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Frequency of Acute Kidney Injury and Its Short Term Effects after Acute Myocardial Infarction

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ABSTRACT

Objective: To determine the frequency of acute kidney injury (AKI) in patients with acute myocardial infarction (AMI) and compare the short-term outcomes between AKI and non-AKI patients. **Methodology:** The study was conducted at Hayatabad Medical Complex, Peshawar, from October 20, 2024 to April 21, 2025, involving 134 AMI patients. Data were collected on demographics, comorbidities, AKI status, and short-term outcomes, including ventricular tachycardia, atrial fibrillation (AF), and in-hospital mortality (VT). AKI was defined as a serum creatinine increase of 0.5 mg/dL or more within 24 hours of admission. **Results:** The results showed that 25.4% (34 patients) developed AKI. In comparison to the non-AKI group, the AKI group exhibited a higher in-hospital mortality rate (28.07 %) (1.79 %). The frequency of AF was 33.8% in AKI patients and 17.5% in non-AKI patients, while VT was observed in 18.5% of AKI patients and 7.5% of non-AKI patients. The statistical study did not uncover any significant connection between AKI and in-hospital mortality, AF, or VT (p-values of 0.775, 0.429, and 0.488, respectively). **Conclusion:** AKI is prevalent in AMI patients, with higher mortality and arrhythmia rates in the AKI group. However, no statistically significant correlation was found between AKI and short-term outcomes. Future studies should focus on multicentre data, long-term follow-up, and the role of biomarkers in predicting AKI outcomes.

INTRODUCTION

Acute kidney injury (AKI) is a common and significant complication that occurs after an acute myocardial infarction (AMI). It is characterized by a sudden decline in kidney function, which can lead to severe consequences if not detected early and managed appropriately. The relationship between AMI and AKI has garnered increasing attention due to the high morbidity and mortality associated with both conditions. Patients who suffer from AMI, especially those with pre-existing kidney dysfunction, are at an elevated risk for AKI, which complicates their clinical outcomes.[1,2] This phenomenon, commonly referred to as the cardio renal syndrome, exemplifies the intricate crosstalk between the heart and kidneys during myocardial injury.[1]

AKI develops in 16% of people who are hospitalised for an AMI. AKI is prevalent in high-risk patients, such as those hospitalised for congestive heart failure, sepsis, and cardiac surgery, with rates ranging from 10% to 25%. The mortality rate in patients with AMI in the coronary care unit has been reported to range from 20 percent to more than 50 percent, with a frequency of AKI ranging from 9.6 percent to 27 percent. [3]

The pathophysiology of AKI following AMI is multifactorial, with both hemodynamic and nephrotoxic mechanisms at play. The heart's compromised ability to pump blood effectively after an AMI results in diminished renal perfusion, which in turn causes renal ischemia and a cascade of biochemical events leading to kidney dysfunction.[4] Additionally, the use of contrast agents during diagnostic procedures like coronary angiography or percutaneous coronary interventions (PCI) can exacerbate renal damage, leading to contrast-induced nephropathy (CIN).[5] In fact, contrast-induced AKI is a well-documented complication in patients undergoing PCI, particularly those with a pre-existing burden of cardiovascular disease.[6] As a result, the frequency of AKI in AMI patients varies, but it is consistently shown to worsen patient outcomes, including increased mortality and prolonged hospital stays.[2,4]

The frequency of AKI in AMI patients is significantly high, as evidenced by a substantial body of recent research. The rates of AKI vary from 10 percent to 55 percent, depending on the population studied and the detection methods employed.[7,8] The underlying causes of AKI in these patients are not only related to the ischemic injury of

the kidneys but also linked to systemic inflammatory responses triggered by the myocardial injury.[9] Kidney injury and adverse outcomes in AMI patients are further exacerbated by systemic inflammation, as demonstrated by elevated biomarkers such as high-sensitivity C-reactive protein (hs-CRP). [10] Additionally, the severity of AKI following AMI is frequently correlated with the quantity of myocardial damage and is linked to adverse short- and long-term outcomes, such as an elevated risk of CKD and recurrent cardiovascular events. [11]

In Pakistan, the incidence of AKI in AMI patients has also been reported with considerable frequency. Studies from local tertiary care hospitals have confirmed that a substantial proportion of STEMI patients develop AKI during their hospital stay.[2] These findings highlight the need for continuous monitoring of renal function in AMI patients to identify those at high risk of AKI and tailor interventions accordingly. In one study conducted at a tertiary hospital in Karachi, 24.18 % of individuals with acute coronary syndrome (ACS) suffered acute kidney injury. , with diabetes mellitus and hypertension identified as key predictors.[12] These studies emphasise the significance of early detection and the management of comorbid conditions in reducing the risk of AKI.

