[Al-Azhar International Medical Journal](https://aimj.researchcommons.org/journal)

Volume 5 | Issue 8 Article 27

8-31-2024

Section: Internal Medicine

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How to Cite This Article

Mohamed, Emad Allam; El Sayed, Mohamed Ahmed; Rezk, Amr Ahmed; and Ali, Mahmoud Samy Abdelaal (2024) "Assessment of Hemodiafiltration Versus Haemodialysis on Anemia Profile Among Regular Haemodialysis Patients," *Al-Azhar International Medical Journal*: Vol. 5: Iss. 8, Article 27.
DOI: https://doi.org/10.58675/2682-339X.2603

ORIGINAL ARTICLE

Assessment of Hemodiafiltration Versus Haemodialysis on Anemia Profile Among Regular Haemodialysis Patients

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Abstract

Background: **Maintenance hemodialysis (HD) is a significant global treatment for end-stage renal disease patients.**
Aim: **To assess the role of hemodiafiltration versus hemodialysis on anemia profile among regular hemodialysis cases.**
Patients, and methods. **This cross-sectional observational research was performed on forty patients randomly separated into two groups: Group A: 20 patients on hemodialysis (HD) modality with hemoglobin < 10 gm/dl to be shifted to hemodiafiltration (HDF) and Group B: 20 patients on HDF modality at nephrology unit Bab El-Sharia, AL Azhar University Hospital.**
Results: **There was a significant increase in hemoglobin (Hb) and hematocrit (HCT) levels in Group B at the 6-month follow-up (p=0.039 and p=0.029, respectively). No significant variations were observed in other parameters, such as red blood cell (RBC) count, white blood cell (WBC) count, and platelet levels. No significant distinctions were found in serum iron, transferrin saturation (TSAT), serum ferritin, serum albumin, serum potassium (K), total iron-binding capacity (TIBC), alanine transaminase (Alt), and bilirubin at any time point. However, a notable increase in serum sodium (Na) was observed in Group B at the 3-month (p=0.045*) and 6-month (p=0.038*) follow-up.**
Conclusion: **Transitioning from HD to HDF didn't significantly impact the duration of the dialysis session. However, HDF showed superior efficacy in improving hematologic parameters, particularly hemoglobin and hematocrit levels, over a 6-month follow-up period. It also improved serum sodium levels, suggesting enhanced electrolyte balance. These findings suggest HDF may offer advantages in managing anemia and controlling electrolytes in hemodialysis patients with anemia.**

Keywords: HD, HDF, Anemia

1. Introduction

The incidence and prevalence of maintenance dialysis are on the rise on a global scale.[1]

World Health Organization data show that, by 2030, there will be an increase in renal replacement therapy (RRT) by up to 223%.[2,3]

One of the most prevalent RRT modalities utilized globally for cases with end-stage renal disease (ESRD) is maintenance hemodialysis (HD).[4,5]

HDF may provide significant benefits in the elimination of molecules of different sizes, reducing the risk of HD-associated amyloidosis, and preventing chronic inflammation.[6]

Observation studies were done comparing laboratory results using two groups of people. Significant increases were observed in the levels of Hgb and serum albumin in the group that underwent a switch from HD to HDF. [7]

Prior research indicates that HDF has been related to improved hemodynamic stability and survival in comparison with standard HD. [8,9]

The objective of this research was to compare the effects of hemodiafiltration and hemodialysis on the anemia profile of cases who undergo routine hemodialysis.

Accepted 21 August 2024.
Available online 31 August 2024

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https://doi.org/10.58675/2682-339X.2603

2. Patients and methods

This cross-sectional observational research was performed on forty cases randomly separated into two groups: Group A: 20 patients on hemodialysis (HD) modality with hemoglobin < 10 gm/dl to be shifted to hemodiafiltration (HDF) and Group B: 20 patients on HDF modality at nephrology unit Bab El-Sharia, AL Azhar University Hospital.

Inclusion Criteria: Patients on regular hemodialysis > 3 months, Hb level below 10 g/dl, Age> 18 years, and male and female.

Exclusion criteria: Bleeding of any reason, malignancy, hospitalization for any cause in the four weeks before the study was excluded, chronic inflammatory diseases, and malnutrition.

Ethical Consideration: All procedures conformed to the guidelines set forth by the ethical committee at Al-Azhar University, and written consent was obtained from all patients. The information collected from participants is strictly confidential. The identities of the study participants will not be disclosed in any report or publication associated with this research. The participants were provided with a comprehensive explanation of the study's objectives, characteristics, and risk-benefit analysis prior to their admission.

Method:

All patients were subjected to: Complete history, physical examinations, anthropometric measurements, lab investigations and erythropoietin and iron supplementations.

Systemic examination

General Appearance: Observing the patient's general appearance for signs of distress or discomfort. Noting their level of consciousness and any signs of fatigue or weakness.

