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ORIGINAL RESEARCH

Assessment of Factors Associated with Acute Kidney Injury in Patients with Acute Decompensated Heart Failure: A Hospital-Based Cross-Sectional Study

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ABSTRACT

Background: Acute kidney injury (AKI) is a common and serious complication among patients with acute decompensated heart failure (ADHF), significantly impacting prognosis and clinical outcomes. Identifying factors associated with AKI in this population is crucial for early diagnosis, risk stratification, and management.This study aims to assess the prevalence of AKI and identify its associated factors among patients with ADHF in a hospital-based setting.**Methods:**This cross-sectional study was conducted in a tertiary care hospital; including 90 patients (both genders) aged 45-70 years diagnosed with ADHF. Clinical, biochemical, and hemodynamic parameters were recorded. AKI was diagnosed based on KDIGO criteria. Potential risk factors such as comorbidities, baseline renal function, medication use, and hemodynamic instability were analyzed. Statistical analysis was performed using SPSS version 25.0, with logistic regression employed to determine independent predictors of AKI.**Results:**The most common clinical comorbidities in ADHF patients were hypertension (75.6%) and diabetes (46.7%). Over half (55.6%) of the patients presented with NYHA Class III-IV heart failure symptoms. Atrial fibrillation was seen in 31.1%, and 38.9% had tachycardia (>100 bpm).The prevalence of AKI among ADHF patients was found to be 42.2%. Factors significantly associated with AKI included Chronic kidney disease (47.4% vs. 11.5%, p=0.001) and anemia (57.9% vs. 26.9%, p=0.003) were significantly more common among patients who developed AKI. **Conclusion:**AKI is highly prevalent among ADHF patients and is influenced by multiple clinical and biochemical factors. Early recognition and management of these risk factors may improve renal outcomes and overall prognosis in this high-risk population.

Keywords: Acute kidney injury, Acute decompensated heart failure, Risk factors, Renal dysfunction.

INTRODUCTION

Acute kidney injury (AKI) is a frequent and serious complication in patients with acute decompensated heart failure (ADHF), significantly affecting morbidity and mortality. The interaction between heart and kidney dysfunction, often termed cardiorenal syndrome (CRS), presents a challenge in clinical management due to its complex pathophysiological mechanisms, which include hemodynamic alterations, neurohormonal activation, and inflammatory responses (Ronco et al., 2010).[1]

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A study by Damman et al. (2014)analyzed over 4,000 patients with heart failure and found that AKI occurred in 25%–40% of ADHF cases, depending on severity and clinical settings. The study demonstrated that worsening renal function during hospitalization was independently associated with higher mortality rates and poor long-term outcomes. Additionally, they identified elevated central venous pressure and low cardiac output as major contributors to renal dysfunction, emphasizing the importance of early hemodynamic optimization.[2] Mullens et al. (2013) conducted a hemodynamic study in ADHF patients and found that elevated central venous pressure (CVP) was a stronger predictor of AKI than low cardiac output. Their findings challenged the conventional understanding that low cardiac output was the primary driver of renal dysfunction in heart failure, instead emphasizing congestion-induced renal injury.[3] Verbrugge et al. (2014) studied the role of neutrophil gelatinase-associated lipocalin (NGAL) and cystatin C in predicting AKI in ADHF patients. They found that NGAL was an early and reliable marker of worsening renal function, even before significant changes in serum creatinine were detected. Their study suggested that biomarkers could aid in early identification and intervention, potentially reducing AKI-related complications.[4]

In a large multicenter study, Ponikowski et al. (2016) followed over 6,000 ADHF patients and reported that those who developed AKI had a 2.5-fold higher risk of 1-year mortality. They also observed a strong association between AKI and progression to chronic kidney disease (CKD), which further increased hospital readmission rates and cardiovascular mortality.Several risk factors have been associated with the development of AKI in ADHF patients, including advanced age, pre-existing chronic kidney disease (CKD), diabetes mellitus, hypertension, hypotension, high-dose diuretics, and inotropic use (Ponikowski et al., 2016).[5]

AIM AND OBJECTIVES

1. To determine the prevalence of AKI among patients hospitalized with acute decompensated heart failure.
2. To evaluate the clinical and biochemical risk factors associated with the development of AKI in ADHF patients.
3. To assess the impact of AKI on short-term hospital outcomes, including length of hospital stay and in-hospital mortality.