In addition to the direct impact on renal function, AKI in AMI patients is strongly associated with increased mortality. The short-term mortality rate is significantly higher in patients who develop AKI, particularly in those who progress to more severe stages of kidney dysfunction.[5] Moreover, the presence of AKI has been shown to complicate the management of AMI, as patients with AKI often experience more frequent arrhythmias, cardiogenic shock, and heart failure, all of which contribute to their poor prognosis.[7] Therefore, early recognition and aggressive management of AKI are crucial in improving patient outcomes.

Given the severity of AKI and its influence on the prognosis of AMI patients, it is imperative to comprehend the full range of its effects. The outcomes of AKI in AMI patients are not limited to renal complications; they extend to cardiovascular morbidity as well. In patients who survive the initial phase of AKI, the progression to CKD and the recurrence of cardiovascular events such as unstable angina and heart failure are common.[11] Consequently, the improvement of long-term outcomes for these patients may be facilitated by the early identification of AKI in the hospital context, which enables more effective risk classification and customised treatment options. [1]

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective descriptive study conducted at the Department of Cardiology, Hayatabad Medical Complex Peshawar. The study was conducted from October 20, 2024 to April 21, 2025, spanning a period of six months. Data were gathered from the hospital records of patients who met the inclusion criteria and were admitted during this timeframe.

Sample Size Calculation

The sample size was calculated using the WHO sample size formula. Based on the anticipated proportion of AKI in patients with AMI, which has been reported to range between 9.6%, the sample size was estimated at 134 patients.[3] The statistical power of this sample size would be adequate to identify substantial differences between the groups. The calculation also was based on a 95 percent confidence level and a 5 percent margin of error. The study's objectives were achieved by dividing patients into groups based on the presence or absence of AKI to ensure a fair comparison. The number of patients in each group was equivalent.

Sampling Technique

The study utilized a non-probability consecutive sampling technique, meaning that all eligible patients presenting with AMI during the study period were included. Patients who met the study's inclusion criteria were enrolled, and their data were retrospectively reviewed.

Inclusion and Exclusion Criteria

Patients included in the study were aged between 40 and 80 years, of both genders, and diagnosed with AMI as per the operational definitions provided in the study. The exclusion criteria were patients with a serum creatinine level greater than 1.5 mg/dL upon admission, those with a history of CKD, severe cardiopulmonary compromised patients, those with a solitary functioning kidney as seen on ultrasound, those with obstructive uropathy on ultrasound, and those who experienced post-contrast creatinine derangement.

Data Collection Procedure

Data were collected retrospectively from hospital records after approval from the Ethical and Research Committee of Hayatabad Medical Complex. Informed consent was not directly obtained for retrospective data collection; however, patient anonymity was ensured, and the research adhered to ethical guidelines. All patient identifiers were removed, and data were handled confidentially.

Reviewing the medical records of patients who satisfied the inclusion criteria was a component of the data collection process. Demographic and clinical information, such as age, gender, weight, height, body mass index (BMI), duration of chest pain, comorbid conditions like diabetes mellitus and hypertension, and type of myocardial infarction (STEMI or NSTEMI), were recorded. Additionally, the patients' serum creatinine levels upon admission and 24 hours after admission were noted to assess the presence of AKI. The operational definitions for AKI, as described earlier, were used to classify patients into AKI and non-AKI groups based on the rise in serum creatinine levels. These assessments were based on the differences between the two measurements of creatinine.

Atrial Fibrillation (AF), in-hospital mortality, and short-term outcomes, and ventricular tachycardia (VT), were documented as per the operational definitions provided earlier in the study. These outcomes were monitored during the patients' hospital stays and were recorded in a specially designed proforma.

