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Clinical and Dialysis-Related Determinants of Post-Dialysis Recovery Time in Patients Receiving Maintenance Haemodialysis: A Cross-Sectional Analysis

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ABSTRACT

Background: Maintenance Haemodialysis (MHD) supports the survival of ESRD patients. It is commonly associated with high Post-Dialysis Recovery Time (PDRT), which is the outcome of physical and psychological stress experienced by the patients post dialysis. Increased PDRT impacts the functional capacity, quality of life, and the patient's clinical performance. The study aimed to analyse the predictors of increased PDRT in MHD patients.

Methods: The study was a cross-sectional observational study conducted among 120 adult ESRD patients undergoing haemodialysis treatment for at least 90 days at a tertiary care hospital. The variables included demographic, clinical, dialysis related, biochemical, nutrition, and quality of life variables. PDRT was evaluated using a standardized patient interview. Data analysis was done using descriptive, non-parametric, correlation analysis, and multiple linear regression tests.

Results: Total 120 patients undergoing maintenance haemodialysis treatment, 58.3% were male and had an average age of 47 years. The recovery from haemodialysis occurred in most patients after more than 240 minutes post-dialysis. The recovery from haemodialysis was significantly related to age (r=-0.186, p=0.011), missed dialysis (r=0.258, p<0.001), ultrafiltration rate.

Conclusion: The study concluded that the prolonged dialysis recovery time was related with the poor nutritional status, inadequate dialysis parameters, and reduced quality of life.

Key-words: Maintenance hemodialysis, End-stage renal disease, Post-dialysis recovery time, Dialysis-related factors, Quality of life

INTRODUCTION

Maintenance haemodialysis (MHD) is a critical life-saving procedure for patients suffering from ESRD in India. However, it has a number of negative consequences in their everyday lives [1,2]. Though it effectively tackles biochemical imbalances and fluid overload, this procedure results in acute physiological stress caused by quick and unstable changes in hemodynamic state, inflammation, and distortion of electrolytes [1-3]. Therefore, it cannot be said that survival is the only indicator of treatment effectiveness in Indian nephrology [1,2]. Moreover, recent research carried out in this part of the world is focused on PROs and functional status as an assessment tool for treatment effectiveness, which confirms that health-related quality of life is low from the perspective of both physical and psychological background [2]. This new trend shows that it is necessary to measure patients' symptom burden along with their traditional long-term survival indicators [1,2].

PDRT) is measured by asking a single standardized question and acts as an effective and precise patient-reported measure that shows the relationship between stressors experienced during the hemodialysis process and the related fatigue and cognitive impairment [4]. The

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duration of post-dialysis recovery time depends on the factors that can be controlled, such as amount of potassium in dialysate and post-dialysis hypotension [3]. Importantly, observational studies show a connection between prolonged post-dialysis recovery time and the risk of hospitalization and death [4]. Thus, the measurement of post-dialysis recovery time contributes to better evaluation of patient satisfaction, in comparison to traditional measurement of adequacy [3,4].

Long-lasting PDRT is indicative of acute post-dialysis fatigue, which is associated with a more acute and high-risk clinical profile in Indian hemodialysis settings [5]. The effects of this psychological and physical strain are multiplied by local socioeconomic conditions, particularly with self-paying patients. Ultimately, the burden of prolonged PDRT limits physical activity separates people from consistent work activities,

Recovery period following dialysis is subject to several clinical and patient-related factors. Even though the above-mentioned aspects allow hypothesizing about factors affecting recovery period, it is necessary to state that there is lack of evidence for such assessments in context of India. According to findings of cohort research conducted among patients in South India, certain conditions such as older age, longer dialysis duration, diabetes disease and cardiovascular diseases lead to high frequency of intradialytic hypertension and necessary hospitalization [6]. At the same time, it should be noted that intradialytic hypotension is proved to be associated with high rates of the ultrafiltration process and considerable inter-dialysis weight gain level based on cross-sectional studies [7]. There are such significant gaps in data as absence of standardized patient-reported outcomes, poor longitudinal studies designed to account for both age and vintage factors in post-dialysis fatigue, and inconsistency in measuring the effect of the dialysate and prescription adjustment on fatigue [6,7].

