# CHARACTERISTICS OF PATIENTS WITH MYOCARDIAL INFARCTION, DIABETES MELLITUS AND CHRONIC RENAL FAILURE

# *KARAKTERISTIKE PACIJENATA SA INFARKTOM MIOKARDA, DIJABETESOM MELITUS I HRONIČNOM BUBREŽNOM INSUFICIJENCIJOM*

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**Abstract**

**Introduction**. Patients with diabetes mellitus and acute myocardial infarction often present with multiple comorbidities, among which chronic kidney disease significantly complicates management and worsens prognosis. This study aimed to assess the impact of chronic kidney disease on clinical, echocardiographic, and coronary findings, as well as on outcomes in diabetic patients with acute myocardial infarction. **Material and Methods.** A total of 1,353 patients with diabetes mellitus and acute myocardial infarction were analyzed and stratified according to the presence or absence of chronic kidney disease. Descriptive and analytical statistical methods, including the Mann-Whitney U and $\chi^2$ tests, were applied to evaluate demographic, clinical, echocardiographic, and angiographic parameters, treatment modalities, hospital stay, and in-hospital mortality. **Results.** Chronic kidney disease was present in 38.4% of patients, predominantly in advanced stages (III-V). Patients with chronic kidney disease were older, more often female, hypertensive, and non-smokers. Echocardiography showed lower left ventricular ejection fraction, larger left atrial volume, and impaired diastolic function. Patients with chronic kidney disease more frequently presented with non-ST elevation myocardial infarction, had multiple coronary stenoses, lower blood pressure, higher heart rates, and worse Killip class. They were less likely to undergo percutaneous coronary intervention and experienced longer hospitalization and higher in-hospital mortality. **Conclusion.** In diabetic patients with acute myocardial infarction, chronic kidney disease is associated with worse clinical, echocardiographic, and angiographic profiles, as well as poorer in-hospital outcomes. These findings underline the importance of individualized management strategies for this particularly high-risk population.

**Key words:** Myocardial Infarction; Diabetes Mellitus; Kidney Failure, Chronic; Renal Insufficiency; Treatment Outcome; Echocardiography; Comorbidity; Prognosis

**Sažetak**

**Uvod.** Pacijenti sa dijabetesom melitus i akutnim infarktom miokarda često imaju i druge pridružene komorbiditete, uključujući hroničnu bubrežnu bolest, što komplikuje lečenje i pogoršava prognozu. Cilj istraživanja bio je procena uticaja hronične bubrežne slabosti na kliničke, ehokardiografske i koronarografske nalaze, kao i na ishod lečenja kod pacijenata sa dijabetesom melitus i akutnim infarktom miokarda. **Materijal i metode.** U analizu je uključeno 1.353 pacijenta sa dijabetesom melitus i akutnim infarktom miokarda. Pacijenti su podeljeni u grupe, sa pridruženim hroničnim bubrežnim slabostima i bez njih. Korišćene su deskriptivne i analitičke statističke metode, uključujući Man–Vitnijev U i $\chi^2$ test, za poređenje demografskih, kliničkih, ehokardiografskih i angiografskih parametara, modaliteta lečenja, trajanja hospitalizacije i intrahospitalne smrtnosti. **Rezultati.** Hroničnu bubrežnu slabost imalo je 38,4% pacijenata, pretežno u uznapredovalim stadijumima (III–V). Pacijenti sa hroničnom bubrežnom slabošću bili su starijeg životnog doba, češće ženskog pola, hipertenzivni i nepušači. Ehokardiografski su imali nižu ejekcionu frakciju leve komore, veći volumen leve pretkomore, kao i češće znake dijastolne disfunkcije leve komore. U navedenoj ispitivanoj grupi pacijenti su češće imali akutni infarkt miokarda bez elevacije ST segmenta, višesudovnu koronarnu bolest, niži arterijski krvni pritisak, veću srčanu frekvenciju i lošiji *Killip* status. Ređe su lečeni perkutanom koronarnom intervencijom, duže hospitalizovani i imali veću intrahospitalnu smrtnost. **Zaključak.** Pacijenti sa dijabetesom melitus, akutnim infarktom miokarda i pridruženom bubrežnom insuficijencijom imaju nepovoljnije kliničke, ehokardiografske i koronarografske nalaze, kao i lošiji intrahospitalni ishod, što ukazuje na potrebu za individualizovanim pristupom lečenju i prilagođenim terapijskim strategijama.