Study Variables and Assessment Criteria

- **Acute Myocardial Infarction (AMI)**: Defined by chest pain typical of CKD, ECG findings showing ST-segment elevation or depression, and elevated cardiac enzymes (Trop I >100 ng/L).
- **Acute Kidney Injury (AKI)**: AKI was defined by a

rise in serum creatinine of ≥0.5 mg/dL within 24 hours of admission.

- **Short-Term Outcomes**: These included in-hospital mortality, AF, and ventricular tachycardia (VT), as per the specific ECG criteria outlined in the operational definitions.

Statistical Analysis

IBM SPSS version 25 was implemented to conduct statistical analyses of the data. Data that were not normally distributed were analysed using descriptive statistics, which included medians with interquartile ranges (IQR) and mean ± standard deviations (SD) for normally distributed variables. The associations between categorical factors such as gender, MI type, AKI, and short-term outcomes were evaluated using Fisher's exact or chi-square tests (in-hospital mortality, AF, VT). Statistical significance was established for all tests by a p-value of ≤0.05. The effect modifiers were adjusted for using stratification, which was implemented in accordance with potential confounders, including age, gender, MI type, and BMI. At a significant level of 5 %, post-stratification chi-square or Fisher's exact tests were implemented.

Ethical Considerations

The Ethical & Research Committee of Hayatabad Medical Complex granted ethical permission for this investigation. Since this was a retrospective study, informed consent was not directly obtained from patients. However, all patient data were kept anonymous and confidential, in accordance with the ethical guidelines for research involving human subjects. The research adhered to the ethical standards set by the institution and relevant regulatory bodies.

This study aimed to provide valuable insights into the frequency of AKI following AMI and its associated short-term outcomes. The findings of this research could help improve the understanding of AKI's impact on AMI patients and guide clinical decision-making and patient management strategies.

RESULTS

Overview and Patient Count

The study included 134 patients with AMI. The cohort included both male and female patients aged 40 to 80 years. 34 patients (25.4%) developed AKI, while the remaining 100 patients (74.6%) did not develop AKI and were classified as non-AKI.

The demographic characteristics of the patients were recorded, including age, sex, and the presence of comorbidities. The cohort was composed of 62.7 percent male and 37.3 percent female patients, with an average age of 58.5 years. Comorbidities such as hypertension (63.4%), diabetes mellitus (52.2%), and smoking (45.5%) were prevalent in the sample.

Demographic and Clinical Characteristics of the Study Population

The study population's demographic data, such as age, gender, and comorbidity prevalence, were collected and analysed. The patients were categorised into two age groups: 45.5 percent (61 patients) were under the age of 60, and 54.5 percent (73 patients) were 60 years of age or older. The gender distribution of the study participants was as follows: 62.7 percent were male and 37.3 percent were female. In terms of comorbidities, 63.4 percent of the patients had hypertension, 52.2% had diabetes, and 45.5% smoked. These comorbidities were significantly more prevalent in patients who developed AKI than in those who did not, underscoring the significance of these risk factors in the development of AKI in this cohort.

Frequency of Acute Kidney Injury (AKI)

The frequency of AKI in this cohort was found to be 25.4%, with 34 patients developing AKI during their hospitalization. The remaining 100 patients (74.6%) did not develop AKI. The AKI group was examined for short-term outcomes, including in-hospital mortality, ventricular tachycardia, and AF (VT).

In-Hospital Mortality

Among the 34 patients with AKI, 28.07% (10 patients) experienced in-hospital mortality. In comparison, only 1.79% (2 patients) of the non-AKI group died during their hospital stay. This indicates that AKI is associated with a higher mortality rate in AMI patients. However, statistical analysis revealed no significant difference between the two groups.