Evidence indicates that high ultrafiltration rates, high weight gain, unadjusted session length, low mineral concentration of dialysate, and a poor thermal management lead to a longer recovery time [8]. However, the application of these factors in Indian conditions, characterized by a lack of resources, water quality, and dialysate composition, is not clear [8]. Although cooling the dialysate is proven to increase intradialytic hemodynamic stability and decrease the patients' fatigue after undergoing dialysis, Indian dialysis units tend to be significantly different in the temperature management systems and monitoring processes used and therefore can hardly use the techniques implied in the international practice [9-11]. The objective of this cross-sectional study is to find out the independent clinical and dialysis related factors that affect the prolonged post-dialysis recovery period in patients undergoing maintenance hemodialysis.

MATERIALS AND METHODS

Research design- The study was a cross-sectional observational study for the clinical dialysis associated determinants for the Post-Dialysis Recovery Time among patients those who were received with the Hemodialysis. The study was conducted in the tertiary care hospital for a period of 1 year. The total patients were 120 those who had underwent with the regular long-term hemodialysis, at least 3 sessions per week, which last for 4 hours for more than 90 days were included in the study. Demographic and clinical data were collected and all of the patients were investigated with the study outcomes. Ethical approval was taken from the Institutional Ethics Committee for the study. Verbal and written consent were taken for the study.

Inclusion criteria

- ✓ All patients age of 18 year were included.
- ✓ Those who were diagnosed with the end-stage renal disease (ESRD) were included
- ✓ Patients those who were received with the regular long-term hemodialysis were included in the study.
- ✓ All written informed consent were taken for the study.

Exclusion criteria

- ✓ Patients with hearing or visual/reading impairments along with dementia or impaired cognitive function were excluded
- ✓ Clinically unstable conditions were not allowed.
- ✓ Patients with liver failure or active malignancy were excluded.

Procedure- Totally 120 ESRD patients on maintenance haemodialysis were included in this cross-sectional study. All eligible participants were thoroughly interviewed for their demographic data, cause of ESRD, comorbidities, duration of haemodialysis, and type of

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vascular access. Physical examination included measurement of pre and post dialysis blood pressure, body temperature, interdialytic weight gain and body mass index (BMI). Dialysis specific variables, such as modality of dialysis, type of dialyzer, blood flow, ultrafiltration rates, dialysate sodium concentration, dialysis temperature, anticoagulant use, dialysis adequacy (Kt/V), duration of one session and number of skipped dialysis sessions per month were recorded. Time of recovery from dialysis (DRT) was estimated based on the interview of patients about the time of recovery from each hemodialysis procedure expressed in minutes based on the predefined protocol. Nutritional status was assessed by using Malnutrition-Inflammation Score (MIS) that included nutritional history, physical examination, body mass index, serum albumin and total iron-binding capacity. Quality of life was measured using KDQOL-36 validated questionnaires. Furthermore, samples of blood before and after haemodialysis were collected for analysis of haemoglobin, electrolytes, creatinine, urea, phosphorus, calcium, PTH, albumin, C-reactive protein and total iron-binding capacity.

Statistical Analysis- Statistical analysis was conducted by the IBM SPSS Statistics 27.0 (IBM Corp., Armonk, NY, USA). Qualitative parameters were presented in the form of frequencies and percentages, whereas quantitative parameters were represented as mean ± SD or median. The normal distribution was analysed with the help of the Kolmogorov-Smirnov test. Group comparisons were conducted with the Mann-Whitney U test for two groups, and with the Kruskal-Wallis test for more than two groups. The association between the continuous parameters were tested using Spearman's rank correlation coefficient. The univariate and multivariate linear regression analyses were conducted to determine factors predicting dialysis recovery period. $p<0.05$ was considered for statistical significance.

