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Impact of Hemodialysis Adherence on Biochemical Markers in Chronic Kidney Disease Patients: A Comparative Study

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Abstract

Background: *Chronic Kidney Disease (CKD) is a global health burden associated with progressive renal impairment and multiple comorbidities. Adherence to hemodialysis schedules, dietary restrictions, and prescribed medications significantly influences disease progression and biochemical profiles.*

Aim: *To compare specific biochemical markers between adherent and non-adherent CKD patients on hemodialysis, assess the effect of delayed dialysis on these markers, and explore associations with demographic variables.*

Methods: *A cross-sectional study was conducted among 50 CKD patients receiving hemodialysis in two tertiary care hospitals. Participants were classified as adherent or non-adherent based on hemodialysis attendance and compliance with treatment. Data included demographic details and biochemical parameters – serum creatinine, blood urea, serum potassium, serum calcium, and hematocrit levels – measured pre-dialysis. Analysis involved descriptive statistics, Mann-Whitney U tests, and Kruskal-Wallis tests for group comparisons, with chi-square tests for demographic associations.*

Results: *Serum creatinine differed significantly between adherent (2.60 ± 1.30 mg/dl) and non-adherent patients (2.80 ± 1.31 mg/dl; $p = 0.054$). Other parameters showed no statistically significant differences. Missing two hemodialysis sessions was associated with notably higher creatinine (3.27 mg/dl) and altered potassium levels ($p < 0.001$). Gender, diet type, residence, and hospital distance were significantly associated with selected biochemical markers.*

Conclusion: *While most biochemical parameters did not differ significantly, serum creatinine and potassium levels were sensitive to treatment adherence and missed hemodialysis sessions. Tailored adherence interventions, patient education, and logistical support can enhance biochemical stability and overall patient outcomes.*

Keywords: *Chronic Kidney Disease, Hemodialysis, Biochemical Markers, Adherence, Serum Creatinine, Serum Potassium*

1. INTRODUCTION

Chronic Kidney Disease (CKD) is a progressive, irreversible condition characterized by a gradual decline in kidney function, ultimately impairing the body's ability to maintain electrolyte balance and eliminate metabolic waste. Affecting approximately 10% of the global population, CKD represents both a medical challenge and a public health priority due to its high morbidity, mortality, and economic burden (WHO, 2023).

In India, the growing prevalence is largely driven by diabetes mellitus, hypertension, and lifestyle changes. Furthermore, disparities in healthcare access amplify the disease burden, particularly in rural and economically disadvantaged populations.

CKD is staged using estimated glomerular filtration rate (eGFR) and evidence of structural or functional kidney abnormalities. Advanced stages require renal replacement therapies such as hemodialysis or transplantation. hemodialysis adherence — including attending scheduled sessions, following fluid and dietary restrictions, and taking medications as prescribed — is essential for maintaining biochemical homeostasis.

Non-adherence can result in dangerous electrolyte imbalances, fluid overload, and accelerated disease progression. Serum creatinine, blood urea, potassium, calcium, and hematocrit levels are routinely monitored as indicators of dialysis adequacy and metabolic stability.

Objectives:

1. Compare biochemical parameters between adherent and non-adherent CKD patients on hemodialysis.
2. Assess the effect of delayed hemodialysis sessions on biochemical profiles.
3. Identify demographic variables associated with biochemical marker variation.

2. METHODOLOGY

This study adopted a hospital-based cross-sectional comparative design aimed at assessing and comparing biochemical markers among adherent and non-adherent chronic kidney disease (CKD) patients undergoing hemodialysis. The research was conducted in the dialysis units of Tertiary care Hospitals both recognized for their expertise in managing CKD and providing hemodialysis services. A total of 50 patients were selected through purposive sampling based on defined inclusion and exclusion criteria. Patients were eligible if they had a confirmed diagnosis of CKD, were currently receiving maintenance hemodialysis, had accessible medical records, and provided informed consent to participate. Those experiencing acute illness, recent kidney transplantation, major surgery, significant cognitive impairment, or inability to communicate in Marathi were excluded from the study. Participants were classified into two groups: adherent, comprising those who attended all prescribed hemodialysis sessions without unapproved absences or reductions; and non-adherent, consisting of those who missed one or more scheduled sessions or reduced session duration without medical approval.