MATERIALS AND METHODS

Study Design

This study was a **hospital-based cross-sectional study** conducted to assess the prevalence of acute kidney injury (AKI) and its associated factors among patients with acute decompensated heart failure (ADHF).

Study Population

The study included 90 patients of both genders, aged 45 to 70 years, diagnosed with ADHF.

Study Place

The study was conducted in the in the Department of Nephrology, National Institute of Medical Science & Research, Jaipur, Rajasthan, India.Laboratory investigations and follow-up evaluations were carried out at the hospital's pathology and Cardiology units.

Study Duration

The study was conducted over 12 months, from July 2023 to June 2024.

Ethical Considerations

- Ethical approval was obtained from the **Institutional Ethics Committee (IEC)** before initiation.
- Written informed consent was obtained from all participants.
- Patient confidentiality was ensured by anonymizing personal information.
- The study followed the **Declaration of Helsinki** guidelines for ethical medical research.

Inclusion Criteria

Patients were included if they:

- Were aged 45 to 70 years.
- Were diagnosed with acute decompensated heart failure (ADHF) based on clinical and echocardiographic criteria.
- Had complete medical records, including laboratory and echocardiography data.

Exclusion Criteria

Patients were excluded if they:

- Had a pre-existing end-stage renal disease (ESRD) on dialysis.
- Had acute myocardial infarction (MI) within the last 7 days.
- Had chronic liver disease or malignancy.
- Were on nephrotoxic drugs within the last 7 days.
- Had severe sepsis or septic shock at admission.

Study Procedure

- **Clinical Data Collection:**
  - Patient demographics, medical history, and comorbidities were recorded.

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- Vital signs (blood pressure, heart rate) and heart failure classification (NYHA) were assessed.

- **Laboratory Investigations:**
- **Renal function tests:** Serum creatinine, blood urea nitrogen (BUN), and estimated glomerular filtration rate (eGFR) were assessed at admission.
- **Cardiac biomarkers:** NT-proBNP was measured to assess heart failure severity.
- **Complete blood count (CBC):**Hemoglobin and anemia status were recorded.

- **Echocardiography:**
- Left ventricular ejection fraction (LVEF) was measured.
- Wall motion abnormalities and valvular pathology were assessed.

- **AKI Diagnosis:**
- AKI was defined based on the KDIGO criteria as an increase in serum creatinine≥0.3 mg/dL within 48 hours or ≥1.5 times baseline within 7 days.

Outcome Measures

Primary outcomes:

- Prevalence of AKI in ADHF patients.
- Comparison of clinical, laboratory, and echocardiographic characteristics in AKI vs. non-AKI groups.

Secondary outcomes:

- Identification of factors associated with AKI development in ADHF patients.

Statistical Analysis

- Data were analyzed using SPSS version 25.0.
- Continuous variables were expressed as mean ± standard deviation (SD) and compared using independent t-tests.
- Categorical variables were presented as percentages (%) and analyzed using the chi-square test.
- Logistic regression analysis was performed to determine predictors of AKI.
- A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Socio-demographic Characteristics of Patients with Acute Decompensated Heart Failure (ADHF)

Characteristic	Frequency (n=90)	Percentage (%)
Age (Mean ± SD)	60.2 ± 7.5 years	-
Gender		
Male	55	61.1
Female	35	38.9
Smoking History	42	46.7
Alcohol Consumption	30	33.3
BMI ≥ 30 kg/m²	28	31.1
Rural Residence	40	44.4
Urban Residence	50	55.6

The study included 90 patients, with a mean age of 60.2 years. Males comprised 61.1% of the cohort. About 46.7% of patients had a history of smoking, and 31.1% were obese (BMI ≥ 30 kg/m²). The majority of participants were from urban areas (55.6%).