RESULTS

Table 1 showed the distribution of parameters of 120 patients who were on maintenance haemodialysis, with median age and dialysis vintage of 47 years and 5 years, respectively. Most patients (58.3%) were males. Hypertension (55.8%), HCV (19.2%), and diabetes (13.3%) were among the major co-morbidities observed. Haemodialysis was the major type of treatment method used, accounting for 95.0%. The most frequent vascular access was AV fistula (86.7%). Patients underwent haemodialysis of 4 hours per sitting with median blood flow rate and Kt/V of 300 mL/min and 1.32, respectively. Inflammatory markers showed the presence of anaemia (mean haemoglobin 9.83 g/dL), high phosphorus level (5.64 mg/dL), and inflammation (median CRP 9.0 mg/L).

Table 1: Distribution of patients with clinical features and dialysis related parameters

Parameter	Overall (N = 120) No. (%) / Mean ± SD / Median (Min–Max)
Age (years)	47.0 (18.0–80.0)
Sex	
Male	70 (58.3%)
Female	50 (41.7%)
Vintage of HD (years)	5.0 (0.25–31.0)
Smokers	23 (19.2%)
Mean Arterial Pressure (MAP) (mmHg)	
Pre-session	98.30 (50.0–153.0)
Post-session	93.0 (37.0–163.0)
Main Comorbidities	
Hypertension	67 (55.8%)
Hepatitis C Virus (HCV)	23 (19.2%)
Diabetes Mellitus (DM)	16 (13.3%)
Ischemic Heart Disease (IHD)	13 (10.8%)

Chronic Obstructive Pulmonary Disease (COPD)	8 (6.7%)
Heart Failure (HF)	5 (4.2%)
Dialysis Modality	
Haemodialysis (HD)	114 (95.0%)
Haemodia filtration (HDF)	6 (5.0%)
HD Schedule	
Morning	62 (51.7%)
Afternoon	49 (40.8%)
Evening	9 (7.5%)
Vascular Access	
AV Fistula	104 (86.7%)
Cuffed Catheter	15 (12.5%)
Graft	1 (0.8%)
HD Prescription	
High-flux Dialyzer	119 (99.2%)
Dialyzer Surface Area (m^2)	1.80 (1.70–2.20)
Blood Flow Rate (mL/min)	300.0 (220.0–450.0)
Session Duration (hours)	4.0 (3.0–5.0)
Ultrafiltration (UF) Volume (mL/session)	3000.0 (0.0–6500.0)
Ultrafiltration Rate (mL/hr)	750.0 (0.0–1625.0)
Dialysate Temperature (°C)	36.50 (35.0–37.20)
Dialysate Sodium (mmol/L)	140.0 (130.0–143.0)
Dialysate Flow (mL/hr)	650.0 (400.0–800.0)
Kt/V (Daugirdas)	1.32 (0.42–2.14)
Serum Potassium (mEq/L)	5.40 (2.30–7.80)
Serum Sodium (mEq/L)	133.0 (121.0–141.0)
Total Iron Binding Capacity (TIBC) (mcg/dL)	230.0 (91.0–481.0)
Haemoglobin (g/dL)	9.83 ± 1.57
Serum Albumin (g/dL)	3.90 (2.40–5.0)
Serum Calcium (mg/dL)	9.0 (6.0–12.10)
Serum Phosphorus (mg/dL)	5.64 ± 1.46
Serum Parathyroid Hormone (PTH) (pg/mL)	355.0 (1.20–3850.0)
C-Reactive Protein (CRP) (mg/L)	9.0 (1.0–208.70)