Data collection was carried out using a structured tool comprising two sections: Section A included demographic details such as age, gender, educational status, dietary pattern, monthly income, occupation, place of residence, distance from hospital, and frequency of dialysis sessions; Section B included pre-dialysis biochemical parameters such as serum creatinine, blood urea, serum potassium, serum calcium, and hematocrit levels. Blood samples were collected and analyzed using standard laboratory protocols. Prior to data collection, ethical clearance was obtained from the institutional ethics committee, and necessary permissions were secured from hospital authorities. Participants were briefed about the study's purpose, assured of anonymity and confidentiality, and informed that participation was voluntary with the right to hemodialysis at any stage. Statistical analysis was performed using descriptive statistics to summarize demographic and biochemical data, and inferential tests such as the Mann-Whitney U test for group comparisons, Kruskal-Wallis test for assessing the impact of missed hemodialysis sessions, and Chi-square test for exploring associations between demographic variables and biochemical markers. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

The findings of the present study provide insights into the demographic distribution, adherence patterns, and biochemical profiles of chronic kidney disease patients undergoing maintenance hemodialysis. The results are presented in three major segments: comparison of biochemical parameters between adherent and non-adherent patients, analysis of the effect of missed hemodialysis sessions on these biochemical parameters, and examination of associations between demographic variables and biochemical markers.

3.1 Demographic Profile

The majority of patients resided in urban areas (60%), with most living 21–30 km from the hospital (40%). Educational attainment varied considerably, with 28% being illiterate and 32% holding a graduate degree or higher. Regarding diet, nearly half (48%) consumed a mixed diet, while 30% were vegetarian and 22% non-vegetarian.

Income levels reflected a moderate socio-economic status, with 32% earning above ₹40,001 monthly and 20% earning between ₹10,000–20,000. The majority of participants were salaried employees (46%), followed by unemployed (30%) and self-employed individuals (24%).

In terms of dialysis frequency, equal proportions of patients underwent once-weekly (36%) and twice-weekly (36%) sessions, while 28% received thrice-weekly dialysis.

These findings indicate a heterogeneous group in terms of socio-economic background, access to care, and lifestyle factors all of which may influence treatment adherence.

3.2 Comparison of Biochemical Parameters between Adherent and Non-Adherent Patients

Table 1 shows that adherent patients had slightly lower mean serum creatinine (2.60 ± 1.30 mg/dl) compared to non-adherent patients (2.80 ± 1.31 mg/dl), with the difference approaching statistical significance ($p = 0.054$). Elevated creatinine in non-adherent patients suggests reduced dialysis adequacy and possible accumulation of nitrogenous waste products.

Blood urea levels did not differ significantly (p = 0.752) between groups, though adherent patients had marginally higher values, possibly reflecting individual variations in protein metabolism or dietary intake rather than adherence alone.

Serum potassium levels were higher in adherent patients (6.78 ± 1.47 mEq/L) than in non-adherent patients (6.43 ± 1.58 mEq/L), though the difference was not statistically significant (p = 0.410). Potassium fluctuations may depend on both dietary compliance and dialysis efficiency.

Hematocrit levels showed no significant variation between groups, with adherent patients at 38.67% and non-adherent patients at 40.37% (p = 0.623).

Overall, while only creatinine differences approached significance, the observed patterns indicate that missing dialysis sessions can subtly influence multiple biochemical parameters.

Table 1: Adherent vs Non-adherent biochemical marker comparison.