**Ključne reči:** infarkt miokarda; dijabetes melitus; hronična bolest bubrega; bubrežna insuficijencija; ishod lečenja; ehokardiografija; komorbiditet; prognoza

## Introduction

Cardiovascular diseases remain the leading cause of death worldwide, with coronary artery disease – most commonly presenting as acute coronary syndrome – accounting for nearly half of all cardiovascular mortality. As life expectancy increases, clinicians are increasingly confronted with patients who not only have cardiovascular disease but also multiple comorbidities. More than 50% of patients hospitalized with acute myocardial infarction (AMI) present with at least one comorbidity, which is associated

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***Abbreviations***

AMI – Acute Myocardial Infarction
DM – Diabetes Mellitus
CKD – Chronic Kidney Disease
CAD – Coronary Artery Disease
PCI – Percutaneous Coronary Intervention
CABG – Coronary Artery Bypass Grafting
STEMI – ST-elevation myocardial infarction
NSTEMI – non-ST-elevation myocardial infarction

with prolonged hospitalization, higher in-hospital mortality, and more frequent readmissions [1–3].

Diabetes mellitus (DM) is a major contributor to atherosclerotic cardiovascular disease. The Framingham Study, as early as the 1970s, demonstrated that individuals with diabetes have a two- to fourfold increased risk of myocardial infarction and up to a sixfold increased risk of heart failure [4]. With the global prevalence of diabetes continuing to rise, its impact on the cardiovascular system and other organs is becoming increasingly significant. Cardiovascular complications remain the leading cause of death among diabetic patients, and post-AMI mortality is consistently higher in this group compared to non-diabetic individuals, underscoring the importance of cardiovascular risk reduction in diabetes management [5].

The coexistence of DM and chronic kidney disease (CKD) represents a growing clinical challenge, particularly in with the setting of AMI. Both conditions independently increase the risk of adverse cardiovascular outcomes, and their combined presence is frequently encountered in clinical practice. Diabetes is the leading cause of CKD in developed countries, primarily through the development of diabetic nephropathy. Conversely, CKD is strongly associated with accelerated vascular disease, systemic inflammation, and left ventricular dysfunction. As populations age and multimorbidity becomes more prevalent, understanding the interplay between DM, CKD, and AMI is crucial for optimizing patient care [6–9].

In light of these associations, the aim of this study was to compare the clinical, echocardiographic, and angiographic characteristics, as well as in-hospital outcomes, of diabetic patients with AMI, stratified by the presence or absence of CKD.

## Material and Methods

From January 2016 to December 2020, a total of 1353 patients with AMI and DM were included in the study. Patients were categorized into two groups according to renal function at admission, assessed by creatinine clearance calculated using the Cockcroft–Gault formula. CKD was defined as a creatinine clearance < 60 mL/min/m², while patients with values ≥60 mL/min/m² were classified as non-CKD. Exclusion criteria were: age < 18, pregnancy, severe valvular heart disease, incomplete medical documentation or missing essential clinical data, and refusal to undergo invasive procedures such as coronary angiography or percutaneous coronary intervention (PCI). The following data were collected and analyzed: demographic and anthropometric characteristics, medical history and comorbidities, clinical parameters at admission, echocardiographic findings, coronary angiographic characteristics, treatment modality (PCI or coronary artery bypass grafting [CABG]), length of hospital stay, and in-hospital mortality.

The study protocol was approved by the local ethics committee. All procedures were conducted in accordance with Good Clinical Practice and principles of the Declaration of Helsinki.

**Table 1.** Risk factors in diabetes mellitus patients with and without chronic kidney disease

| | Category | Non-CKD | CKD | p |
|---|---|---|---|---|
| Age (years) | < 65 | 388 (46.5%) | 44 (8.5%) | < 0.001 |
| | ≥ 65 | 446 (53.5%) | 475 (91.5%) | |
| Sex | Male | 550 (65.9%) | 234 (45.1%) | < 0.001 |
| | Female | 284 (34.1%) | 285 (54.9%) | |
| Family history of ischemic heart disease | No | 602 (72.2%) | 426 (82.1%) | < 0.001 |
| | Yes | 232 (27.8%) | 93 (17.9%) | |
| Arterial hypertension | No | 119 (14.3%) | 54 (10.4%) | 0.038 |
| | Yes | 715 (85.7%) | 465 (89.6%) | |
| Smoking habits | Non-smoker | 459 (55.5%) | 404 (77.8%) | < 0.001 |
| | Smoker | 375 (45%) | 115 (22.2%) | |
| Dyslipidemia | No | 501 (60.1%) | 330 (63.6%) | 0.197 |
| | Yes | 333 (39.9%) | 189 (36.4%) | |
| BMI (kg/m²) | < 29.9 | 510 (61.2%) | 395 (76.1%) | < 0.001 |
| | ≥ 30 | 324 (38.8%) | 124 (23.9%) | |