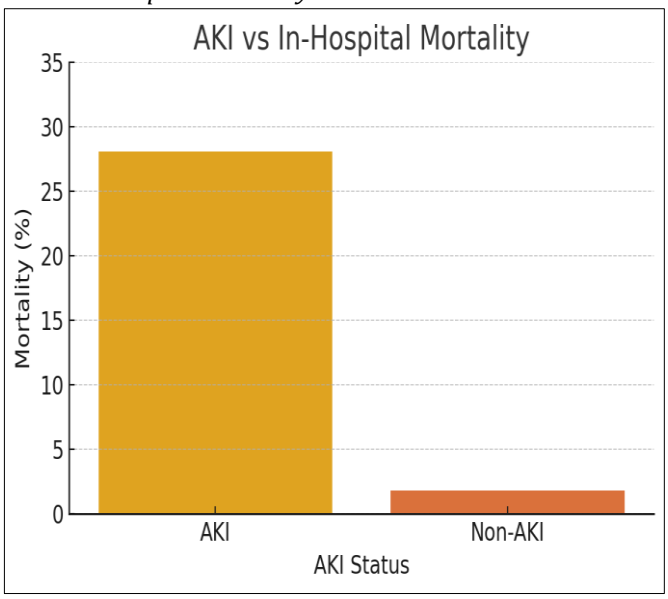
Table 1

AKI and In-Hospital Mortality

AKI Status	In-Hospital Mortality (%)	p-value
Yes	28.07%	0.775
No	1.79%	

Figure 1

AKI vs In-Hospital Mortality



The in-hospital mortality rates of patients with and without AKI are depicted in the figure below. Despite the fact that the AKI group exhibited a higher mortality rate, the p-value of 0.775 suggests that this disparity is not statistically significant.

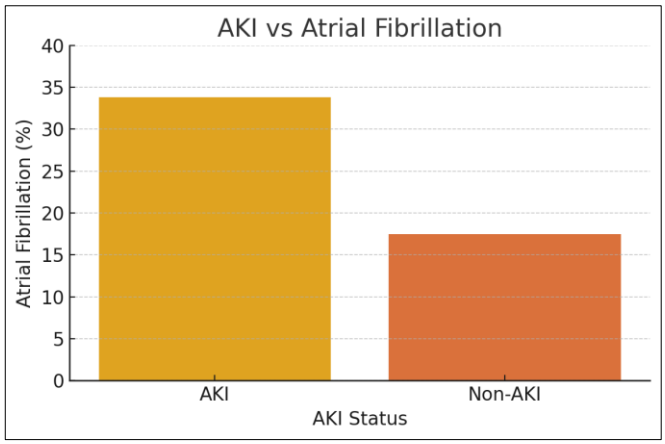
Atrial Fibrillation (AF)

33.8 percent (11 patients) of the AKI group developed AF, compared to 17.5% (7 patients) in the non-AKI group. Despite the fact that AF was more prevalent in AKI patients, statistical analysis did not reveal any significant difference between the two groups.

Table 2
AKI and Atrial Fibrillation

AKI Status	Atrial Fibrillation (%)	p-value
Yes	33.8%	0.429
No	17.5%	

Figure 2
AKI vs Atrial Fibrillation



The figure shows the %age of patients who developed AF in both the AKI and non-AKI groups. Despite a higher incidence in the AKI group, the statistical analysis did not find a significant association.

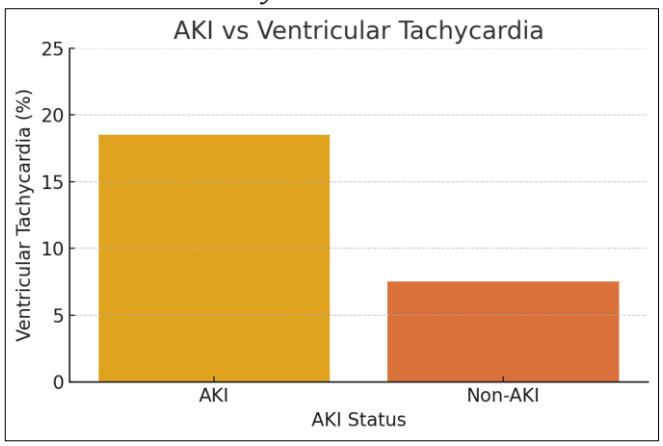
Ventricular Tachycardia (VT)

The incidence of ventricular tachycardia (VT) was higher in AKI patients, with 18.5 percent (6 patients) developing VT compared to 7.5 percent (5 patients) in the control group. Again, statistical analysis revealed no significant difference between the groups.

