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Original Article

A Prospective Study on Drug Utilization Evaluation and Outcome Assessment in Patients with Acute Kidney Injury

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ABSTRACT:

Background: In hospitalized patients, Acute Kidney Injury (AKI) is associated with worse outcomes and higher mortality, yet evidence on prescribing patterns and outcomes in resource-limited settings is scarce. **Objectives:** To evaluate therapeutic outcomes, drug utilization patterns, and comorbidity burden in hospitalized AKI patients using KDIGO staging. **Materials and Methods:** A prospective observational study was conducted from February to August 2025 in the General Medicine and Nephrology departments of MVJ Medical College and Research Hospital, enrolling 78 adult AKI admissions. Demographic, clinical, laboratory, and medication data were recorded; KDIGO stages were assigned, and outcomes were assessed at discharge. **Results:** The cohort was predominately male (60.3%) with >40 years of age representing the majority. KDIGO distribution was Stage 1 (43.6%), Stage 2 (24.4%), and Stage 3 (32.1%). Drug utilization was dominated by fluid therapy (89.7%), diuretics (55.1% -furosemide 46.2%) and antibiotics (51.3% - ceftriaxone 16.7%, piperacillin-tazobactam 9%, ceftazidime 9%). Clinical outcomes showed complete renal recovery in 33.3% of patients, partial recovery in 61.5%, no recovery in 5.2%; ICU admission occurred in 23.1% and progression to chronic kidney disease in 5.1 %. Higher KDIGO stage correlated significantly with dialysis requirement (χ^2=35.25, p<0.001) and poorer resolution (χ^2=12.99, p=0.011). **Conclusion:** This study underscores the critical need to detect acute kidney injury promptly, to vigilantly oversee medication regimens, and to apply judicious drug-use practices in order to improve patient outcomes. Moreover, there is a clear demand for extensive, multicenter investigations with extended observation periods to more thoroughly assess chronic renal sequelae and to formulate refined pharmacologic approaches for managing AKI in inpatient environments.

Keywords: Acute Kidney Injury, Clinical Outcomes, Comorbidities, Drug Utilization Evaluation, KDIGO staging, Pharmacotherapy.

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INTRODUCTION

Acute Kidney Injury (AKI) refers to a sudden decline in renal function that manifests as either a rise in serum creatinine levels or a drop in urine output within a span of hours to a few days. This rapid deterioration is linked to significant morbidity and a high risk of death, prolonged hospitalization, and increased healthcare costs worldwide. Recent epidemiologic studies worldwide have identified AKI in 10-20% of all hospitalized patients and in more than 50% of severely ill patients. This illustrates the gravity of the situation for public health.[1,2] Despite advancements in supportive care, Acute Kidney Injury (AKI) remains associated with adverse short- and long-term outcomes, including progression to Chronic Kidney Disease (CKD) and an increased risk of mortality.[2] The Kidney Disease: Improving Global Outcomes (KDIGO) recommendations have facilitated the recognition and comparison of research by standardizing the classification and staging of Acute Kidney Injury (AKI) based on alterations in blood creatinine levels and urine output.[3] The revised KDIGO recommendations emphasize the necessity of early detection, optimizing hemodynamic status, avoiding nephrotoxins, and delivering tailored supportive care to prevent disease progression and mitigate long-term renal complications[3]. Standardized staging has enhanced prognostic classification and facilitated the evaluation of therapeutic interventions across diverse clinical settings. Patients with preexisting comorbidities like hypertension, diabetes mellitus, cardiovascular disease, and sepsis can develop Acute Kidney Injury (AKI). These circumstances increase the likelihood of individuals experiencing renal autoregulation issues, endothelial dysfunction, and heightened sensitivity to ischemia and nephrotoxic shocks.[4] Pharmacotherapy fulfills a dual role in the management of Acute Kidney Injury (AKI).

