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Concurrent Kidney failure and Diabetes Mellitus as Prognostic Indicators in Acute Myocardial Infarction

[1]Vikram Aditya, [2]Shubham Bhaskar, [3]Ahraz Ali Imam

Senior Resident, Department of General Medicine, Nalanda Medical College & Hospital, Patna, Bihar, India (drad ityav506@gmail.com)
Senior Resident, Department of General Medicine, Nalanda Medical College & Hospital, Patna, Bihar, India (shubham12345bhaskar@gmail.com)
Senior Resident, Department of General Medicine, Nalanda Medical College & Hospital, Patna, Bihar, India (dr.ahraz.ali@gmail.com)
Corresponding Author: Satish Kumar, (drsatishpatna@gmail.com)

ABSTRACT

Background: Acute myocardial infarction (AMI) remains a leading cause of morbidity and mortality worldwide. Diabetes mellitus (DM) and kidney failure are significant risk factors that independently worsen the prognosis of AMI patients. The combined effect of these comorbidities on patient outcomes is a critical area of research due to the compounded risks they present. This study aimed to estimate the prognostic significance of concomitant diabetes mellitus and kidney failure in people with AMI, focusing on in-hospital mortality, length of hospital stays, and major adverse cardiac events (MACE).

Methods: This cohort study comprised 185 individuals with AMI, from 2022 to 2023. Participants were categorized into four groups based on the presence or absence of DM and kidney insufficiency. Clinical outcomes were analyzed using descriptive statistics, ANOVA, Chi-square tests, and multivariate regression analysis to adjust for potential confounders.

Results: Group IV (patients with both DM and kidney failure) had the highest in-hospital mortality rate (26.7%), longest hospital stay (7.8 ± 3.1 days), and highest incidence of MACE (50%). Multivariate regression analysis identified both DM (OR 2.3, 95% CI 1.5-3.5) and kidney failure (OR 3.1, 95% CI 2.0-4.8) as significant independent predictors of adverse outcomes.

Conclusion: Patients with concomitant diabetes mellitus and kidney failure face significantly worse outcomes following AMI compared to those with either condition alone or neither. These findings underscore the need for intensive monitoring and tailored therapeutic strategies for this high-risk population.

Recommendations: Healthcare providers should adopt integrated care approaches for AMI patients with diabetes and kidney failure. Further research should focus on developing and evaluating specific interventions to improve outcomes in these patients.

Keywords: Acute Myocardial Infarction, Diabetes Mellitus, Kidney failure, Prognostic Factors, Major Adverse Cardiac Events, In-Hospital Mortality

INTRODUCTION

Heart attacks, also referred to as acute myocardial infarction (AMI), are serious cardiovascular events that seriously jeopardise public health worldwide. It occurs when the heart's blood flow is interrupted for a prolonged length of time, harming or even killing cardiac muscle. Globally, AMI is the leading cause of morbidity and death. Therefore, early detection and efficient treatment are essential to enhance patient outcomes [1].

Among the numerous risk factors for AMI, diabetes mellitus and kidney failure have been identified as particularly influential. Diabetes mellitus (DM), described by chronic hyperglycemia due to deficiency or resistance of insulin, significantly increases the risk of cardiovascular diseases, including AMI [2]. This increased risk is attributable to several mechanisms, such as accelerated atherosclerosis, increased platelet aggregation, and endothelial dysfunction, which collectively contribute to the development and progression of coronary artery disease (CAD).

Chronic kidney disease (CKD), also known as kidney failure, is a significant risk factor for AMI. The hallmark of CKD is a progressive decrease of kidney function over time that causes waste products to build up and fluid imbalances in the body. Cardiovascular events are more common in patients with CKD because of conditions such inflammation, endothelial dysfunction, dyslipidemia, and hypertension [3]. Additionally, the decreased ability to excrete sodium and water can lead to fluid overload and increased cardiac workload, further exacerbating the risk of AMI.

The interplay between DM and kidney failure compounds the risk of adverse cardiovascular outcomes. Individuals with both conditions often exhibit a synergistic increase in the severity of CAD and a higher incidence of AMI [4]. This combined burden complicates clinical management and often results in poorer prognoses compared to patients with either condition

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alone. Given the significant implications for patient care, understanding the impact of concurrent DM and kidney failure on AMI outcomes is crucial for developing effective therapeutic strategies.

The study aimed to assess the prognostic significance of kidney failure and diabetes mellitus in individuals with acute myocardial infarction (AMI).

METHODOLOGY

Study Design

A retrospective cohort study.

Study Setting

The study was done at Nalanda Medical College and Hospital (NMCH), Patna, Bihar, India, spanning from 2022-2023

Participants

The study included 185 patients diagnosed with AMI. Participants were selected based on the availability of data required to calculate the estimated glomerular filtration rate (eGFR).

Inclusion Criteria

- Patients diagnosed with acute myocardial infarction.
- Availability of data to calculate eGFR.
- Complete medical records including the status of diabetes mellitus.

