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Haematology International Journal
ISSN: 2578-501X

Variation in Hematocrit Levels among Chronic Kidney Disease Patients based on Dialysis Adherence

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Research Article
Volume 9 Issue 1
Received Date: December 27, 2024
Published Date: January 17, 2025
DOI: 10.23880/hij-16000266

Abstract

Background: Chronic kidney disease (CKD) is a major global health issue, often progressing to end-stage renal disease (ESRD), requiring dialysis. Anemia is a frequent complication of CKD, and hematocrit levels are used as an indicator of anemia severity. However, the effect of dialysis adherence on hematocrit levels has not been well explored.

Objective: To examine variations in hematocrit levels in CKD patients based on adherence to dialysis treatment.

Methods: This cross-sectional study included 120 CKD patients undergoing hemodialysis. Adherent patients attended at least 90% of prescribed dialysis sessions, while non-adherent patients attended less than 90%. Hematocrit levels were measured through routine blood tests taken within one week prior to participation. Demographic data and dialysis adherence information were gathered from patient records. Statistical analysis was performed using t-tests, Pearson's correlation, and multivariable linear regression to assess the relationship between dialysis adherence and hematocrit levels, controlling for confounders.

Results: Adherent patients had significantly higher hematocrit levels compared to non-adherent patients (mean = 34.5% vs. 30%, $p < 0.001$). A strong positive correlation was found between adherence and hematocrit levels ($r = 0.71$, $p < 0.001$). Multivariable analysis revealed dialysis adherence as an independent predictor of hematocrit levels ($\beta = 0.63$, $p < 0.001$) after adjusting for age, gender, BMI, and comorbidities.

Conclusion: This study highlights a significant relationship between dialysis adherence and hematocrit levels in CKD patients. Improving adherence to dialysis may help control anemia and enhance clinical outcomes in this population.

Keywords: Chronic Kidney Disease, Hemodialysis, Hematocrit, Dialysis Adherence, Anemia, CKD

Abbreviations

CKD: Chronic Kidney Disease; ESRD: End-Stage Renal Disease; BMI: Body Mass Index.

Introduction

Chronic Kidney Disease (CKD) has become an increasing problem that the world tries to deal with regarding overall health. Some studies estimate that about 10% of the world

population has CKD, and many of these people progress to end-stage renal disease (ESRD), requiring them to be put on dialysis [1]. Of all the modes of dialysis for patients with ESRD, hemodialysis happens to be the most frequent, and keeping to the required rules under which a dialysis regimen would be established ensures the provision of especially good health outcomes. Among the reasons cited in managing the CKD and ESRD patients is hematocrit, which represents the component of red blood cells in the blood volume. It is an important marker since most of their levels drop frequently in CKD patients, leading to the most common complication-poor quality of life and increased morbidity and mortality due to anemia [2].

Anemia in CKD is mainly due to a combination of suppressed production of erythropoietin hormones; iron deficiencies such as those caused by blood lose attributed to dialysis. It is well known that adequate dialysis can improve erythropoiesis as well as hematocrit levels among patients with CKD, but many people still have challenges when trying to adhere to prescribed schedules of dialysis treatments; it is correlated to adverse results such as worse anemia management, more hospitalizations, and maybe even increased mortality [3].

Among the different variables that help define the adherence to dialysis are socioeconomic barriers, psychological issues, and burden of treatment. An example would be non-adherence where a patient misses a scheduled session of dialysis due to a transportation challenge that leads the patient not to reach the scheduled session, a financial problem, or a patient's mental condition like depression [4]. There have been many studies which have shown that lack of adequate compliance with dialysis is related to health problems arising out of it; however, there is little published information about how the same has affected hematocrit levels in chronic kidney disease (CKD) patients.

This study aims to determine if there exists an association between dialysis adherence and hematocrit levels within a cohort of CKD patients undergoing hemodialysis. In doing so, we seek to shed more light on how such adherence influences the management of anemia in these patients and emphasize adherence as an important modifiable factor for improving patient outcomes.

Methods

The present study was cross-sectional and evaluated hematocrit levels in Chronic Kidney Disease (CKD) patients in terms of their dialysis treatment adherence. Institutional review board approval was obtained, and consent in writing was taken from every participant. One hundred twenty CKD patients receiving regular hemodialysis treatment were recruited for the study through a single dialysis center. The sample size was driven by effect size estimated and power analysis to find significant differences between the two groups, adherent and non-adherent. These criteria selected adults aged 18 years or older diagnosed with CKD Stage 5 who underwent maintenance hemodialysis at least thrice a week for at least three months. Any individual, who has undergone a kidney transplant, has active malignancy, is pregnant, or has other serious comorbidities that may affect their hematocrit levels (e.g., severe bleeding disorders, recent major surgeries) were excluded from the study. Patients were then dichotomized based on their adherence to dialysis into two groups: adherent (> 90% of prescribed dialysis sessions) and non-adherent (< 90% of prescribed dialysis sessions). Adherence to dialysis was estimated by reviewing the past three months' records of the patients.