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Antibiotics, diuretics, vasopressors, and alkalizing agents are essential for addressing the underlying causes and metabolic disorders. Inappropriate prescribing, inappropriate dosing in renal impairment, and the use of potentially nephrotoxic drugs all worsen AKI and prolong recovery tim.[5] Rational prescribing and DUE are therefore required to improve clinical outcome in AKI. A large number of studies have assessed the incidence and morbidity associated with AKI, but most studies have focused either on patients in intensive care, on specific causes or on long-term renal outcome. Not much potential data from Indian tertiary-care centers available comparing the pharmacologic use, KDIGO stage, burden of comorbidities and short-term treatment outcome in general medicine and nephrology wards of hospitals, despite the fact that early-stage AKI is most frequently encountered in these wards. In addition, real-world data on drug prescribing patterns and the association between pharmacologic use and dialysis requirement and renal recovery outcome in resource-limited settings are lacking. The aim was to characterize treatment and medication trends, to determine the hospital outcome of patients with AKI, to study the medication prescribing patterns and in-hospital prevalence of AKI, and to study the association of AKI with comorbidities, disease severity and outcomes.

MATERIALS AND METHODS

The prospective observational study was conducted at MVJ Medical College and Research Hospital located at Hoskote in the Department of Nephrology and General Medicine for a period of 6 months from February 2025 to August 2025. Ethical clearance was secured from the Institutional Ethics Committee before the study began. For this study, all eligible patients diagnosed with Acute kidney injury admitted during the study period were included. A total of 78 individuals met the study's inclusion requirements. The criteria stipulated that participants must be receiving therapy for acute kidney injury defined according to KDIGO guidelines and be aged 18 years or older. Patients with Chronic Kidney Disease (CKD), End-Stage Renal Disease (ESRD), a history of renal transplantation, as well as pregnant or lactating women, were excluded from enrollment. All eligible patients were enrolled in the study after obtaining informed consent from the patients themselves or from their legal representatives. Patient data was collected using a specially designed case record form encompassing demographic details, clinical diagnosis, comorbidities, lab investigations including serum creatinine, blood urea nitrogen, electrolytes (sodium, potassium, bicarbonate), urine output, details of prescribed medications, length of hospital stay and clinical outcomes. Outcomes were assessed based on the changes in the laboratory parameters, duration of hospitalization, ICU admission, and resolution status. Statistical analysis was done using MS-Excel, SAS 9.4 software to find the association between categorical variables (KDIGO staging, dialysis, resolution status). All descriptive data presented using mean, median, standard deviation and ranges. the input data from a structured format was visualized in patterns using charts and Tables.

RESULTS

The research study was conducted to evaluate the therapeutic outcomes, medications prescribing patterns, and to figure out the prevalence of co-morbidities in AKI patients. The study was conducted among 78 patients during the course study in Nephrology and General medicine Department of MVJ Medical College and Research Hospital.

Sociodemographic profile scale

During the study period 78 subjects diagnosed with Acute Kidney Injury were selected for the study. In the study the patients were classified according to their age, gender, BMI body mass index Table 1.

Clinical profile scale

KDIGO Staging

The cohort was divided according to KDIGO stages: 43.6% were in Stage 1, 24.4% in Stage 2, and 32.1% in Stage 3. Baseline serum creatinine was taken from each patient's previous laboratory records when available; for those lacking prior data, the baseline was estimated with the MDRD back-calculation, assuming a glomerular filtration rate of 75 mL/min/1.73 m^2 (Figure 1).

Causes of AKI

Among the 78 patients studied, the etiologies of Acute Kidney Injury (AKI) were distributed as follows: unspecified causes accounted for 20 patients (25.6%), Acute Tubular Necrosis (ATN) for 10 patients (12.8%), sepsis for 18 patients (23.1%), hypovolemia for 19 patients (24.4%), heart failure for 6 patients (7.7%), and renal obstruction for 5 patients (6.4%).

AKI Progression status

Among the study population, 4 patients (5.1%) progressed from AKI to CKD, whereas 74 patients (94.9%) did not show progression.

Distribution of KDIGO Staging and dialysis requirements

In this study, Acute Kidney Injury (AKI) severity was assigned using the KDIGO staging system. Of the 78 patients, 34 (43.6%) were in Stage 1, 19 (24.4%) in Stage 2, and 25 (32.1%) in Stage 3. Overall, 16 patients (20.5%) needed renal replacement therapy (dialysis), while the remaining 62 (79.5%) were treated conservatively. Dialysis use differed markedly by KDIGO stage. Only one patient in Stage 1 (1.9%) required dialysis; the other 33 (97.1%) were managed without it. No patients in Stage 2 needed dialysis, with all 19 (100%) receiving conservative care.

