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Unlocking the path to better recovery: Factors influencing dialysis recovery time in hemodialysis patients

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ABSTRACT

Objectives: Hemodialysis is essential for patients with end-stage kidney disease, yet the post-treatment recovery period – dialysis recovery time (DRT) – is a significant determinant of quality of life. In India, where chronic kidney disease is prevalent, understanding the factors influencing DRT can aid in developing strategies to improve patient outcomes.

Materials and Methods: This cross-sectional study examined 160 adult patients undergoing maintenance hemodialysis in Mumbai across multiple centers. We assessed various demographic, clinical, and dialysis-related factors to determine their impact on DRT. Data collection included demographic profiles, comorbidities, dialysis parameters (e.g., frequency and ultrafiltration rate), and laboratory values (hemoglobin, albumin, and electrolyte levels). DRT was measured using a simple health-related quality of life question: "How long does it take you to recover from a dialysis session? and then categorized into three groups: Less than 2 h, 2–6 h, and more than 6 h.

Results: Type 2 diabetes mellitus (T2DM), anemia, and higher ultrafiltration volumes significantly extend DRT. Specifically, T2DM patients were three times more likely to experience prolonged recovery. Unemployed patients were also found to have increased recovery times as compared to others. In addition, greater interdialytic weight gain and aggressive ultrafiltration correlated with extended recovery, likely due to fluid imbalance and cardiovascular strain.

Conclusion: The study underscores the need for tailored care strategies, such as optimized fluid management, anemia treatment, and nutritional support, to mitigate post-dialysis fatigue and improve recovery. These findings offer valuable insights for clinicians aiming to enhance patient-centered dialysis care and reduce DRT, potentially improving adherence and long-term health outcomes for Indian hemodialysis patients.

Keywords: Chronic kidney disease, Diabetes mellitus, Dialysis recovery time, Hemodialysis

INTRODUCTION

Hemodialysis is a life-sustaining treatment for patients with end-stage kidney disease. While this therapy is crucial for managing renal failure, it can significantly impact patients' quality of life. One important aspect of this impact is the dialysis recovery time (DRT), defined as the time it takes for a patient to resume normal activities after a dialysis session.[1]

In India, where the prevalence of chronic kidney disease is estimated to be 17.2% of the adult population,[2] understanding factors affecting DRT is crucial for improving patient outcomes and overall well-being. Despite its importance, limited research has been conducted on DRT in the Indian context, where socioeconomic factors, dietary habits, and healthcare accessibility differ from those in Western countries.

This study aims to investigate the various factors influencing DRT among hemodialysis patients in India. By identifying these factors, healthcare providers can potentially implement strategies to reduce recovery time and thereby enhance patients' quality of life.

MATERIALS AND METHODS

Study design and setting

This cross-sectional study was conducted as a multicenter study (which included 4 stand-alone dialysis centers and 1 tertiary care hospital) in different regions of North Mumbai between January 2024 and May 2024.

Participants

Adult patients (≥18 years) undergoing maintenance hemodialysis for at least three months were eligible for inclusion. Patients with cognitive impairment, acute

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illnesses, or those unwilling to provide informed consent were excluded.

Sample size

A sample size of 160 patients was calculated using G*Power software, assuming a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, and power ($1-\beta$) = 0.80 for multiple regression analysis with up to 20 predictor variables.

Data collection

Demographic and clinical data were collected through patient interviews and medical record reviews. DRT was assessed using a validated simple health-related quality of life question: "How long does it take you to recover from a dialysis session?,[3] which asked patients to estimate the time it typically takes them to recover to their baseline level of well-being after a dialysis session. The average recovery time in hours was noted for the three consecutive dialysis sessions and converted to minutes as well. Based on a previous study done by Rayner *et al.*[1] the reported DRT was reclassified as <2 h, 2–6 h, and >6 h.

Variables studied included

1. Demographic factors: Age, gender, education level, employment status, dialysis financial support
2. Clinical factors: Cause of chronic kidney disease (CKD), comorbidities (Diabetes mellitus [DM], hypertension [HTN], coronary artery disease [CAD], and cerebrovascular accident [CVA]), native urine output
3. Dialysis-related factors: Dialysis vintage, dialysis access, dialysis frequency, interdialytic weight gain (IDWG), ultrafiltration rate
4. Laboratory parameters: Serological status, hemoglobin, serum albumin, calcium, phosphorus, sodium, potassium.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences version 26.0. Descriptive statistics were used to summarize patient characteristics. Univariate analysis was performed to identify factors associated with DRT. Variables with $P < 0.1$ in univariate analysis were included in a multiple linear regression model to determine independent predictors of DRT. A $P < 0.05$ was considered statistically significant.