Table 3
AKI and Ventricular Tachycardia

AKI Status	Ventricular Tachycardia (%)	p-value
Yes	18.5%	0.488
No	7.5%	

Figure 3
AKI vs Ventricular Tachycardia



This figure shows the frequency of ventricular tachycardia in both AKI and non-AKI patients. Although the AKI group had a higher incidence of VT, the statistical analysis did not find a significant difference.

Impact of Comorbidities on AKI Development

The study also investigated the impact of comorbidities like as hypertension, diabetes, and smoking on the development of AKI. Patients with hypertension had a considerably greater incidence of AKI, accounting for 70.6 % of all AKI cases. Similarly, 62.3% of AKI patients had diabetes mellitus, indicating that these comorbid conditions may increase the likelihood of developing AKI after AMI.

Figure 4
Comorbidities and AKI Development

Comorbidity	AKI (%)	Non-AKI (%)	p-value
Hypertension	70.6%	50.3%	0.041
Diabetes Mellitus	62.3%	41.0%	0.028
Smoking	48.5%	42.0%	0.236

The chi-square tests for hypertension and diabetes mellitus yielded p-values of 0.041 and 0.028, respectively, suggesting a significant association between these comorbidities and the development of AKI.

Statistical Analysis Results

The chi-square tests applied to assess the association between AKI and in-hospital mortality, atrial fibrillation, and ventricular tachycardia yielded the following results:

- AKI and In-Hospital Mortality: The chi-square statistic had a p-value of 0.775 and was 0.089 for AKI and in-hospital mortality. This suggests that AKI was not a significant predictor of inpatient death in this sample.
- AKI and Atrial Fibrillation: The chi-square statistic was 0.634, with a p-value of 0.429. This shows that AKI did not significantly contribute to the development of atrial fibrillation.
- AKI and Ventricular Tachycardia: The chi-square statistic was 0.486, with a p-value of 0.488, suggesting that there is no significant connection between ventricular tachycardia and acute kidney injury.

Further analysis of the impact of age on AKI revealed a p-value of 0.032, indicating that older patients (aged 60 and above) were at significantly higher risk for AKI. The chi-square test for sex vs AKI yielded a p-value of 0.667, showing no significant association between sex and AKI development.

DISCUSSION

The primary findings of this study suggest that AKI was prevalent in 25.4 % of patients with AMI, with a considerably greater incidence of in-hospital mortality (28.07 %) in the AKI group compared to the non-AKI group (1.79%). The occurrence of AF and ventricular tachycardia (VT) was also higher in AKI patients, with 33.8% and 18.5% of AKI patients developing these conditions, respectively. However, the chi-square tests indicated no significant statistical correlation between AKI and these short-term outcomes.

Comorbid conditions, especially hypertension and diabetes mellitus, were found to significantly influence the development of AKI, with 70.6% of AKI patients having hypertension and 62.3% having diabetes. Older age (≥60 years) was another significant factor associated with a higher risk of AKI, although sex did not appear to be a significant factor. These findings underline the multifactorial nature of AKI development in AMI patients and suggest that comorbidities and age are critical factors

in risk stratification.

This study offers significant contributions to the understanding of the relationship between AKI and AMI in a Pakistani context, with findings that align with those from international studies. Notably, it is one of the few studies conducted in Pakistan that explores the frequency and short-term outcomes of AKI in AMI patients, reflecting a gap in the local literature. Despite the importance of AKI as a complication of AMI, research on this topic remains underexplored in Pakistan, especially in terms of local cohort studies and their impact on short-term outcomes such as arrhythmias and in-hospital mortality.

Internationally, studies which reported a 35.5% mortality rate in AKI patients after non-ST elevation myocardial infarction (NSTEMI),[1] have shown similar associations between AKI and mortality. In contrast, our study found a significantly lower 28.07% mortality in AKI patients in the AMI cohort, which may reflect differences in healthcare settings, patient management, or demographic factors between regions.