In contrast, dialysis was common among Stage 3 patients: 15 individuals (60%) required it, whereas 10 (40%) were treated without dialysis.

Drug Utilization Patterns in AKI

In this cohort, 55.1% of patients (43/78) received diuretics, most commonly furosemide (46.2% of all patients), followed by Dytor (7.7%) and mannitol (1.3%). Antibiotics were prescribed to 51.3% of patients (40/78); the most frequently used agents were ceftriaxone (16.7%), piperacillin-tazobactam (9.0%), ceftazidime (9.0%), meropenem (5.1%), ciprofloxacin (3.8%), amikacin (3.8%), and azithromycin, vancomycin, and augmentin (each 1.3%). Alkalizing agents were given to 34.6% of patients (27/78), with sodium bicarbonate used for an average of 6.2 days (range 3-10) in a 1-0-1 dosing schedule (70%). Vasopressors were administered to 5.1 % of patients (4/78), predominantly norepinephrine (2.3% of all patients) for an average of 2.3 days (range 3-10) in a 0-0-1 schedule (75%). Fluid therapy was the most common intervention, given to 89.7% of patients (70/78) (Table 2).

Resolution Status

With respect to therapeutic outcomes, (5.2%) had no recovery, (61.5%) achieved partial recovery, and (33.3%) achieved complete recovery. The majority of patients showed partial recovery, while complete recovery was observed in nearly one-third of the cases. The recovery status of patients was determined by the laboratory parameters, especially Serum Creatinine (SCr).

Co-morbidity in AKI patients

In the study Hypertension was the most frequent comorbidities, present in 25 patients at Stage 1, 10 patients at Stage 2 and 14 patients at Stage 3. Diabetes was also highly prevalent, others diseases like cardiovascular disease, liver dysfunction, chronic kidney disease, sepsis, respiratory disease, and gastrointestinal diseases were recorded. The findings indicate that a considerable proportion of AKI patients had multiple underlying comorbidities, with hypertension and diabetes being most common, and a trend towards higher prevalence of chronic kidney disease and liver dysfunction in Stage 3 AKI (Table 3).

Distribution of laboratory parameters

The biochemical parameters showed improvement from admission to discharge. Mean serum creatinine decreased from 3.12 ±2.34 to 1.89±1.23, mg/dL and blood urea reduced from 76.4±45.2 to 47.8±25.1, similarly a significant improvement in the electrolytes (sodium, potassium and bicarbonate) (Table 4).

Length of Hospital Stay

The study found that most patients (64.1%) were hospitalized for fewer than seven days; an additional 32.1% remained in the hospital for 7-14 days, while 3.8% required stays exceeding 14 days.

Clinical outcomes in AKI patients

In the cohort, 27 patients (33.3%) achieved complete renal recovery, while 47 patients (61.5%) experienced only partial recovery. Four patients (5.2%) had no recovery of kidney function. Regarding broader clinical outcomes, 18 patients (23.1%) required admission to the intensive care unit, and 4 patients (5.1%) progressed to chronic kidney disease.

Statistics

Statistical analyses were performed with SAS 9.4. The distribution of continuous variables was evaluated with the Shapiro-Wilk test (PROC UNIVARIATE); variables that followed a normal distribution are reported as mean ± standard deviation, whereas those that did not are expressed as median (interquartile range), with minima and maxima reported when needed. Categorical variables are shown as frequencies and percentages (PROC FREQ). Associations between categories were examined with the chi-square test, applying Fisher's exact test when >20% of expected cells were <5. Effect sizes were quantified with Cramer's V (Tables > 2 × 2) or Phi (2 × 2 Tables). The relationship between KDIGO stage and dialysis requirement was highly significant ($\chi^2 = 35.248$, $d_f = 2$, $p<0.001$), with a strong effect (Phi = 0.672, 95% CI 0.52-0.78). KDIGO stage also correlated with clinical resolution ($\chi^2=12.988$, $d_f=4$, $p=0.011$; Phi = 0.408, 95% CI 0.22-0.58). No association was found between KDIGO stage and length of stay ($\chi^2 = 2.974$, $p=0.562$). Power calculations confirmed ≥80% power to detect medium effect sizes (Phi ≈ 0.30) at $\alpha=0.05$. All statistical tests were conducted as two-tailed analyses, and a *p*-value below 0.05 was deemed indicative of statistical significance.