Table 2 showed the correlation between dialysis recovery time and different clinical parameters. Significant negative correlations were noted with age ($r = -0.186$, $p = 0.011$), dialyzer surface area ($r = -0.171$, $p = 0.019$), ultrafiltration volume ($r = -0.174$, $p = 0.016$), ultrafiltration rate ($r = -0.187$, $p = 0.010$), dialysate sodium ($r = -0.205$, $p = 0.004$), mean arterial pressure after dialysis ($r = -0.188$, $p = 0.009$), serum phosphorus ($r = -0.171$, $p = 0.018$), and serum albumin ($r = -0.150$, $p = 0.041$). Significant positive correlations were found for missed dialysis ($r = 0.258$, $p < 0.001$) and Malnutrition-Inflammation Score ($r = 0.233$, $p = 0.001$) which showed positive correlations. The KDQOL-36 domains showed negative correlations, which revealed the prolonged time for recovery related with poor quality of life.

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Table 2: Correlation Analysis between Dialysis Recovery Time and Clinical, Dialysis, Laboratory, Nutritional, and Health-Related Quality of Life Parameters

Variable	r	p-value
Age (years)	-0.186	0.011
HD Vintage (years)	0.098	0.176
Frequency of HD (per week)	-0.076	0.294
Missed sessions (per month)	0.258	<0.001
Dialyzer surface area (m^2)	-0.171	0.019
Blood flow rate (mL/min)	0.038	0.603
Duration per session (hours)	-0.031	0.673
Ultrafiltration volume (mL)	-0.174	0.016
Ultrafiltration rate (mL/hr)	-0.187	0.01
Dialysate temperature (°C)	-0.052	0.475
Dialysate sodium (mmol/L)	-0.205	0.004
Dialysate flow (mL/hr)	0.224	0.002
Kt/V (Daugirdas)	0.116	0.108
URR	0.124	0.086
MAP (mmHg)		
Pre-dialysis	-0.055	0.451
Post-dialysis	-0.188	0.009
Change in MAP	-0.149	0.039
Hemoglobin (g/dL)	0.022	0.764
Serum Potassium (mEq/L)	-0.089	0.221
Serum Sodium (mEq/L)	-0.041	0.578
Serum Creatinine (mg/dL)	0.018	0.806
TIBC (mcg/dL)	0.02	0.782
Serum Calcium (mg/dL)	0.04	0.586
Serum Phosphorus (mg/dL)	-0.171	0.018
CRP (mg/L)	-0.019	0.794
Serum Albumin (g/dL)	-0.15	0.041
Malnutrition-Inflammation Score (MIS)	0.233	0.001
Symptom/Problem List	-0.385	<0.001
Effects of Kidney Disease	-0.314	<0.001
Burden of Kidney Disease	-0.262	0.001
SF-12 Physical Composite	-0.225	0.002
SF-12 Mental Composite	-0.347	<0.001

Fig. 1 showed the distribution of DRT by various categories of recovery. The majority of patients had a recovery period of more than 240 minutes, which was frequent category of recovery. On the other hand, very few patients recovered within 30–60 minutes and about a fifth recovered within 30 minutes. The figure highlighted that recovery after dialysis had taken longer for many patients undergoing maintenance haemodialysis.

Fig. 2 shows the nutritional profile of the patients on maintenance haemodialysis therapy. The mean BMI was higher compared to the median MIS. This was an indication that the majority of the patients had maintained their body weights to be within the acceptable range regardless of the nutritional problems.

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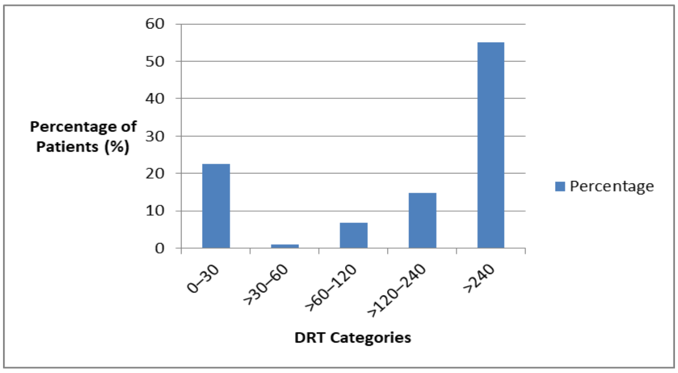