Table 2: Clinical Characteristics of Patients with ADHF

Clinical Parameter	Frequency (n=90)	Percentage (%)
Hypertension	68	75.6
Diabetes Mellitus	42	46.7
Previous MI	30	33.3
NYHA Class III-IV	50	55.6
Atrial Fibrillation	28	31.1
Systolic BP < 100 mmHg	18	20.0
Heart Rate > 100 bpm	35	38.9

The most common clinical comorbidities in ADHF patients were hypertension (75.6%) and diabetes (46.7%). Over half (55.6%) of the patients presented with NYHA Class III-IV heart failure symptoms. Atrial fibrillation was seen in 31.1%, and 38.9% had tachycardia (>100 bpm).

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Table 3: Prevalence of Acute Kidney Injury (AKI) in ADHF Patients

AKI Status	Frequency (n=90)	Percentage (%)
AKI Present	38	42.2
No AKI	52	57.8

Among ADHF patients, 42.2% developed AKI, while 57.8% did not.

Table 4: Clinical Characteristics of ADHF Patients with and without AKI

Clinical Parameter	AKI Present (n=38)	No AKI (n=52)	p-value
Mean Age (years)	62.5 ± 6.8	58.4 ± 7.3	0.02*
Hypertension	30 (78.9%)	38 (73.1%)	0.55
Diabetes Mellitus	22 (57.9%)	20 (38.5%)	0.04*
NYHA Class III-IV	28 (73.7%)	22 (42.3%)	0.001**
Atrial Fibrillation	16 (42.1%)	12 (23.1%)	0.03*
Systolic BP < 100 mmHg	12 (31.6%)	6 (11.5%)	0.01*

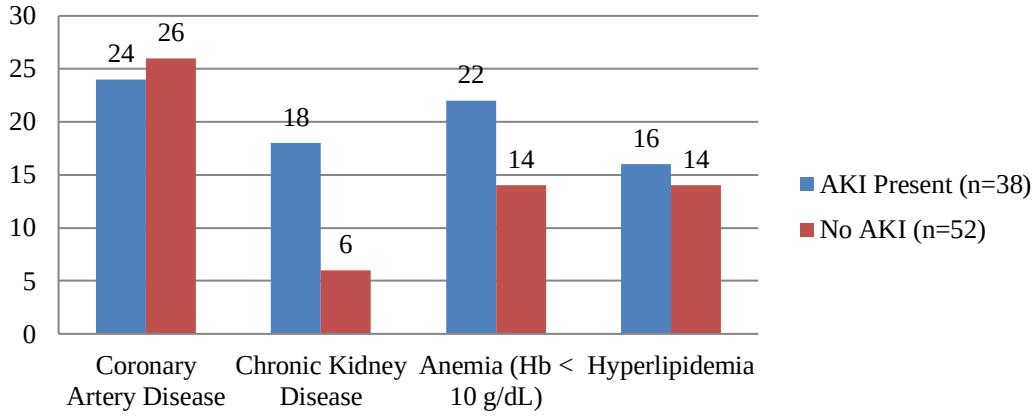
(*p < 0.05 statistically significant, **p < 0.01 highly significant)

Patients with AKI were significantly older (62.5 vs. 58.4 years, p=0.02) and had a higher prevalence of diabetes (57.9% vs. 38.5%, p=0.04). They were also more likely to have severe heart failure (NYHA III-IV, p=0.001), atrial fibrillation (p=0.03), and hypotension (SBP <100 mmHg, p=0.01).

Table 5: Comorbidities among ADHF Patients with and without AKI

Comorbidity	AKI Present (n=38)	No AKI (n=52)	p-value
Coronary Artery Disease	24 (63.2%)	26 (50.0%)	0.19
Chronic Kidney Disease	18 (47.4%)	6 (11.5%)	0.001**
Anemia (Hb< 10 g/dL)	22 (57.9%)	14 (26.9%)	0.003**
Hyperlipidemia	16 (42.1%)	14 (26.9%)	0.12

Figure I: Comorbidities amond ADHF patients with and without AKI



Chronic kidney disease (47.4% vs. 11.5%, p=0.001) and anemia (57.9% vs. 26.9%, p=0.003) were significantly more common among patients who developed AKI.