RESULTS

Demographics and clinical characteristics

Study population demographics

Age and gender

The study involved 160 patients with a mean age of 53.74 years; among them, 62.5% were men [Table 1].

Table 1: Demographic, clinical, and laboratory parameters of patients.

Parameter	Total patients (*n*=160)
Age [years], mean (SD)	53.74 (14.28)
Sex (%)	
Men	100 (62.50)
Women	60 (37.50)
Weight [kg], median (range)	[*n*=151] 57.00 (32.20–111.00)
Education (%)	
School	58 (36.25)
Graduate	43 (26.88)
College	35 (21.88)
Illiterate	15 (9.38)
Post-graduate	9 (5.63)
Occupation (%)	
Retired	60 (37.50)
Unemployed	46 (28.75)
Private job	43 (26.88)
Businessman	11 (6.88)
Finance (%)	
Cash	74 (46.25)
Insurance	50 (31.25)
Charity	36 (22.50)
Comorbid conditions (%)	
T2DM	74 (46.25)
HTN	137 (85.63)
CVA	33 (20.63)
CAD	16 (10.00)
Access (%)	
AVF	121 (75.63)
Permacath	33 (20.63)
Temporary catheter	6 (3.75)
Duration of dialysis [years], median (range)	2.00 (0.02–21.00)
Frequency of dialysis, median (range)	3.00 (2.00–4.00)
Frequency of dialysis (%)	
Twice weekly	57 (35.63)
Thrice weekly	102 (63.75)
Fourth weekly	1 (0.63)
Interdialytic weight gain [kg], median (range)	2.20 (0.10–6.20)
Ultrafiltration [mL], median (range)	2.80 (0.50–10.50)
Hemoglobin [g/dL], mean (SD)	10.05 (1.71)
Albumin [g/dL], median (range)	[*n*=159] 3.80 (1.33–4.90)

(Contd...)

Table 1: *(Continued).*

Parameter	Total patients (*n*=160)
Calcium [mg/dL], mean (SD)	[*n*=159] 8.43 (0.90)
Phosphorus [mg/dL], median (range)	[*n*=159] 4.73 (1.33–11.75)
Sodium [mmol/L], median (range)	137.00 (127.00–161.00)
Potassium [mmol/L], mean (SD)	5.03 (0.88)

Data shown as *n* (%), unless otherwise specified. AVF, Arteriovenous fistula, CAD: Coronary artery disease, CVA: Cerebral vascular disease, HTN: Hypertension, T2DM: Type-2 diabetes mellitus, SD: Standard deviation

Education and occupation

The education levels varied, with 36.25% of participants having a school-level education, and fewer had college or postgraduate qualifications. Regarding employment, 37.5% were retired, and 28.75% were unemployed.

Financial coverage

Patients primarily paid through cash (46.25%) or insurance (31.25%).

Clinical comorbidities and access for dialysis

Prevalence of conditions

HTN was the most common comorbidity, affecting 85.63% of patients, followed by type 2 diabetes mellitus (T2DM) at 46.25% and cerebral vascular disease (CVA) at 20.63%.

Dialysis access

The arteriovenous fistula (AVF) was the most common access type, used by 75.63% of patients, followed by permacath and temporary catheters, which are usually associated with acute settings or earlier stages of dialysis dependency.

Dialysis parameters and recovery time (DRT)

Frequency of dialysis

Most of the patients (63.75%) underwent dialysis three times a week, while 35.63% had it twice weekly. More frequent dialysis could suggest greater severity of kidney dysfunction among participants or provider preferences.

DRT

The DRT – a measure of how long patients feel fatigued or unwell post-dialysis – was classified into three categories:

Table 2: Association between the DRT and variable factors.