Fig. 1: Distribution of Post-Dialysis Recovery Time among Maintenance Haemodialysis

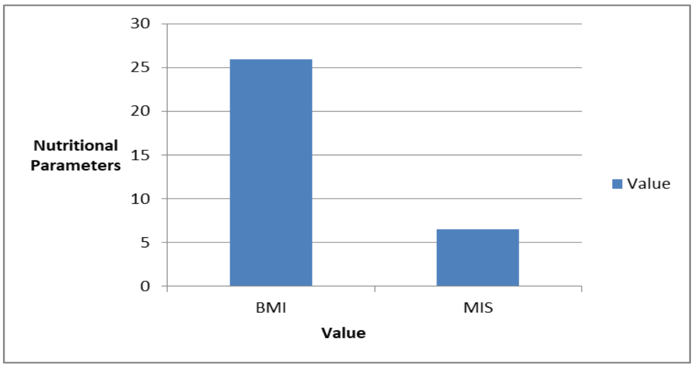

Fig. 2: Nutritional Characteristics of Maintenance Hemodialysis Patients

Fig. 3 represented the medians of the KDQOL-36 subscales of the maintenance haemodialysis population. The highest median value was noted in the Effects of Kidney Disease scale, which was followed by the Symptom/Problem List subscale, demonstrating relatively better control over the symptoms and perception of illness. The scale with the lowest median value was seen in the Burden of Kidney Disease scale, which demonstrated that there was a significant effect of dialysis on the individual's daily activities. Also the Physical Composite score of the SF-12 was lower than the SF-12 Mental Composite score.

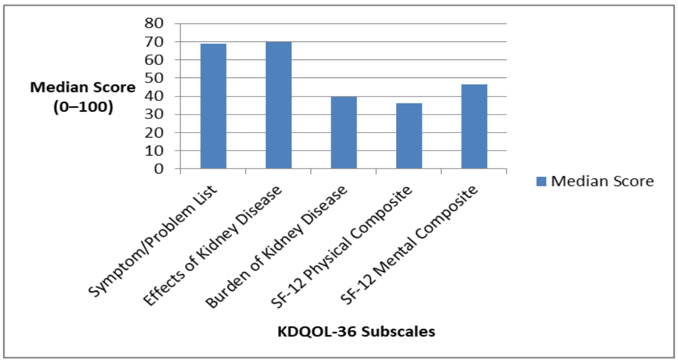

Fig. 3: KDQOL-36 Subscale Scores among Maintenance Haemodialysis Patients

DISCUSSION

A comprehensive cross-sectional study focusing on 2,689 patients in India indicated that many of them experienced greater than 12 hours of post-dialysis recovery time (DRT) [10]. Higher rates of ultrafiltration Data obtained from other countries where Indian centers were included highlighted that less sodium in the dialysate (<140 mEq/L) and greater fluid removal (>13 mL/kg/h) and higher rates of intradialytic hypotension were linked to longer DRT and were the only statistically significant variables related to DRT as well as being female, being malnourished, and having chronic illnesses [10].

facilitated delays in recovery [8]. It is noteworthy that prolonged DRT of greater than 12 hours placed patients in a high-risk category by increasing hospitalization by

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22% and mortality by 47% showing the importance of adjusting the factors related to dialysis prescriptions that could be controlled [8].

In an observational study conducted in Vijayapura, Karnataka, where 205 hemodialysis sessions were evaluated from 90 patients of chronic kidney disease, it was observed that 33.2% of sessions were complicated whereby intradialytic hypotension caused most of the episodes at 20.4%. There was also strong correlation between these hypotensive sessions with increased ultrafiltration rates (UFR), more ultrafiltration goals, and higher interdialytic weight gain [7]. Furthermore, retrospective data has proven that unscaled UFR works significantly and independently as an MHR. In other words, any unscaled UFR that is higher than 1,000 mL/h gives rise to MHR above 1.5, irrespective of weight of patients from the range of 80 kg to 140 kg, thus necessitating the clinical prospect of defining unscaled thresholds to properly appraise the risks in patients across various ranges of sizes [12].