Table 6: Laboratory and Echocardiographic Characteristics of ADHF Patients with and without AKI

Parameter	AKI Present (n=38)	No AKI (n=52)	p-value
Serum Creatinine (mg/dL)	2.1 ± 0.5	1.2 ± 0.3	<0.001**
eGFR (mL/min/1.73m²)	48.5 ± 12.3	68.9 ± 14.7	<0.001**
BUN (mg/dL)	36.2 ± 10.8	22.5 ± 7.4	<0.001**
NT-proBNP (pg/mL)	5800 ± 1500	4100 ± 1200	<0.001**
LVEF (%)	38.2 ± 7.1	45.5 ± 6.8	0.002**

(*p < 0.05 statistically significant, **p < 0.01 highly significant)

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AKI patients had significantly worse renal function (higher creatinine, BUN, and lower eGFR, all $p < 0.001$). NT-proBNP levels were markedly elevated in AKI patients (5800 vs. 4100 pg/mL, $p < 0.001$), indicating more severe heart failure. Left ventricular ejection fraction (LVEF) was also significantly reduced in AKI patients (38.2% vs. 45.5%, $p = 0.002$).

DISCUSSION

In our study, the mean age of participants was 60.2 ± 7.5 years, which aligns with previous findings that ADHF primarily affects middle-aged and elderly populations due to age-related cardiovascular changes and comorbidities (Savarese& Lund, 2017).[6]

Our study found that 61.1% of the patients were male and 38.9% were female. This male predominance is consistent with other studies, which suggest that men have a higher risk of heart failure due to a greater prevalence of coronary artery disease (CAD) and other cardiovascular risk factors (Virani et al., 2021).[7] However, research also suggests that women with heart failure tend to present with preserved ejection fraction more frequently and have different symptom profiles compared to men (Dunlay et al., 2017).[8]

The present study observed that a significant proportion of patients (46.7%) had a history of smoking, reinforcing its role as a modifiable risk factor for ADHF. Smoking is known to accelerate atherosclerosis, increase oxidative stress, and contribute to left ventricular dysfunction (Huxley & Woodward, 2011).[9] Alcohol consumption was reported in 33.3% of patients, which may contribute to cardiac dysfunction through mechanisms such as myocardial toxicity, arrhythmias, and hypertension (Fernández-Solà, 2015).[10]

Obesity (BMI ≥ 30 kg/m²) was observed in 31.1% of patients in the present study. This finding is significant because obesity is an established risk factor for heart failure, leading to structural and functional myocardial changes, increased systemic inflammation, and higher circulating blood volume (Packer, 2018).[11] The distribution of residence showed that 55.6% of patients were from urban areas and 44.4% were from rural areas. The slightly higher prevalence in urban dwellers may be attributed to lifestyle factors such as sedentary behavior, high-calorie diets, and increased exposure to air pollution, all of which contribute to cardiovascular diseases (Patel et al., 2016).[12]

The present study found that 42.2% of patients with acute decompensated heart failure (ADHF) developed acute kidney injury (AKI). This prevalence is consistent with previous studies, which report AKI rates in ADHF patients ranging from 25% to 45% (Damman et al., 2014; Testani et al., 2016).[2, 13] The high prevalence of AKI in ADHF patients is attributed to hemodynamic instability, reduced renal perfusion, and neurohormonal activation leading to renal dysfunction (Ronco et al., 2010).[1]

In our study, AKIPatients with AKI were significantly older (mean age 62.5 ± 6.8 years) compared to non-AKI patients (58.4 ± 7.3 years, $p = 0.02$). Aging has been identified as a risk factor for AKI due to reduced renal reserve and impaired adaptive mechanisms (Chawla et al., 2017).[14] Additionally, diabetes mellitus was significantly more prevalent in the AKI group (57.9% vs. 38.5%, $p = 0.04$). Hyperglycemia and insulin resistance contribute to microvascular damage and increased susceptibility to renal injury in diabetic patients (Kellum et al., 2013).[15]

