Time increase the Risk of Cardiac Surgery-associated Acute Kidney Injury. 2023;17:18744346256499. Available from: https://opennursingjournal.com
19] Gameiro J, Fonseca JA, Jorge S, Lopes JA. Acute kidney injury definition and diagnosis: A narrative review. Vol. 7, Journal of Clinical Medicine. MDPI; 2018.
20] Gangadharan S, Sundaram KR, Vasudevan S, Ananthakrishnan B, Balachandran R, Cherian A, et al. Predictors of acute kidney injury in patients undergoing adult cardiac surgery. Ann Card Anaesth. 2018 Oct 1;21(4):448–54.
21] Zakkar M, Bruno VD, Guida G, Angelini GD, Chivasso P, Suleiman MS, et al. Postoperative acute kidney injury defined by RIFLE criteria predicts early health outcome and long-term survival in patients undergoing redo coronary artery bypass graft surgery. Journal of Thoracic and Cardiovascular Surgery. 2016 Jul 1;152(1):235–42.
22] Lagny MG, Jouret F, Koch JN, Blaffart F, Donneau AF, Albert A, et al. Incidence and outcomes of acute kidney injury after cardiac surgery using either criteria of the RIFLE classification Clinical Research. BMC Nephrol. 2015 May 30;16(1).
23] Kim WH, Park MH, Kim HJ, Lim HY, Shim HS, Sohn JT, et al. Potentially modifiable risk factors for acute kidney injury after surgery on the thoracic aorta: A propensity score matched case-control study. Medicine (United States). 2015 Jan 2;94(2):e273.
24] Jiang W, Teng J, Xu J, Shen B, Wang Y, Fang Y, et al. Dynamic Predictive Scores for Cardiac Surgery-Associated Acute Kidney Injury. J Am Heart Assoc. 2016 Aug 1;5(8).
25] Che M, Li Y, Liang X, Xie B, Xue S, Qian J, et al. Prevalence of Acute Kidney Injury following Cardiac Surgery and Related Risk Factors in Chinese Patients. Nephron Clin Pract. 2010 Sep 22;117(4):305–11.
26] Khan YH, Sarriff A, Adnan AS, Khan AH, Mallhi TH, Jummaat F. Progression and outcomes of non-dialysis dependent chronic kidney disease patients: A single center longitudinal follow-up study. Nephrology. 2017 Jan;22(1):25–34.
27] Xie X, Wan X, Ji X, Chen X, Liu J, Chen W, et al. Reassessment of acute kidney injury after cardiac surgery: A retrospective study. Internal Medicine. 2017;56(3):275–82.
28] Heise D, Sundermann D, Braeuer A, Quintel M. Validation of a clinical score to determine the risk of acute renal failure after cardiac surgery. 2009; Available from: www.elsevier.com/locate/ejcts
29] Ferreiro A, Lombardi R. Acute kidney injury after cardiac surgery is associated with mid-term but not long-term mortality: A cohort-based study. PLoS One. 2017 Jul 1;12(7).
30] Fang Y, Ding X, Zhong Y, Zou J, Teng J, Tang Y, et al. Acute Kidney Injury in a Chinese Hospitalized Population. Blood Purif. 2010;30(2):120–6.
31] Chen SW, Chang CH, Fan PC, Chen YC, Chu PH, Chen TH, et al. Comparison of contemporary preoperative risk models at predicting acute kidney injury after isolated coronary artery bypass grafting: a retrospective cohort study. BMJ Open [Internet]. 2016;6:10176. Available from: http://dx.doi.org/
32] Neyra JA, Hu MC, Minhajuddin A, Nelson GE, Ahsan SA, Toto RD, et al. Kidney Tubular Damage and Functional Biomarkers in Acute Kidney Injury Following Cardiac Surgery. Kidney Int Rep. 2019 Aug 1;4(8):1131–42.
33] Tang YZ, Zeng P, Liao Y, Qin Z, Zhang H, Li B, et al. Correlation between perioperative parecoxib use and postoperative acute kidney injury in patients undergoing non-cardiac surgery: A retrospective cohort analysis. Vol. 11, BMJ Open. BMJ Publishing Group; 2021.
34] Guan C, Li C, Xu L, Zhen L, Zhang Y, Zhao L, et al. Risk factors of cardiac surgery-associated acute kidney injury: development and validation of a perioperative predictive nomogram. J Nephrol. 2019 Dec 26;32(6):937–45.
35] Xie X, Wan X, Ji X, Chen X, Liu J, Chen W, et al. Reassessment of acute kidney injury after cardiac surgery: A retrospective study. Internal Medicine. 2017;56(3):275–82.
36] Barkhordari K, Yasseri F, Yousefshahi AM, Shafiee F. Risk Factors for Acute Kidney Injury in Coronary Artery Bypass Graft Surgery Patients Based on the Acute Kidney Injury Network Criteria [Internet]. Vol. 13, J Teh Univ Heart Ctr. 2018. Available from: http://jthc.tums.ac.ir
37] Gao Xuxia, Ma Liping, Ma Hanying, Cai Jin, Deng Liqun, Qiao Manli. Analysis of the incidence and risk factors of acute kidney injury in 4 878 patients after cardiac surgery. Chinese Journal of Nephrology. 2020;36(05):359–65.
38] Heringlake M, Nowak Y, Schön J, Trautmann J, Berggreen AE, Charitos EI, et al. Postoperative intubation time is associated with acute kidney injury in cardiac surgical patients. Crit Care. 2014;18(5).