Chi-square test	r	*P*-value
Interdialytic weight gain (kg)	0.196	0.021*
Ultrafiltration (L/session)	0.178	0.035*
Lower albumin (g/dL)	0.232	0.006*

DRT: Dialysis recovery time, r: Correlation coefficient. *: Statistical significance ($P < 0.05$)

- Less than 2 h (18.13%)
- 2–6 h (41.25%)
- More than 6 h (28.13%)

Associations between DRT and clinical factors

The analysis sought to identify factors influencing DRT, considering variables such as IDWG, ultrafiltration, albumin, T2DM, and hemoglobin (Hb) levels.

Positive correlation with DRT

IDWG

There was a significant positive correlation with DRT (r = 0.196, $P = 0.021$), suggesting patients who gained more weight between sessions needed longer recovery times. This may indicate fluid overload and inefficient ultrafiltration during dialysis [Table 2].

Ultrafiltration

A positive but weaker correlation between ultrafiltration volumes and DRT was noted ($P = 0.035$). Higher ultrafiltration volumes might indicate more aggressive fluid removal, which could contribute to fatigue and longer recovery times.

Albumin levels

Lower albumin levels correlated positively with DRT (r = 0.232, $P = 0.006$). Albumin, often an indicator of nutritional status, may also impact patients' physical resilience and recovery post-dialysis.

Multivariate analysis of factors affecting DRT

T2DM

Patients with T2DM were 3.013 times more likely to have prolonged DRT ($P = 0.012$). This suggests that diabetic patients, likely experiencing more complications, have greater recovery needs post-dialysis [Table 3].

Anemia

Low Hb levels (<12 g/dL) were associated with prolonged DRT (odds ratio [OR] = 1.508, $P = 0.003$). Anemia is

Table 3: Multivariate linear regression analyses for parameters affecting the DRT.

Parameters	Multivariate analysis		
	OR	95% CI	*P*-value
T2DM	3.013	(1.273, 7.128)	0.012*
Ultrafiltration (L/session)	0.598	(0.378, 0.946)	0.028*
Anemia (Hb: <12 g/dL)	1.508	(1.147, 1.982)	0.003*
Low albumin (g/dL)	0.316	(0.129, 0.775)	0.012*
Phosphorus (mg/dL)	0.776	(0.600, 1.003)	0.053

Hb: Hemoglobin, CI: Confidence interval, DRT: Dialysis recovery time, OR: Odds ratio, T2DM: Type-2 diabetes mellitus, *: Statistical significance ($P < 0.05$)

common among dialysis patients and is linked to fatigue and poor quality of life, hence affecting recovery.

Ultrafiltration

Higher ultrafiltration volumes were associated with prolonged DRT (OR = 0.598, $P = 0.028$). This relationship could imply that excessive fluid removal, which is not within optimal volumes, prolongs recovery.

Albumin levels

Lower albumin levels were associated with longer DRT (OR = 0.316, $P = 0.012$), supporting the role of good nutritional status in reducing fatigue and promoting faster recovery.

Specific subgroup insights on DRT

Demographic factors

Analysis of demographic factors revealed no significant differences in DRT by sex or education. However, unemployed patients exhibited higher DRT ($P = 0.050$).

Clinical

Patients without T2DM reported lower DRT as compared to patients with T2DM.

DISCUSSION

Demographic influence on DRT

Age and sex are important demographic factors in DRT, with older patients generally experiencing longer recovery times due to the cumulative impact of age-related physiological decline and comorbid conditions.[4] Male patients tend to have higher rates of end-stage renal disease, which is consistent with findings from the dataset and reflects patterns found globally.[5]

Lower education and employment levels also influence DRT. For example, patients with limited formal education or unemployment are often more susceptible to poorer health outcomes due to limited access to health resources and reduced social support. Studies by Vart *et al*. and Tao *et al*. support the association between lower socioeconomic status and extended recovery times due to higher stress and decreased overall well-being among these populations.[6,7]

Comorbidities and their effect on DRT

The high prevalence of HTN and T2DM among dialysis patients in the dataset is consistent with studies indicating these as major contributors to CKD progression.[8,9] Patients with diabetes, in particular, showed prolonged DRT due to complications from diabetic nephropathy and systemic inflammation. This aligns with research by Debnath *et al*., which found that patients with T2DM often report greater post-dialysis fatigue and slower recovery.[10] This finding is also supported by Aoun *et al*., who highlight that the metabolic and vascular complications of diabetes exacerbate CKD progression and lead to greater post-dialysis fatigue.[11]