Demographic and clinical characteristics were retrieved from patient records such as age, sex, comorbidities (hypertension, diabetes mellitus, and cardiovascular disease), and body mass index (BMI). Routine blood tests were performed to obtain the hematocrit levels during regular dialysis sessions for each patient. The hematocrits were recorded within a week before the patient started the study to ensure measurements reflected the present state of health.

Dialysis adherence was evaluated from the recorded percentage of prescribed dialysis sessions attended by each patient. The total number of sessions prescribed during the past 3 months was recorded and patients were considered adherent if they attended 90% of their scheduled sessions. On the other hand, members were classed as non-adherent if they missed more than 10% of their prescribed dialysis sessions. Whenever possible, reasons for missed sessions, such as issues with transportation, issues with money, and health-related problems, were noted.

The demographics and clinical characteristics of the study participants were summarized using descriptive statistics. Age, BMI, and hematocrit levels were continuous variables expressed as means and standard deviations, while frequencies and percentages were used to present categorical variables such as gender, comorbidities, and adherence status. Independent t-tests were used to compare continuous variables between adherent and non-adherent groups, while differences in categorical variables and adherence status were assessed using chi-square tests.

Pearson's correlation analysis was adopted to see how dialysis adherence relates with hematocrit levels. Multivariable linear regression analysis was used to control for other confounders like age, gender, BMI, and comorbidities such as hypertension, diabetes, cardiovascular

disease. P values < 0.05 were considered significant. All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY). This study followed ethical principles in the Declaration of Helsinki and ensured that all patient data were anonymized and treated confidentially. Patients were informed about the intent of the study before voluntary participation in the study. Any patient unwilling to participate hasn't suffered any penalty but continued to receive quality standard care.

Results

This study aimed to investigate the variation in hematocrit levels among Chronic Kidney Disease (CKD) patients based on their adherence to dialysis treatment. A total of 120 CKD patients were included in the analysis, with participants categorized into two groups based on their dialysis adherence: adherent (≥ 90% of prescribed dialysis sessions) and non-adherent (< 90% of prescribed dialysis sessions).

Participant Demographics and Baseline Characteristics

The demographic and baseline clinical characteristics of the study participants are summarized in Table 1. The average age of the participants was 58.3 ± 12.1 years. There were 60 adherent patients (50%) and 60 non-adherent patients (50%). The majority of participants were male (63%), with a mean body mass index (BMI) of 27.5 ± 4.3 kg/m^2. The distribution of comorbidities such as hypertension, diabetes mellitus, and cardiovascular disease was similar between the two groups.

Characteristic	Adherent (n = 60)	Non-Adherent (n = 60)	Total (n = 120)	p-value
Age (years)	57.8 ± 10.9	58.7 ± 13.3	58.3 ± 12.1	0.765
Gender (Male)	38 (63.3%)	38 (63.3%)	76 (63.3%)	1
BMI (kg/m^2)	26.9 ± 4.1	28.1 ± 4.5	27.5 ± 4.3	0.144
Hypertension	45 (75%)	48 (80%)	93 (77.5%)	0.655
Diabetes Mellitus	35 (58.3%)	38 (63.3%)	73 (60.8%)	0.598
Cardiovascular Disease	25 (41.7%)	27 (45%)	52 (43.3%)	0.733

Table 1: Demographic and Baseline Characteristics of Participants.

Hematocrit Levels Based on Dialysis Adherence

The primary outcome of this study was the variation in hematocrit levels between adherent and non-adherent patients. Hematocrit levels were significantly higher in the adherent group compared to the non-adherent group, with a mean hematocrit value of 34.5% ± 4.2% in the adherent group and 30.2% ± 5.6% in the non-adherent group (p < 0.001).

Group	Hematocrit (%)	p-value
Adherent (n = 60)	34.5 ± 4.2	< 0.001
Non-Adherent (n = 60)	30.2 ± 5.6	
Total (n = 120)	32.4 ± 5.1	

Table 2: Hematocrit Levels in CKD Patients Based on Dialysis Adherence.

Stratification by Dialysis Frequency

Further analysis revealed that within the adherent group, patients who adhered to 95-100% of their prescribed dialysis sessions had a significantly higher hematocrit level (mean = 35.8% ± 3.5%) compared to those who adhered to 90-94% of their sessions (mean = 32.3% ± 4.0%), suggesting a dose-dependent relationship between dialysis adherence and hematocrit levels. This trend was not observed in the non-adherent group, where hematocrit levels remained consistently low, irrespective of the frequency of dialysis attendance.

Adherence Group	Hematocrit (%)	p-value
95-100% Adherence (n = 40)	35.8 ± 3.5	< 0.001
90-94% Adherence (n = 20)	32.3 ± 4.0	
< 90% Adherence (n = 60)	30.2 ± 5.6	

Table 3: Stratification of Hematocrit Levels Based on Dialysis Adherence Frequency

Correlation between Hematocrit Levels and Dialysis Adherence

A Pearson correlation analysis was performed to assess the relationship between dialysis adherence and hematocrit levels. A significant positive correlation was found (r = 0.71, p < 0.001), suggesting that higher adherence to dialysis treatment was associated with increased hematocrit levels.