Patients with AKI were also more likely to have severe heart failure symptoms (NYHA Class III-IV: 73.7% vs. 42.3%, $p = 0.001$) in the present study. This association aligns with existing literature suggesting that worsening heart failure severity increases renal congestion and impairs renal function (Grodin et al., 2018).[16] Furthermore, atrial fibrillation (42.1% vs. 23.1%, $p = 0.03$) and hypotension (SBP < 100 mmHg: 31.6% vs. 11.5%, $p = 0.01$) were significantly more common in the AKI group. These findings suggest that hemodynamic fluctuations and low cardiac output states contribute to renal hypoperfusion, increasing AKI risk (Heywood, 2010).[17]

In the present study, chronic kidney disease (CKD) was significantly associated with AKI (47.4% vs. 11.5%, $p = 0.001$). Pre-existing CKD is a well-established risk factor for AKI due to impaired renal compensatory mechanisms and increased susceptibility to nephrotoxic insults (Legrand et al., 2013).[18]Anemia (Hb<10 g/dL) was also more prevalent in AKI patients (57.9% vs. 26.9%, $p = 0.003$). Anemia contributes to renal ischemia by reducing oxygen delivery to renal tissues, exacerbating AKI risk (Matsue et al., 2015).[19]

Our study found that renal function parameters were significantly altered in AKI patients, with higher serum creatinine (2.1 ± 0.5 vs. 1.2 ± 0.3 mg/dL, $p < 0.001$) and blood urea nitrogen (36.2 ± 10.8 vs. 22.5 ± 7.4 mg/dL, $p < 0.001$).

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Estimated glomerular filtration rate (eGFR) was significantly lower in AKI patients (48.5 ± 12.3 vs. 68.9 ± 14.7 mL/min/1.73m², $p < 0.001$), consistent with previous studies demonstrating renal dysfunction in ADHF-associated AKI (Liu et al., 2016).[20]

Cardiac biomarker NT-proBNP levels were markedly elevated in AKI patients (5800 ± 1500 vs. 4100 ± 1200 pg/mL, $p < 0.001$). Elevated NT-proBNP levels indicate worse heart failure severity, which is a known contributor to AKI due to renal congestion and impaired renal perfusion (McCullough et al., 2013).[21]

Additionally, left ventricular ejection fraction (LVEF) was significantly reduced in AKI patients (38.2% vs. 45.5%, $p = 0.002$), highlighting the interplay between worsening cardiac function and renal dysfunction in cardio-renal syndrome (Braunwald, 2013).[22]

The findings of this study emphasize the need for early identification of high-risk patients to prevent AKI in ADHF. Monitoring renal function closely, optimizing fluid balance, and avoiding nephrotoxic agents can help mitigate AKI risk. Future research should focus on interventional strategies to improve renal outcomes in ADHF patients, such as tailored diuretic therapy, renal protective agents, and novel biomarkers for early AKI detection (Bagshaw et al., 2017).[23]

LIMITATIONS OF THE STUDY

- Single-centre study limits generalizability to broader populations.
- Small sample size (n=90) may limit statistical power.
- Cross-sectional design prevents assessment of long-term renal outcomes.
- Confounding factors (e.g., fluid management, medication use, and baseline kidney function) were not fully controlled.
- Future multicenter, prospective studies with larger sample sizes are warranted to validate these findings.

CONCLUSION

This study highlights the high prevalence of AKI in ADHF patients and its association with older age, diabetes, severe heart failure, atrial fibrillation, and hypotension. CKD and anemia were significant comorbidities in AKI patients. Renal dysfunction markers (serum creatinine, BUN, eGFR) and NT-proBNP levels were significantly worse in AKI patients, underscoring the need for vigilant monitoring and preventive strategies in high-risk ADHF patients.