Skin Examination: Signs of pallor, which may indicate anemia and bruising or hematoma formation at vascular access sites. Signs of infection, including redness, warmth, swelling, or drainage. Skin dryness or pruritus (itchiness), which can be common in hemodialysis patients

Head and Neck: Signs of jugular venous distension, which can indicate fluid overload. Edema in the face and neck. Signs of anemia, such as pale conjunctiva and mucous membranes. Enlarged thyroid gland or masses.

Cardiovascular Examination: Palpating and auscultate the precordium for any abnormal heart sounds. Assess for signs of fluid overload, such as peripheral edema, ascites, or jugular venous distension.

Respiratory Examination: Examining the chest for any signs of respiratory distress. Listen to lung sounds for crackles or wheezing, which may indicate fluid overload or pulmonary congestion.

Abdominal Examination: Palpating the abdomen for any tenderness or masses. Assess for signs of ascites, which can occur in patients with fluid overload.

Extremities: Signs of edema, particularly in the legs and feet, Bruising or infection at vascular access sites, and muscle weakness or atrophy.

Neurological Examination: Assess the patient's mental status and orientation. Evaluate cranial nerves, reflexes, and motor and sensory functions.

Vascular Access Site Examination: Carefully inspect the vascular access site (fistula, graft, or catheter) for Bruising, hematoma, or bleeding. Signs of infection, such as redness, swelling, or drainage. Thrill and bruit (for fistulas and grafts) to ensure adequate blood flow.

Musculoskeletal Examination: Check for joint pain or limited range of motion, which can be associated with conditions like renal osteodystrophy.

Neuropathy Assessment: Evaluate for signs of neuropathy, which can be common in long-term hemodialysis patients. Check for sensory deficits, particularly in the lower extremities.

Statistical Analysis

The statistical application for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA), was utilized to analyze the collected data. For parametric (normal) variables, quantitative data were expressed as mean±standard deviation and ranges. Conversely, for non-parametric information, non-normally distributed variables were represented by the median and interquartile range (IQR). Furthermore, qualitative variables were delineated in percentage form. The normality of the data was examined using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The following experiments were conducted: When comparing two means, a t-test for significance on independent samples was utilized. The Mann-Whitney Company U test is used to compare two groups using non-parametric data. The chi-square test was applied to compare qualitative data across groups. The accepted margin of error was five percent, and the confidence interval was established at ninety-five patients. The p-value was deemed significant in the following manner: Value of probability (P): A P-value less than 0.05 was deemed to be statistically significant. A P value less than 0.01 was deemed to be of exceptional significance. A P-value greater than 0.05 was deemed to be insignificant.

3. Results

There were no significant differences in gender distribution (X2=0.107, P=0.774). The mean age, height, weight, and BMI show no significant variations between the groups. Kidney disease prevalence also demonstrated no significant difference (X2=1.450, P=0.694) (Table 1).

Table 1. Comparison of Demographic between Groups A and B.

		GROUP A (N=20)		GROUP B (N=20)		TEST VALUE	P-VALUE
		N	%	N	%		
GENDER	Male	13	65.0%	12	62.5%	X^2=0.107	0.774
	Female	7	35.0%	8	37.5%		
AGE	Mean ±SD	61.3 ± 11.8		62.1 ± 13.5		T=0.529	0.621
	Range	45 - 75		48 – 78			
HEIGHT	Mean ±SD	173.6±17.2		169.6±18.9		T=0.677	0.502
	Range	158 - 185		156 - 182			
WEIGHT	Mean ±SD	65.7 ± 7.54		69.2 ± 10.07		T=1.262	0.215
	Range	55 - 84		56 – 82			
BMI	Mean ±SD	22.4 ± 2.98		24.1 ± 4.85		T=0.771	0.446
	Range	18 - 29		19 – 34			
KIDNEY DISEASE	Bolysistic kidney	1	5.0%	0	0%	X^2=1.450	0.694
	High chronic	9	45.0%	10	50.0%		
	Chronic diabetic	7	35.0%	8	40.0%		
	Analgesic abuse	3	15.0%	2	10.0%		

Using: t-Independent Sample t-test for Mean±SD; X2= Chi- Square test, when appropriate p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.01 is highly significant

In comparing Group A and Group B for the duration of dialysis, the mean durations were 5.3 ± 1.5 and 5.6 ± 1.8, respectively. The t-test for independent samples reveals a test value of 0.227 with a corresponding p-value of 0.538. As the p-value exceeds 0.05, the difference in the duration of dialysis among the two groups was considered insignificant (Table 2).

Table 2. Comparison of Duration of Dialysis between Groups A and B.

		GROUP A (N=20)	GROUP B (N=20)	TEST VALUE	P-VALUE
DURATION OF DIALYSIS	Mean ±SD	5.3 ± 1.5	5.6 ± 1.8	0.227	0.538
	Range	3 - 7	3 - 8		

There was a significant increase in hemoglobin (Hb) and hematocrit (HCT) levels in Group B at the 6-month follow-up (p=0.039 & p=0.029, respectively). No significant variations were observed in other parameters, such as red blood cell (RBC) count, white blood cell (WBC) count, & platelet levels (Table 3)

Table 3. Comparison of Hematological test between Groups A and B.