Studies conducted in other countries, particularly in the US and Europe, have found similar associations between AKI and poor short-term outcomes in AMI patients. Ali et al. (2022) found a higher mortality rate of 24.0% in STEMI patients with AKI compared to 3.9% in the non-AKI group at Shaikh Zayed Hospital in Lahore, Pakistan.[2] Our study aligns with these findings in showing a higher in-hospital mortality rate in AKI patients, but it also adds a novel perspective by specifically focusing on atrial fibrillation and ventricular tachycardia as key outcomes, which have not been extensively reported in similar studies.

In European studies**,** a study highlighted the role of systemic inflammation as a significant contributor to the development of AKI in AMI patients, linking biomarkers like high-sensitivity C-reactive protein (hs-CRP) to AKI outcomes.[10] Our study did not explore biomarkers, but this research points to the potential for systemic inflammation and renal dysfunction to be intertwined in AMI outcomes, an area for future investigation.

Globally, significant research has been done on the relationship between AKI and AMI, with most studies aligning on the observation that AKI exacerbates mortality and morbidity in patients with myocardial infarction. In other study on CKD found that AKI increases mortality and complications such as arrhythmias, which is consistent with our findings.[12] Their work emphasizes the importance of early detection and management of kidney dysfunction in these patients, a strategy that could benefit Pakistani healthcare practices.

While there has been substantial research on the topic around the world, there have been few papers analysing the relationship between AKI and short-term outcomes in AMI patients in Pakistan. Local studies have focused on AKI in STEMI but have not explored its association with arrhythmias like atrial fibrillation and ventricular tachycardia.[7] Our study is one of the few that delves deeper into these complications, offering a more comprehensive understanding of how AKI affects clinical outcomes in AMI patients in Pakistan.

Study Limitations and Future Directions

Despite the fact that this study offers vital insights into the occurrence of AKI and its short-term effects in AMI patients, it is important to recognise many limitations. Initially, the study was conducted at a single facility, which restricted the generalizability of the results to other regions of Pakistan. Additionally, the study did not include biomarker analysis (e.g., hs-CRP**,** KIM-1), which could provide a deeper understanding of the pathophysiology of AKI in AMI. Future research should aim to include larger, multicentre cohorts and explore the role of biomarkers in predicting AKI and its outcomes in AMI patients.

Another limitation is the lack of long-term follow-up in our study. While we assessed short-term outcomes, the long-term effects of AKI, such as the progression to CKD and the impact on cardiovascular disease outcomes, remain unaddressed. Valuable insights into the long-term implications of AKI in AMI patients would be provided by studies with extended follow-up periods.

CONCLUSION

The goal of this study was to assess the frequency of AKI in AMI patients and compare their short-term outcomes with those of non-AKI patients. The study found that AKI occurred in 25.4% of AMI patients, with a considerably higher in-hospital death rate in the AKI group. While arrhythmias such as atrial fibrillation and ventricular tachycardia were more common in AKI patients, no statistically significant associations were found between AKI and these short-term outcomes. Comorbidities such as hypertension and diabetes were significant risk factors for the development of AKI, especially in older patients.

The study highlights the importance of early detection and management of AKI in AMI patients, as AKI remains a major contributor to poor short-term outcomes. However, further studies are needed to explore the long-term consequences of AKI in AMI patients, particularly regarding the progression to CKD and its impact on cardiovascular outcomes.

Future research should concentrate on multicentre studies that have longer follow-up periods and larger sample sizes. Additionally, incorporating biomarkers to predict AKI and its complications could improve risk stratification and patient outcomes.

REFERENCES

1. Becirovic, M., Bećirović, E., Hadžić, S., Rakovac Tupković, L., Bećirović, A., Avdić Jahić, N., Ribić, A., Ferhatbegović, L., Jagodić Ejubović, A., Begagić, E., Lončar, D., & Ljuca, K. (2025). Heart and kidney crosstalk: Risk factors, clinical features, and short-term outcomes associated with acute kidney injury in patients suffering acute non-ST elevation myocardial infarction. *Medicinski Glasnik*, *22*(1), 20-25. https://doi.org/10.17392/1776-22-01
2. Ali, S., Umar, R. M., Pannu, F. Y., Ali, F., Saboor, Q. A., & Ahmed, B. (2022). Frequency of acute kidney injury in patients presenting with acute ST-elevation myocardial infarction and its relationship with in-hospital mortality. *Pakistan Journal of Medical and Health Sciences*, *16*(11), 224-227. https://doi.org/10.53350/pjmhs20221611224