DISCUSSION

Acute kidney damage is a complex clinical illness affected by patient demographics, comorbidities, hemodynamic anomalies, and pharmaceutical interventions. Current global assessments identify Acute Kidney Injury (AKI) as a significant factor in hospital morbidity, mortality, and the future onset of chronic kidney disease.[1,6] In this prospective study conducted at a tertiary-care hospital, therapeutic outcomes, drug consumption patterns, and the prevalence of comorbidities were assessed according to KDIGO staging criteria, thereby offering comprehensive real-world evidence from a non-ICU environment.

The demographic distribution noted in this study, characterized by a male predominance and increased incidence in patients over 40 years of age, corresponds with previously documented epidemiological patterns.[1,7]Age-associated nephron attrition, elevated incidence of chronic illnesses, and heightened exposure to potentially nephrotoxic pharmaceuticals may elucidate this

trend. Comparable results have been observed in global cohorts indicating that older persons exhibit heightened susceptibility to AKI and inferior outcomes.[1] The prevalence of KDIGO Stage 1 in this population presumably indicates earlier identification in general medicine and nephrology departments, in contrast to ICU-based research where more advanced stages are prevalent.[3,6] The revised KDIGO recommendations highlight that early identification and timely treatment are crucial for preventing the progression of disease, and the distribution noted in this study indicates successful application of standardized diagnostic criteria.[3]

Pre-renal causes, including sepsis and hypovolemia, were prevalent in this sample. Sepsis-associated Acute Kidney Injury (AKI) is extensively established and is driven by systemic inflammation, microvascular dysfunction, endothelial damage, and hemodynamic instability.[6,8] The notable correlation shown between elevated KDIGO stages and the necessity for dialysis aligns with global research indicating that severe AKI is a robust predictor of renal replacement therapy.[6,9] This discovery confirms the predictive significance of KDIGO stage within the study cohort.

Fluid treatment was the predominant therapeutic intervention, aligning with guideline-directed management that prioritizes hemodynamic optimization and renal perfusion restoration.[3] Effective fluid resuscitation is fundamental to the management of AKI; yet, both fluid overload and insufficient resuscitation can negatively affect outcomes, requiring personalized evaluation.[6] Diuretics, primarily furosemide, were commonly utilized for volume regulation. Evidence suggests that although diuretics may not directly enhance renal recovery or survival, they are effective in managing fluid overload and minimizing consequences such pulmonary edema.[10] The prescribing pattern identified in this study aligns with symptomatic therapy in accordance with current guidelines.

Almost 50% of the patients received antibiotics, reflecting the burden of AKI due to infection. However, drug-induced nephrotoxicity is a potentially preventable cause of hospital-acquired AKI.[5,11] The contemporary literature stresses

Figure 1: KDIGO Staging.

Table 1: Distribution of sociodemographic details.

Characteristics		*n*	Percentage (%)
Age	<20	1	1.3
	21-30	3	3.8
	31-40	4	5.1
	41-50	21	26.9
	51-60	23	29.5
	61-70	16	20.5
	>70	10	12.8
Gender	Male	47	60.3
	Female	31	39.7
BMI	<18.5	4	5.1
	18.5-24.9	67	85.9
	25	7	9

Table 2: Drug Utilisation Pattern.

Drug Category	Patients Percentage (%)	Most Common Drug	Average Duration (Days)	Common Frequency
Diuretics	48.7 (38/78)	Furosemide	4.5 (Range 2-15)	1-0-1 (75%)
Antibiotics	51.3 (40/78)	Ceftriaxone	4.8 (Range 2-10)	1-0-1 (60%)
Alkalizing agents	29.5 (23/78)	Sodium bicarbonate	6.2 (Range 3-10)	1-0-1 (70%)
Vasopressors	5.1 (4/78)	Noradrenaline	2.3 (Range 3-10)	0-0-1 (75%)
Fluid therapy	89.7 (70/78)	-	-	-

Table 3: Distribution of Comorbidities with KDIGO staging.