Exclusion Criteria

- Patients with a diagnosis of malignancy.
- Incomplete medical records.
- Patients without eGFR data.

Bias

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Selection bias was minimized by including consecutive patients meeting the inclusion criteria. Multiple independent reviewers extracted data to reduce observer bias.

Variables

Variables included presence of DM and kidney failure, in-hospital mortality, hospital stay period, and major adverse cardiac events (MACE).

Sample size:

To calculate the sample size for this study, the following formula was used for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

- n = sample size
- Z = Z-score corresponding to the desired level of confidence
- p = estimated proportion in the population
- E = margin of error *Data Collection*

Data was retrospectively collected from hospital medical records. This included demographic details, clinical presentations, laboratory results, eGFR values, diabetes mellitus status, and clinical outcomes such as in-hospital mortality and MACE.

Procedure

Patient records of those diagnosed with AMI during the study period were reviewed. Data regarding eGFR and diabetes mellitus status were extracted.

Participants were categorized into four groups based on the presence of DM and kidney failure:

- Group I: Neither DM nor kidney failure (eGFR $\geq$ 60 ml/min/1.73 m^2).
- Group II: DM without kidney failure.
- Group III: Kidney failure without DM.

- Group IV: Both DM and kidney failure.

Statistical Analysis

A database containing the extracted data was assembled for analysis. The features of the patients were summarised using descriptive statistics. The variables were displayed as percentages, frequencies, and mean ± standard deviation. ANOVA and the Chi-square test was used when comparing the four groups. The effects of DM and kidney failure on in-hospital mortality and MACE were assessed using multivariate regression analysis, taking into account any confounding variables. Statistical significance was attained when the p-value was less than 0.05.

Ethical considerations:

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULT

A total of 185 individuals with AMI were comprised in the study. The demographic and baseline clinical attributes of the individuals are detailed in Table 1. The mean age across all groups was 63.9 years, with a higher mean age observed in Group IV (66.8 years). The majority of participants were male (63.8%), and the prevalence of hypertension, hyperlipidemia, and smoking was similar across groups. Group IV had the lowest mean eGFR (42.8 ml/min/1.73 m^2), indicating the most severe kidney failure.

Table 1: Baseline Characteristics of Study Participants

Characteristic	Group I (n=70)	Group II (n=45)	Group III (n=40)	Group IV (n=30)	Total (n=185)
Age (years)	61.2 ± 12.1	63.5 ± 11.5	64.3 ± 13.0	66.8 ± 12.8	63.9 ± 12.4
Male (%)	45 (64.3)	30 (66.7)	25 (62.5)	18 (60.0)	118 (63.8)
Hypertension (%)	30 (42.9)	20 (44.4)	18 (45.0)	15 (50.0)	83 (44.9)
Hyperlipidemia (%)	35 (50.0)	22 (48.9)	19 (47.5)	16 (53.3)	92 (49.7)

Smoking (%)	20 (28.6)	12 (26.7)	11 (27.5)	9 (30.0)	52 (28.1)
Mean eGFR (ml/min/1.73 m²)	80.5 ± 12.3	78.2 ± 14.1	45.7 ± 10.5	42.8 ± 11.3	64.3 ± 22.8

The study focused on in-hospital mortality as the primary endpoint, with secondary outcomes encompassing hospital stay duration and major adverse cardiac events (MACEs), which are defined as a combination of recurrent AMI, stroke, and revascularization requirement. Table 2 displays the clinical outcomes for each of the groups.

Table 2: Clinical Outcomes of Study Participants

Outcome	Group I	Group II	Group III	Group IV	Total
In-hospital Mortality (%)	3 (4.3)	5 (11.1)	6 (15.0)	8 (26.7)	22 (11.9)
Length of Hospital Stay (days)	5.2 ± 2.1	6.1 ± 2.4	6.5 ± 2.6	7.8 ± 3.1	6.2 ± 2.6
MACE (%)	10 (14.3)	12 (26.7)	13 (32.5)	15 (50.0)	50 (27.0)

Patients in Group IV exhibited the highest in-hospital mortality rate at 26.7%, compared to 4.3% in Group I, 11.1% in Group II, and 15.0% in Group III. Additionally, Group IV patients had the longest hospital stays, averaging 7.8 days, indicating more severe and prolonged clinical courses. The frequency of MACE was also notably higher in Group IV (50%), demonstrating that individuals with both diabetes mellitus and kidney failure faced a substantially greater risk of adverse cardiac events.

Comparative analysis using ANOVA and the Chi-square test revealed significant differences in clinical outcomes among the four groups ($p < 0.05$). The detailed statistical outcomes are shown in Table 3.

Multivariate regression analysis was conducted to adjust for potential confounders, including age, gender, hypertension, hyperlipidemia, and smoking status. The analysis identified both

DM and kidney failure as significant independent predictors of in-hospital mortality and MACE ($p < 0.01$).