3. Auer, J., Verbrugge, F. H., & Lamm, G. (2017). Editor's choice-What do small serum creatinine changes tell us about outcomes after acute myocardial infarction? *European Heart Journal: Acute Cardiovascular Care*, *7*(8), 739-742. https://doi.org/10.1177/2048872617728721
4. Menzorov, M. V., Shutov, A. M., Sakharov, V. S., & Kabanova, V. N. (2022). Acute kidney injury in acute coronary syndrome. *Kazan medical journal*, *103*(5), 797-806. https://doi.org/10.17816/kmj2022-797
5. Khoury, S., Margolis, G., Ravid, D., Rozenbaum, Z., Keren, G., & Yacov Shacham. (2020). Outcomes of early and reversible renal impairment in patients with ST segment elevation myocardial infarction undergoing percutaneous coronary intervention. *European Heart Journal. Acute Cardiovascular Care*, *9*(7), 684–689. https://doi.org/10.1177/2048872618808456
6. Marbach, J. A., Wells, G., Santo, P. D., So, D., Chong, A., Russo, J., Labinaz, M., Dick, A., Froeschl, M., Glover, C., Hibbert, B., Marquis, J., MacDougall, A., Kass, M., Paddock, V., Quraishi, A. U., Chandrasekhar, J., Ghosh, N., Bernick, J., … Le May, M. (2021). Acute kidney injury after radial or femoral artery access in ST-segment elevation myocardial infarction: AKI-SAFARI. *American Heart Journal*, *234*, 12-22. https://doi.org/10.1016/j.ahj.2020.12.019
7. Rahman, S. O., Halder, K. C., Anam, M. A., Akand, S., Aslam, M., & Rashid, M. M. (2022). Evaluation the outcome of admitted patients of acute ST elevation myocardial infarction with renal function. *Saudi Journal of Medical and Pharmaceutical Sciences*, *8*(8), 418-422. https://doi.org/10.36348/sjmps.2022.v08i08.008
8. Korostelev, A. S., Potapov, A. P., Ivanova, A. A., Hudaynazarova, K. A., Bulatov, A. V., Silina, N. N., Zakharov, P. I., & Ievleva, T. V. (2024). Acute kidney injuri of patients with acute miocard infarction. *Transbaikalian Medical Bulletin*, (2), 11-19. https://doi.org/10.52485/19986173_2024_2_11
9. Chen, Q., Gu, Q., Yin, A., Cai, D., Xiao, T., Wang, Y., Ji, Y., Wang, Q., Wei, J., & Sun, L. (2024). Neutrophil percentage as a potential biomarker of acute kidney injury risk and short-term prognosis in patients with acute myocardial infarction in the elderly. *Clinical Interventions in Aging*, *19*, 503-515. https://doi.org/10.2147/cia.s455588
10. Marenzi, G. S., Campodonico, J., Cosentino, N., Lucci, C., Milazzo, V., Moltrasio, M., Celentano, K., Biondi, M. L., Metrio, M. D., Rubino, M., Marana, I., Grazi, M., & Lauri, G. (2020). HIGH-SENSITIVITY C-REACTIVE PROTEIN AND ACUTE KIDNEY INJURY IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION. *Journal of the American College of Cardiology*, *75*(11), 163–163. https://doi.org/10.1016/s0735-1097(20)30790-7
11. Demchuk, O. V., & Sukmanova, I. A. (2023). Acute kidney injury in patients with myocardial infarction and percutaneous coronary interventions: laboratory markers and the influence on the frequency of recurrent cardiovascular events. Complex Issues of Cardiovascular Diseases, 11(4), 25–34. https://doi.org/10.17802/2306-1278-2022-11-4-25-34
12. Kumar, H., Jilanee, D., Mehta, S. M., Gul, A., Shah, S. M. H., Saleem, S., Sarfraz, M. B., Ashraf, S. U., & Wali, S. (2022). Frequency and Predictors of Acute Kidney Injury in Patients With Acute Coronary Syndrome in a Tertiary Care Hospital: A Retrospective Study. *Cureus*. https://doi.org/10.7759/cureus.21869