Sl. No.	Comorbidity	Stage 1		Stage 2		Stage 3		Total
		N	(%)	N	(%)	N	(%)	
1.	Hypertension	25	32.05	10	17.95	14	17.95	49
2.	Diabetes	20	25.64	11	14.1	14	17.95	45
3.	CVD	9	25.64	4	5.13	8	10.26	21
4.	Liver dysfunction	4	11.54	1	1.28	1	1.28	6
5.	Sepsis	11	3.85	7	8.97	8	10.26	26
6.	Respiratory disease	10	14.10	11	14.1	2	2.56	23
7.	GI disease	4	5.13	4	5.13	4	5.13	12

renal dose adjustment, therapeutic drug monitoring, and antimicrobial stewardship activities to prevent further renal damage if the etiology of AKI can be removed. Although dose appropriateness was not formally assessed, our study reinforces the need for a rational use assessment and the involvement of clinical pharmacy in managing antimicrobials.

Although the study sheds light on prescribing patterns, it did not systematically assess several crucial pharmacotherapy factors-namely renal dose adjustments, drug-drug interactions, and exposure to nephrotoxic agents. These variables were inconsistently documented in patient charts, and the case record form was not designed to capture them prospectively. Since inappropriate renal dosing and the use of nephrotoxic medications are well-known contributors to the progression of acute kidney injury, the omission of such analyses limits the ability to fully evaluate the rationality and safety of the pharmacotherapy administered to this patient cohort.

Alkalizing agents were also frequently used to treat metabolic acidosis, a common complication of patients with Acute Kidney Injury (AKI). Bicarbonate therapy was probably effective in some patients with severe metabolic acidosis, although the effects on mortality and need for dialysis are uncertain.[6,12]Thus, bicarbonate use in this cohort may have reflected clinical judgment regarding the management of metabolic derangements.[13,14]

Most patients were either resolved or had improvement in their metabolic derangement by the study concluded. A minority of patients progressed to CKD. Acute Kidney Injury (AKI) is progressively recognized as a standalone risk factor for developing Chronic Kidney Disease (CKD) due to enduring structural damage and inflammatory pathways that may linger beyond apparent clinical recovery.[4,7] Extensive cohort studies indicate that even temporary episodes of Acute Kidney Injury (AKI) elevate long-term renal risk.[6] The observed low advancement rate in this study may be ascribed to early-stage predominance and a restricted follow-up period. The statistically significant correlation between KDIGO staging and clinical resolution underscores the prognostic relevance of disease severity at presentation.[6,9]

Furthermore, the study did not evaluate Adverse Drug Reactions (ADRs). Although the hospital operates an active pharmacovigilance program, ADR information was not uniformly recorded across all inpatient charts, and the research lacked a dedicated ADR monitoring system or a formal causality assessment framework. Extracting such data retrospectively could have introduced misclassification, which is why ADR analysis was omitted. In addition, pharmacoeconomic factors-such as treatment costs and the overall economic burden-were not examined because billing information was unavailable. These gaps may limit the practical relevance of the results, especially in settings with limited resources.

Comorbidities such as hypertension and diabetes were notably prevalent in this cohort, aligning with global literature that illustrates their contributory role in AKI susceptibility and negative outcomes.[4,7] Furthermore, chronic vascular and endothelial dysfunction in these patients can lead to renal hypoperfusion and poor recovery. Having multiple coexisting health conditions

Table 4: Distribution of laboratory Parameter.

PARAMETER	ADMISSION (Mean±SD)	DISCHARGE (Mean±SD)
Serum creatinine (mg/dL)	3.12±2.34	1.89±1.23
Blood urea (mg/dL)	76.5±45.2	47.8±25.1
Sodium (mEq/L)	135.2±6.8	137.9±4.2
Potassium (mEq/l)	4.3±0.9	4.0±0.7
Bicarbonate (mEq/L)	18.9±4.1	22.3±2.8

has been linked to a higher likelihood of requiring dialysis and experiencing suboptimal recovery.[6]