Table 3: Multivariate Regression Analysis for In-Hospital Mortality and MACE

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Diabetes Mellitus	2.3	1.5 - 3.5	< 0.01
Kidney failure	3.1	2.0-4.8	< 0.01
Age	1.2	1.0-1.4	0.04
Hypertension	1.1	0.8-1.6	0.22
Hyperlipidemia	1.0	0.7-1.4	0.75
Smoking	1.3	0.9-1.9	0.15

DISCUSSION

The study analyzed 185 patients diagnosed with AMI, categorizing them into four distinct groups based on the presence or absence of diabetes mellitus and kidney failure. The key findings revealed significant differences among the groups. Group IV, comprising patients with both DM and kidney failure, exhibited the highest in-hospital mortality rate at 26.7%, compared to 4.3% in Group I, 11.1% in Group II, and 15.0% in Group III. This group also had the longest average hospital stay of 7.8 days, indicating more severe and prolonged clinical courses. Furthermore, the incidence of MACE was highest in Group IV at 50%, compared to 14.3% in Group I, 26.7% in Group II, and 32.5% in Group III. These outcomes suggest that the coexistence of diabetes mellitus and kidney failure significantly exacerbates the prognosis for AMI patients.

Multivariate regression analysis further supported these findings, identifying both DM and kidney failure as significant independent predictors of in-hospital mortality and MACE. This remained true even after adjusting for other factors such as age, hypertension, hyperlipidemia, and smoking status. The odds ratios for diabetes mellitus and kidney failure were 2.3 and 3.1, respectively, highlighting the substantial impact of these conditions on patient outcomes.

The results clearly indicate that individuals with both DM and kidney failure are at a markedly higher risk for adverse outcomes following AMI. The significantly higher mortality rate in

Group IV suggests that the combination of these conditions creates a high-risk patient profile, likely due to the compounded effects on cardiovascular health. The extended hospital stays for these patients point to more severe or complicated clinical courses, requiring intensive management and treatment of complications. Additionally, the high incidence of MACE underscores the critical need for comprehensive cardiovascular care and monitoring in this patient population.

Recent studies continue to provide valuable insights into the prognostic significance of diabetes mellitus and kidney failure in individuals with AMI. A study analyzed data from 9905 AMI patients, highlighting that those with both DM and kidney failure exhibited significantly worse clinical outcomes compared to those with either condition alone or neither condition. This group had higher in-hospital mortality rates and a greater incidence of MACE during both the 1- and 12-month follow-ups. The study demonstrated a stepwise increase in 12-month composite MACE rates from patients without either condition to those with both, emphasizing the compounded risk posed by these comorbidities [5].

Another recent investigation focused on the impact of chronic therapy with GLP-1 receptor agonists (RA) and SGLT-2 inhibitors (SGLT-2i) in diabetic AMI patients. This study, involving 146,798 AMI patients, found that those treated with GLP-1 RA and SGLT-2i had better in-hospital outcomes compared to those not receiving these therapies. Specifically, patients treated with these drugs had lower incidences of acute cardiac failure and acute renal injury requiring renal replacement therapy, suggesting a protective effect of these medications in the context of AMI [6].

A multiethnic study of 8680 Asian AMI patients investigated the outcomes of those without standard modifiable cardiovascular risk factors (SMuRF-less). It found that the presence of kidney failure significantly worsened the prognosis of these patients, with higher mortality rates observed in those with decreased renal function [7].

Additionally, a study demonstrated that kidney function at the time of AMI maintained prognostic value for more than 10 years. The study followed patients over a decade, revealing that those with lower eGFR levels had substantially higher all-cause mortality rates compared to those with normal renal function. This long-term analysis underscores the enduring impact of kidney failure on patient survival following AMI [8].

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Another study estimated the combined effect of diabetes and kidney failure on AMI outcomes. The researchers found that the presence of both conditions was related with increased rates of recurrent myocardial infarction, heart failure, and mortality within one year of the initial AMI event. This study further supports the need for intensive management and follow-up care for patients with these comorbidities [9].

CONCLUSION

The findings of the study emphasize the necessity for targeted and aggressive management strategies in AMI patients with concurrent diabetes mellitus and kidney failure. Clinicians should be particularly vigilant in monitoring these patients, adopting more intensive therapeutic and preventive measures to improve their outcomes. The study underscores the importance of integrated care approaches to address the complex needs of this high-risk patient population, aiming to mitigate the compounded adverse effects of these comorbidities on cardiovascular health.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: Healthcare providers should adopt integrated care approaches for AMI patients with diabetes and kidney failure. Further research should focus on developing and evaluating specific interventions to improve outcomes in these patients.

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List of abbreviations:

AMI - Acute Myocardial Infarction

DM - Diabetes Mellitus

CKD - Chronic Kidney Disease

CAD - Coronary Artery Disease

MACE - Major Adverse Cardiac Events

eGFR - Estimated Glomerular Filtration Rate

CI - Confidence Interval

OR - Odds Ratio

GLP-1 RA - Glucagon-like Peptide-1 Receptor Agonists

SGLT-2i - Sodium-Glucose Cotransporter-2 Inhibitors

SMuRF - Standard Modifiable Cardiovascular Risk Factors

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