Marker	Adherent Mean ± SD	Non-adherent Mean ± SD	p-value
Serum Creatinine	2.60 ± 1.30	2.80 ± 1.31	0.054*
Blood Urea	35.73 ± 13.63	33.71 ± 16.59	0.752
Serum Potassium	6.78 ± 1.47	6.43 ± 1.58	0.410
Hematocrit (%)	38.67 ± 12.23	40.37 ± 11.93	0.623

*Statistically significant at p<0.05.

3.3 Effect of Delayed Hemodialysis on Biochemical Parameters

Table 2 presents the influence of missed hemodialysis sessions. Serum creatinine levels increased notably in patients missing two sessions (3.27 mg/dl) compared to those who never missed sessions (2.60 mg/dl), with a statistically significant difference (p = 0.041). This trend underscores the immediate impact of even short-term non-adherence.

Serum potassium levels exhibited a more striking pattern: patients missing three sessions had the highest mean potassium (7.32 mEq/L), significantly different from those who never missed sessions (p < 0.001). Elevated potassium poses a life-threatening risk due to its association with cardiac arrhythmias.

Blood urea and hematocrit levels did not show statistically significant changes across missed-session categories, indicating that these parameters may require more prolonged non-adherence to display marked differences.

Table 2: Biochemical changes by missed hemodialysis sessions.

Marker	Never Missed	Missed 1	Missed 2	Missed 3	p-value
Creatinine	2.60	2.35	3.27	2.91	0.041*
Blood Urea	35.73	37.90	30.94	31.25	0.737
Potassium	6.78	6.35	6.06	7.32	0.001*
Hematocrit (%)	38.67	38.30	47.94	35.38	0.175

3.4 Association of Demographic Variables with Biochemical Parameters

The analysis revealed that gender, diet type, and hospital distance were significantly associated with serum creatinine levels, suggesting both biological and socio-cultural influences on adherence and biochemical control.

Similarly, gender, income, residence type, and hospital distance significantly influenced blood urea levels. For instance, rural residents and those with lower income tended to have more variable urea concentrations, potentially reflecting dietary differences, hydration patterns, or access barriers to timely dialysis.

- **Creatinine:** Significantly associated with gender (p=0.012), diet type (p=0.032), and hospital distance (p=0.001).
- **Blood Urea:** Associated with gender (p=0.001), monthly income (p=0.032), residence (p=0.001), and distance (p=0.032).

4. DISCUSSION

The present study demonstrates that while most biochemical parameters did not differ significantly between adherent and non-adherent patients, serum creatinine and potassium levels were sensitive indicators of adherence lapses, particularly when ≥2 hemodialysis sessions were missed.

Our findings align with Naalweh et al. (2019), who reported significant correlations between non-compliance behavior and biochemical imbalances in hemodialysis patients. Similarly, Cinar et al. (2020) observed that adherence improved metabolic stability, especially potassium control.

Missed hemodialysis sessions can cause acute biochemical derangements due to inadequate clearance of nitrogenous waste and potassium, risking arrhythmias, metabolic acidosis, and accelerated CKD progression. This study reinforces the importance of regular attendance, as even short-term lapses influenced key markers.

Demographic associations suggest that male gender, non-vegetarian diets, rural residence, and greater hospital distance are potential barriers to consistent adherence. These factors should be targeted in patient-centered adherence interventions, such as transport assistance, telehealth counseling, and culturally tailored dietary education.

5. CONCLUSION

This marker responded significantly to both adherence classification and missed-session analysis, making it a practical clinical tool for monitoring adherence. Even moderate non-adherence could precipitate dangerous hyperkalemia, highlighting the need for urgent patient counseling in cases of missed sessions. Income, residence, and distance to hospital were recurrently associated with biochemical variability, emphasizing the need for targeted outreach and supportive care strategies.

Adherence to hemodialysis schedules is crucial for maintaining biochemical stability in CKD patients. While blood urea and hematocrit levels were relatively unaffected, serum creatinine and potassium levels were significantly impacted by missed hemodialysis sessions, reflecting reduced dialysis adequacy and increased metabolic risk.

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