BMI – Body Mass Index

**Table 2.** Clinical findings at admission, treatment modality, and outcomes in diabetes mellitus patients with and without chronic kidney disease

| | Non-CKD | CKD | p |
|---|---|---|---|
| STEMI | 572 (68.6%) | 315 (60.7%) | 0.003 |
| NSTEMI | 262 (31.4%) | 204 (39.3%) | |
| Systolic blood pressure (mmHg) | 140.84 ± 24.01 | 138.31 ± 26.35 | 0.039 |
| Diastolic blood pressure (mmHg) | 81.76 ± 13.60 | 80,44 ± 14.69 | 0.029 |
| Heart rate (beats/min) | 83.24 ± 18.0 | 86.30 ± 22.09 | 0.012 |
| Killip class | | | |
| I | 572 (73.1%) | 265 (54.1%) | < 0.001 |
| II-IV | 211 (26.9%) | 225 (45.9%) | |
| Number of coronary artery stenoses | | | |
| Single lesion | 490 (70.8%) | 231 (65.6%) | 0.087 |
| More than one lesion | 202 (29.2%) | 121 (34.4%) | |
| PCI | 693 (83.1%) | 352 (67.8%) | < 0.001 |
| CABG | 19 (2.3%) | 5 (1%) | 0.075 |
| Length of hospital stay (days) | 6.18 ± 5.44 | 7.97 ± 6.64 | < 0.001 |
| In-hospital mortality | 2 (0.2%) | 16 (3.1%) | < 0.001 |

STEMI – ST-elevation myocardial infarction; NSTEMI – non-ST-elevation myocardial infarction; CABG – coronary artery bypass graft; PCI – percutaneous coronary intervention

*Statistical analysis*

Descriptive statistics were used to summarize data, including measures of central tendency, variability, and relative frequencies.

For inferential analysis, empirical distribution testing was performed. Depending on data distribution, group comparisons were made using the Mann–Whitney U test and the chi-square ($\chi^2$) test.

## Results

Based on renal function, patients were divided into two groups: those with CKD (n = 519; 38.4%) and those without CKD (n = 834; 61.6%). The mean age of the overall cohort was 68.61 ± 10.09 years, and 784 patients (57.9%) were male. Within the CKD group, advanced stages (III-V) were present in 488 patients (94%): stage III in 399 (76.9%), stage IV in 70 (13.5%), and stage V in 19 (3.7%). Significant differences in were observed in diabetes treatment modalities: insulin-dependent diabetes mellitus was more prevalent among patients with CKD (40.5%), while non-insulin-dependent diabetes was more common in those without CKD (70.1%; p < 0.001).

*Risk Factors*

The distribution of cardiovascular risk factors is shown in **Table 1.** Patients with CKD were more frequently older than 65 years and more often female. Compared with the non-CKD group, they had a lower prevalence of positive family history for ischemic heart disease, a higher prevalence of arterial hypertension, were more commonly non-smokers, and were less frequently obese.

*Clinical, Angiographic, and Outcome Parameters*

Clinical characteristics at admission, angiographic findings, treatment modalities, and in-hospital outcomes are presented in **Table 2**. Patients with CKD more frequently presented with non-ST-elevation myocardial infarction (NSTEMI) rather than ST-elevation myocardial infarction (STEMI). On admission, they had lower average systolic and diastolic blood pressure, higher heart rate, and were more often classified as Killip class II–IV, indicating more severe heart failure. Coronary angiography revealed a higher prevalence of multivessel coronary artery disease in the CKD group, suggesting more advanced atherosclerosis. Treatment strategies also differed:

**Table 3.** Echocardiographic parameters at admission

| | Non-CKD | CKD | p |
|---|---|---|---|
| EF (%) | 47.06 ± 9.25 | 43.21 ± 10.68 | < 0.001 |
| LAV (mL) | 62.98 ± 19.99 | 68.10 ± 22.51 | 0.042 |
| E/e' | 12 ± 5 | 14 ± 7 | <0.001 |
| LVMI (g/m²) | 76.39 ± 47.71 | 84.50 ± 44.08 | 0.238 |

EF – ejection fraction; LAV – left atrial volume; E/E' - early mitral inflow velocity and mitral annular early diastolic velocity ratio; LVMI – left ventricular mass index

patients without CKD were more frequently treated with PCI, whereas those with CKD were more often managed conservatively. Hospitalization was significantly longer in patients with CKD, reflecting their more complicated clinical course. Importantly, in-hospital mortality was markedly higher among CDK patients, underscoring the prognostic significance of impaired renal function in AMI.