The current investigation possesses several methodological aspects that warrant acknowledgment. The limited sample size and single-center nature restrict the generalizability of the findings, and outcomes were evaluated solely during the hospital stay, precluding assessment of long-term renal recovery and progression to chronic kidney disease. Individuals with pre-existing CKD or ESRD were excluded to avoid baseline renal impairment confounding AKI staging; nevertheless, this exclusion diminishes relevance to typical clinical scenarios where AKI often arises on a background of CKD. Advanced biomarkers such as NGAL and KIM-1, which can improve early AKI detection, were not accessible at our facility, our research still depends on KDIGO staging based on serum creatinine, which remains the worldwide "gold standard" for settings with limited resources. Moreover, because the work is observational, it can only suggest associations rather than establish causality. In spite of these constraints, the study offers valuable prospective real-world insight into AKI management within a resource-limited tertiary hospital and underscores the necessity for multicenter trials with larger cohorts, extended follow-up periods, systematic ADR surveillance, evaluation of nephrotoxic drug exposure, and incorporation of pharmacoeconomic analyses.

LIMITATIONS

This investigation has several noteworthy limitations. It was carried out at a single tertiary-care center with a relatively modest sample size (n=78), which constrains the generalizability of the findings and diminishes statistical power for subgroup analyses. Outcomes were measured only during the hospital stay, and no post-discharge or long-term follow-up data were obtained, precluding assessment of chronic kidney disease progression and late mortality.

Drug-related factors such as drug-drug interactions, exposure to nephrotoxic agents, and renal dose adjustments were not examined because these variables were inconsistently documented in patient records and were omitted from the data-collection instrument, limiting the ability to fully evaluate rational prescribing.

Although the institution operates a functional pharmacovigilance center, Adverse Drug Reactions (ADRs) were not analyzed since ADR information was not uniformly recorded in inpatient files and systematic causality assessment lay beyond the study's scope. Pharmacoeconomic aspects-including treatment cost, affordability, and cost-effectiveness-were not evaluated due to lack of access to billing and expenditure data.

Patients with pre-existing CKD or ESRD were excluded according to the pre-specified protocol to avoid confounding baseline renal dysfunction with AKI-related changes; this exclusion reduces applicability to real-world populations where AKI often occurs on a background of CKD. Advanced biomarkers such as NGAL, KIM-1, and cystatin-C were unavailable at the institution and therefore could not be incorporated.

Finally, the observational design prevents the establishment of causal relationships between drug utilization and clinical outcomes, and unmeasured confounding factors may have influenced the results. Despite these limitations, the study offers meaningful real-world data on AKI management and underscores the need for larger multicenter investigations with extended follow-up, structured ADR surveillance, evaluation of nephrotoxic drug exposure, and comprehensive pharmacoeconomic assessment.

CONCLUSION

Acute Kidney Injury (AKI) is frequently encountered among hospitalized patients, especially those with comorbid conditions such as hypertension, diabetes, and sepsis. In this prospective observational study, the most commonly employed interventions were fluid therapy, diuretics, and antibiotics, and the majority of patients presented with early KDIGO stages. A higher KDIGO stage was significantly linked to the need for dialysis and to poorer recovery outcomes. Although most participants achieved partial or complete renal recovery during their hospital stay, a small subset progressed to chronic kidney disease. These results highlight the critical role of early AKI detection, diligent pharmacotherapy monitoring, and prompt therapeutic action. Nevertheless, the findings should be viewed in light of the study's constraints, which include being conducted at a single site, having a relatively small cohort, and lacking extended follow-up data. Future multicenter investigations with larger cohorts, systematic evaluation of nephrotoxic drug exposure, adverse-drug-reaction monitoring, pharmacoeconomic analysis, and extended renal outcome assessment are required to optimize inpatient pharmacotherapeutic strategies for AKI.

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ABBREVIATIONS

KDIGO: Kidney Disease Improving Global Outcomes; **SCr:** Serum Creatinine; **AKI:** Acute Kidney Injury; **CKD:** Chronic Kidney Disease; **ESRD:** End-Stage Renal Disease; **CVD:** Cardiovascular Disease; **GI Disease:** Gastrointestinal Disease.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICAL APPROVAL

Ethics review board of MVJ Medical College and Research Hospital, Hosakote has granted approval with IEC No - MVJMC&RH/IEC-02/2025.

DATA LINKING

The authors refrain from disclosing the study's data, as sharing patient- specific information is deemed unethical by the Institutional Ethics Committee.

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