Furthermore, effective management of HTN is crucial in CKD patients, as it significantly affects fluid management and cardiovascular health. A meta-analysis by Agarwal *et al*. indicates that poorly controlled HTN is associated with higher IDWG and fluid overload, factors that directly impact recovery time and quality of life.[12]

Dialysis access types and their relevance

The predominant use of AVF among patients is in line with guidelines from the National Kidney Foundation, which recommends AVF for stable dialysis due to its lower risk of infection and thrombosis.[13] Although this dataset did not show a significant impact of access type on DRT, studies suggest that patients using AVF have better long-term outcomes and fewer complications, which can indirectly improve their overall recovery experience.[14]

The frequency of dialysis also plays a critical role in DRT. While most of the patients in this dataset underwent dialysis thrice weekly, studies, including one by Jaber *et al*., show that increased frequency (daily or nocturnal dialysis) can help reduce IDWG and improve recovery times, especially in patients with fluid management challenges.[15]

Fluid management and DRT

IDWG and ultrafiltration

IDWG correlated positively with DRT in this dataset, indicating that patients with significant fluid retention experience more pronounced post-dialysis fatigue. This is consistent with findings from Alvarez *et al*., who reported that higher IDWG often necessitates aggressive ultrafiltration during dialysis, which increases cardiovascular strain and leads to longer recovery times.[16]

Ultrafiltration volume

Higher ultrafiltration rates were associated with prolonged DRT, supporting research by Bossola *et al*., which linked aggressive fluid removal to increased symptoms of fatigue, hypotension, and longer recovery times post-dialysis.[17] Patients undergoing higher ultrafiltration are at greater risk of intradialytic hypotension and cramps, which directly impact their physical recovery.[18]

Nutritional and hematological factors

Albumin levels

Albumin, a marker of nutritional status, correlated with DRT in this study, with lower albumin associated with prolonged recovery. Low albumin levels, indicative of protein–energy wasting (PEW), are common in dialysis patients and linked to increased morbidity and mortality.[19] A study by Kalantar-Zadeh *et al*. further demonstrates that poor nutritional status in dialysis patients can exacerbate fatigue and reduce physical resilience, thus extending DRT.[20]

Hb and anemia

Anemia, often due to reduced erythropoietin production in CKD, was associated with prolonged DRT in this dataset. Anemia leads to decreased oxygen delivery to tissues, causing fatigue and impaired physical function, which aligns with findings from Daugirdas *et al.* that anemia management significantly improves recovery time and quality of life.[21] Erythropoiesis-stimulating agents (ESAs) and iron supplementation are standard treatments to improve Hb levels and alleviate fatigue among CKD patients, thus reducing DRT.[22,23]

Implications for clinical practice

Nutritional support

Given the association between albumin levels and DRT, dietary interventions to improve protein intake and nutritional status are crucial. This is supported by research from Kaysen *et al*., which emphasizes that individualized nutritional support can help alleviate PEW and improve DRT.[24]

Anemia management

Addressing low Hb levels with ESAs and iron supplements is beneficial. Studies, including that by Gandra *et al*., show that anemia treatment reduces fatigue and enhances recovery. Routine anemia management could be prioritized to minimize DRT in dialysis patients.[25]

Fluid management strategies

Individualizing ultrafiltration targets and reducing IDWG are essential strategies. According to Agarwal *et al*., maintaining an optimal fluid balance can mitigate post-dialysis symptoms and decrease DRT, especially for patients who struggle with fluid management.[26]

Future research directions

Future studies could further explore the impact of increased dialysis frequency or duration for patients with significant fluid retention and examine the effects of specific nutritional and anemia management interventions on DRT in diverse populations.

CONCLUSION

The findings underscore that demographic, clinical, and treatment factors such as employment status, T2DM, anemia, albumin levels, and fluid management significantly influence DRTs. Individualized patient care that includes nutritional support, fluid balance optimization, and anemia management can enhance patient outcomes by shortening DRT. Further studies are encouraged to confirm these findings and develop guidelines for improving the post-dialysis experience.

Ethical approval: The research/study was approved by the Institutional Review Board at Wockhardt Hospitals, number ECR/624/Inst/MH/2014/RR-17, dated January 2024.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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