Dialysate cooling to a temperature of 35.5–36.0°C is a guaranteed way to improve hemodynamic stability and speed up recovery after dialysis for subjects across different geographic areas of India [13,14]. A crossover study conducted with a sample of 25 subjects showed that the application of 35.5°C as a dialysate temperature lowered systolic and diastolic blood pressure variability at 4 hours of the research without a decrease of the urea clearance efficiency [13]. Likewise, a research study conducted with the sample of 50 subjects indicated that dialysate cooling is able to provide an increase of systolic blood pressure level and heart rate drop while relieving incidence of intradialytic symptoms and fatigue, as indicated by 76% of the subjects preferring dialysate cooling techniques [14].

A tertiary-care study involving 47 patients revealed that 44.7% presented with fatigue, 72.3% with depression, and 68.1% with suboptimal sleep hygiene and quality, signifying a strong association of symptoms influencing post-dialysis recovery. Fatigue intensity was shown to correlate with greater depression levels (P=0.006) and self-paying patients exhibited more significant depression symptoms (20.0±11.8 against 12.9±8.8) [5]. Another study with 310 patients confirmed high proportions of poor sleep (59.6%) and depression (44.8%); whereas female gender, older age, diabetes mellitus, and BMI above 30 were identified as significant predictors of the above. These factors confirm the influence of psychological and physical stresses on post-dialysis fatigue [5,15].

The optimization of modifiable, treatment-related factors is important for the development of clinical practice and reduction of recovery time after dialysis. Since lower levels of sodium in the dialysate correlate strongly with prolonged recovery, the prescription of more sodium individually or to a degree in excess of what is necessary may be thought out, taking into consideration cramps, thirst, and interdialytic weight gain [8,16]. Moreover, intensive weight loss during treatment, high volume of fluids removed, and longer periods of treatment have been associated with a prolonged recovery period so that the medical team has to develop realistic dry weight goals and achieve gradual changes in ultrafiltration parameters [8,16].

CONCLUSIONS

This study concluded that the prolonged DRT was highly correlated with clinical, dialysis, nutrition, and health-related quality of life indicators in patients on maintenance haemodialysis. The majority of the patients spend more than 240 minutes for their recovery after the haemodialysis session, which highlighted the post-haemodialysis recovery period, was quite prolonged. There were significant correlations between DRT and age, missed dialysis sessions, ultrafiltration indicators, dialysate sodium, post-haemodialysis mean arterial pressure, phosphorus level in the blood serum, serum albumin, and Malnutrition-Inflammation Score. The prolonged dialysis recovery time was associated with significantly decreased scores of KDQOL-36 subscales, which implied poor physical and psychological state as well as increased burden of the disease. The results of nutritional assessment showed that although the patients have rather high body mass index, the signs of malnutrition and inflammation were still present.

CONTRIBUTION OF AUTHORS

Research concept – Parashuram, Rajashree A.N, Rochustnu Tarun Satish T

Research design – Parashuram, Rajashree A.N, Rochustnu Tarun Satish T

Supervision – Parashuram

Materials – Parashuram, Rajashree A.N, Rochustnu Tarun Satish T

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Data collection – Rajashree AN, Rochustnu Tarun Satish T
Data analysis and interpretation – Parashuram, Rajashree A.N, Rochustnu Tarun Satish T
Literature search – Rajashree A.N, Rochustnu Tarun Satish T
Writing article – Rajashree A.N, Rochustnu Tarun Satish T
Critical review – Parashuram, Rajashree A.N
Article editing – Parashuram, Rajashree A.N, Rochustnu Tarun Satish T
Final approval – Parashuram, Rajashree A.N, Rochustnu Tarun Satish T

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