*Echocardiographic Parameters*

Echocardiographic findings at admission are presented in **Table 3**. Compared with the non-CKD group, patients with CKD had significantly lower left ventricular ejection fraction, larger left atrial systolic volume, and higher E/e′ ratio.

## Discussion

The interplay between coronary artery disease (CAD), DM and CKD represents a complex and multifactorial relationship with substantial clinical implications. Each condition independently increases cardiovascular risk; however, when present together, as often seen in practice, they act synergistically, accelerating disease progression, complicating treatment, and worsening prognosis. A deeper understanding of this triad is essential for optimizing management and improving patient outcomes.

In this study, the prevalence of CKD among patients with DM and AMI was 38.4%, higher than in some previous reports [10]. This may be explained by the exclusive inclusion of diabetic patients – since DM is the leading global cause of CKD – as well as by local population characteristics, as suggested in earlier research [11].

Patients with CKD were more often older than 65 years, female, hypertensive, and non-smokers, consistent with prior findings [11]. Interestingly, obesity was less common among CKD patients, possibly reflecting advanced disease stages (CKD stages III–V), where unintentional weight loss is frequent. While some studies report no significant difference in BMI between groups, discrepancies may arise from variations in CKD stage distribution [12].

Chronic kidney disease itself is a well-recognized independent risk factor for cardiovascular disease. Beyond traditional risk factors such as DM, hypertension, and dyslipidemia, CKD introduces additional pathophysiological mechanisms - including chronic inflammation, endothelial dysfunction, and oxidative stress – that promote accelerated atherosclerosis and adverse cardiac outcomes. In our study, patients with CKD more often presented with NSTEMI, lower blood pressure, higher heart rate, and Killip class II–IV, all markers of a more severe clinical condition. Angiographic findings also revealed a higher prevalence of multivessel coronary artery disease, suggesting more diffuse and complex atherosclerosis in CKD patients, consistent with prior reports [13,14].

Echocardiographic evaluation further demonstrated educed left ventricular ejection fraction, increased left atrial volume, and elevated E/e′ ratio in CKD patients. These abnormalities reflect impaired systolic and diastolic function, in line with existing literature, and represent strong predictors of adverse cardiovascular outcomes [15–17]. Such findings may partly account for the poorer prognosis in this subgroup. Treatment strategies differed notably between groups. PCI was performed less frequently in CKD patients, while conservative management was more common. This trend may reflect concerns about procedural risks such as contrast-induced nephropathy and bleeding. Nonetheless, while PCI in CKD patients is associated with higher complications and mortality rates, it remains an important therapeutic option, underscoring the need for careful risk stratification and individualized management. CKD patients in our study also had significantly longer hospitalizations and markedly in-hospital mortality, confirming the negative impact of renal impairment on clinical outcomes. These results corroborate previous evidence demonstrating that CKD is independently associated with adverse outcomes following AMI, irrespective of infarction type or treatment strategy [18].

Several limitations of this study must be acknowledged. First, its retrospective design precludes the establishment of causality between CKD and adverse outcomes in diabetic AMI patients. Second, renal function was assessed only at admission using creatinine clearance by the Cockcroft–Gault formula, without follow-up measurements. Although widely used in clinical practice, this method is less precise than eGFR estimated with MDRD or CKD-EPI equations. Due to incomplete data on serum creatinine, height, and weight, eGFR could not be calculated, and CKD classification relied solely on creatinine clearance. Similarly, left atrial volume index could not be determined because body surface area was unavailable; therefore, left atrial volume was analyzed in absolute terms. Third, information on long-term outcomes such as readmissions, recurrent cardiovascular events, or post-discharge mortality was lacking. Furthermore, important potential confounders – including medication adherence, glycemic control, and socioeconomic status – were not evaluated. Finally, as this was a single-center study, the generalizability of the findings may be limited.

## Conclusion

In patients with acute myocardial infarction and diabetes mellitus, the presence of chronic kidney disease is associated with significantly worse clinical presentation and prognosis. Chronic kidney disease complicates treatment decisions, heightens procedural risks, prolongs hospitalization, and markedly increases in-hospital mortality.

Early identification of renal impairment and the application of individualized treatment strategies are crucial for improving outcomes in this high-risk population. Further research should further elucidate the mechanisms linking diabetes, chronic kidney disease, and cardiovascular disease, and support the development of tailored, multidisciplinary care approaches.

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