Variable	Correlation Coefficient (r)	p-value
Dialysis Adherence (%)	0.71	< 0.001
Hematocrit (%)		

Table 4: Correlation between Dialysis Adherence and Hematocrit Levels.

Multivariable Analysis

Multivariable regression analysis was conducted to adjust for potential confounders, including age, gender, BMI, hypertension, diabetes, and cardiovascular disease. Even after adjusting for these factors, dialysis adherence remained a significant predictor of hematocrit levels (β = 0.63, p < 0.001), further supporting the association between higher adherence to dialysis and improved hematocrit levels in CKD patients.

Variable	β (95% CI)	p-value
Dialysis Adherence (%)	0.63 (0.48, 0.78)	< 0.001
Age (years)	-0.12 (-0.18, -0.06)	0.001
Gender (Male)	0.45 (-0.21, 1.10)	0.182
BMI (kg/m^2)	0.08 (-0.02, 0.18)	0.11
Hypertension	0.25 (-0.01, 0.51)	0.06
Diabetes Mellitus	0.17 (-0.10, 0.43)	0.223
Cardiovascular Disease	-0.10 (-0.40, 0.20)	0.502

Table 5: Multivariable Regression Analysis of Factors Influencing Hematocrit Levels.

Discussion

The key aim of this research is to study variations of hematocrit level among Chronic Kidney Disease (CKD) patients based on their adherence to dialysis therapy. The results of this study further indicate that adherence to therapy is significantly related to hematocrit levels with adherents having higher hematocrit values than non-adherents. This finding holds true even after adjustment for the confounding factors of age, gender, body mass index, hypertension, diabetes and cardiovascular disease.

Adherence had a mean level of hematocrit of 34.5% which was significantly higher than the lowest level of 30.2% for non-adherence (p < 0.001). This is corroborated by recent studies mentioning the importance of adherence to dialysis in managing anemia among CKD patients. Higher dialysis adherence translated to better management of anemia because sufficient dialysis minimizes the use of erythropoiesis-stimulating agents (ESAs) [5]. A more recent publication provided information, with respect to the incident anemia, on how non-adherence translates to worse anemia control and greater reliance on pharmaceutical therapy and poor overall CKD outcomes in patients [6].

Counting the frequency of dialysis sessions stratified the population of adherent patients, which yielded a dose-dependent relationship between the level of adherence to dialysis and hematocrit levels. Those patients who adhere to 95-100% of their prescribed dialysis sessions had the highest mean hematocrit level (35.8%), while those who visited physiotherapy at 90-94% had a lower mean hematocrit (32.3%). This finding agrees with a more recent study by Tsai YC, et al. [7], which indicated that even minor reductions in dialysis frequency were associated with suboptimal hematocrit and anemia management in hemodialysis patients [3]. Therefore, it can be inferred from the dose-related association that strict adherence to dialysis prescriptions is key in maintaining optimal hematocrit and preventing anemia in CKD patients.

With a Pearson correlation analysis, dialysis adherence- and hematocrit showed a significant positive relationship (r=0.71, p<0.001). Such a strong correlation indicates that patients that observe high adherence to dialysis treatment are more likely to have good hematocrit levels, a very reliable reflection of anemia levels. This was further attested to by Kuczera P, et al. [8], who pointed out the favorable effects of adherence to dialysis on hematologic factors, especially hematocrit, in their cohort of hemodialysis patients [4].

Dialysis adherence continued to be an independent predictor of significance on hematocrit levels (β=0.63, p<0.001), controlling for confounding factors such as age, gender, and chronic diseases (hypertension, diabetes, and cardiovascular disease). This corresponds with the recent multivariable analyses by Vaziri ND, et al. [9], demonstrating that dialysis compliance was independently associated with better anemia management and increased hematocrit levels in CKD-dialysis patients [5]. Thus, these results imply that dialysis compliance has a strong, independent, and robust effect on hematocrit levels, independent of other clinical variables.

Non-adherence to dialysis treatment is a modifiable risk factor for poor anemia management, thus affecting worse general outcomes. Meantime, physicians are encouraged to educate patients, offer psychological support, and devise practical solutions such as assistance in transport and flexible scheduling of dialysis to improve adherence. Recent studies have found that better adherence improved hematocrit while reducing the need for ESA therapy and hospital admissions, thus enhancing the quality of life for CKD patients [10].

Conclusion

Adherence to the prescription of dialysis is demonstrated to associate with much better hematocrit levels with CKD patients. The more adherent patients had higher hematocrit values which were dependent on the frequency of the dialysis sessions. The study findings illustrate the importance of fostering high dialysis adherence and its benefits on the management of anemia and overall health among CKD

patients through clinical practice. Improvements in dialysis adherence should be targets for intervention, yielding optimized clinical outcomes and lower anemia burden for CKD patients.

Conflicts of Interest

There is no conflict of interest regarding this article.

Funding

There was no funding received for this study.

Data Availability

The data of the findings of this study are all shared on this article.

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