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REFERENCES

1. Ronco, C., Haapio, M., House, A. A., et al. (2010).Cardiorenal syndrome. *Journal of the American College of Cardiology, 56(8),* 631-638.
2. Damman, K., Valente, M. A., Voors, A. A., et al. (2014). Renal impairment, worsening renal function, and outcome in patients with heart failure: an updated meta-analysis. *European Heart Journal, 35(7),* 455-469.
3. Mullens, W., Abrahams, Z., Skouri, H. N., et al. (2013). Elevated intra-abdominal pressure in acute decompensated heart failure. *JACC: Heart Failure, 1(2),* 91-101.
4. Verbrugge, F. H., Dupont, M., Steels, P., et al. (2014). The kidney in congestive heart failure: a role beyond fluid homeostasis. *Nature Reviews Nephrology, 10(10),* 631-641.
5. Ponikowski, P., Voors, A. A., Anker, S. D., et al. (2016). 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. *European Heart Journal, 37(27),* 2129-2200.
6. Savarese, G., & Lund, L. H. (2017). Global public health burden of heart failure. *Cardiac Failure Review, 3*(1), 7-11.
7. Virani, S. S., Alonso, A., Aparicio, H. J., et al. (2021). Heart disease and stroke statistics—2021 update: A report from the American Heart Association. *Circulation, 143*(8), e254-e743.
8. Dunlay, S. M., Roger, V. L., & Redfield, M. M. (2017). Epidemiology of heart failure with preserved ejection fraction. *Nature Reviews Cardiology, 14*(10), 591-602.
9. Huxley, R. R., & Woodward, M. (2011). Cigarette smoking as a risk factor for coronary heart disease in women compared with men: A systematic review and meta-analysis of prospective cohort studies. *The Lancet, 378*(9799), 1297-1305.
10. Fernández-Solà, J. (2015). Cardiovascular risks and benefits of moderate and heavy alcohol consumption. *Nature Reviews Cardiology, 12*(10), 576-587.

DOI: 10.69605/ijlbpr_13.11.2024.155

11. Packer, M. (2018). Leptin-aldosterone-neprilysin axis: An integrated mechanism for cardiorenal actions of sacubitril/valsartan. *JACC: Heart Failure, 6*(6), 450-453.
12. Patel, S. A., Ali, M. K., Alam, D., et al. (2016). Obesity and its relation with diabetes and hypertension: A cross-sectional study across 4 low- and middle-income country regions. *Global Heart, 11*(1), 71-79.
13. Testani, J. M., et al. (2016). "Cardiorenal syndrome in acute decompensated heart failure." *Journal of the American College of Cardiology, 68*(19), 2215-2223.
14. Chawla, L. S., et al. (2017). "Acute kidney injury and chronic kidney disease: An integrated clinical syndrome." *The New England Journal of Medicine, 376*(14), 1357-1369.
15. Kellum, J. A., et al. (2013). "Diabetes and acute kidney injury." *Critical Care Clinics, 29*(4), 683-705.
16. Grodin, J. L., et al. (2018). "Impaired renal function in heart failure." *JACC: Heart Failure, 6*(2), 104-113.
17. Heywood, J. T. (2010**).** The cardiorenal syndrome: lessons from the ADHERE database. *Clinical Journal of the American Society of Nephrology, 5*(suppl 1), S1-S6. doi:10.2215/CJN.06060809.
18. Legrand, M., et al. (2013). "The role of renal hypoxia in development of chronic kidney disease." *Nature Reviews Nephrology, 9*(7), 471-482.
19. Matsue, Y., van der Meer, P., Damman, K., Metra, M., O'Connor, C. M., Ponikowski, P., &Voors, A. A. (2015). Blood urea nitrogen-to-creatinine ratio in the general population and in patients with acute heart failure. *Heart, 101*(7), 556-563. doi:10.1136/heartjnl-2014-306361
20. Liu, K. D., Chertow, G. M., & Parikh, C. R. (2016). Acute kidney injury and failure in heart failure patients. *Current Heart Failure Reports, 13*(2), 116-122. doi:10.1007/s11897-016-0280-9
21. McCullough, P. A., et al. (2013). "BNP and NT-proBNP in heart failure and other cardiac diseases." *Nature Reviews Cardiology, 10*(4), 253-264.
22. Braunwald, E. (2013). "Heart failure." *JACC: Heart Failure, 1*(1), 1-20.
23. Bagshaw, S. M., et al. (2017). "Novel biomarkers for early detection of acute kidney injury." *Clinical Journal of the American Society of Nephrology, 12*(2), 200-210.