		GROUP A (N=20)	GROUP B (N=20)	TEST VALUE	P-VALUE
		BASELINE			
HB	Mean ±SD	8.70 ± 0.12	8.81 ± 0.21	0.400	0.692
	Range	8.6 – 8.8	8.6 – 8.9		
HCT	Mean ±SD	35 ± 1.4	34 ± 1.6	0.312	0.757
	Range	33 - 36	32 - 36		
RBC	Mean ±SD	4.2 ± 0.2	4.3 ± 0.1	0.318	0.753
	Range	4 – 4.4	4.1 – 4.4		
WBC	Mean ±SD	6.78 ± 1.87	6.19 ± 1.90	0.840	0.657
	Range	5.3 – 7.8	5.2 – 7.6		
PLATELETS	Mean ±SD	177.8 ± 45.5	176.9 ± 58.4	0.419	0.677
	Range	120 - 210	120 - 220		
		FOLLOW UP AFTER 3 MONTH			
HB	Mean ±SD	8.71 ± 0.22	8.84 ± 0.15	0.398	0.543
	Range	8.4 – 9.0	8.8 – 9.2		
HCT	Mean ±SD	36 ± 1.5	35 ± 1.8	0.296	0.769
	Range	34 - 37	33 - 38		
RBC	Mean ±SD	4.1 ± 0.25	4.2 ± 0.1	0.571	0.572
	Range	3.9 – 4.4	4.0 – 4.5		
WBC	Mean ±SD	6.80 ± 2.31	6.32 ± 1.90	0.226	0.823
	Range	5.3 – 7.7	5.4 – 7.8		
PLATELETS	Mean ±SD	182.6 ± 48.2	181.7 ± 56.4	0.453	0.653
	Range	130 - 210	135 - 230		
		FOLLOW UP AFTER 6 MONTHS			
HB	Mean ±SD	8.70 ± 0.21	9.06 ± 0.18	2.134	0.039*
	Range	8.5 – 8.9	8.8 – 9.2		
HCT	Mean ±SD	35 ± 1.5	37 ± 2.1	2.264	0.029*
	Range	34 - 37	34 - 39		
RBC	Mean ±SD	4.2 ± 0.21	4.3 ± 0.1	0.908	0.370
	Range	3.9 – 4.4	4.1 – 4.4		
WBC	Mean ±SD	6.77 ± 1.34	6.68 ± 1.90	1.793	0.081
	Range	5.3 – 7.8	5.2 – 7.6		
PLATELETS	Mean ±SD	180.8 ± 48.6	184.9 ± 52.6	0.203	0.841
	Range	120 - 220	130 - 230		

when appropriate p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.01 is highly significant

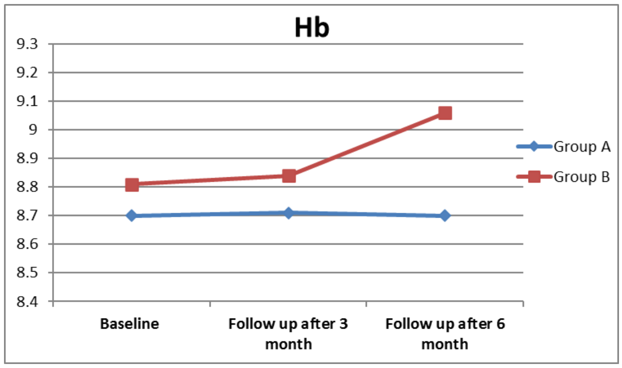

Figure 1. Comparison of Hb between Groups A and B.

No significant distinctions were discovered in serum iron, transferrin saturation (TSAT), serum ferritin, serum albumin, serum potassium (K), total iron-binding capacity (TIBC), alanine transaminase (Alt), and bilirubin at any time point. However, a notable increase in serum sodium (Na) was observed in Group B at the 3-month ($p=0.045^*$) & 6-month ($p=0.038^*$) follow-ups. Other parameters show consistent values between the groups across the observation period (Table 4)

Table 4. Comparison of Serum Parameters between Groups A and B.

		GROUP A (N=20)	GROUP B (N=20)	TEST VALUE	P-VALUE
BASELINE					
SERUM IRON	Mean ±SD	193.8 ± 20.34	184.6 ± 19.67	0.451	0.675
	Range	150 – 215	140 – 220		
TSAT	Mean ±SD	20.6 ± 5.2	22.1 ± 4.8	0.521	0.630
	Range	9 - 45	8 - 47		
SERUM FERRITIN	Mean ±SD	574.1 ± 51.1	552.6 ± 48.0	0.498	0.644
	Range	240 - 650	250 - 650		
SERUM NA	Mean ±SD	115 ± 3.12	119 ± 3.68	1.379	0.240
	Range	108 - 136	110 - 133		
SERUM ALBUMIN	Mean ±SD	4.12 ± 0.28	3.98 ± 0.23	1.322	0.257
	Range	3 - 5	3 – 5		
SERUM K	Mean ±SD	4.9 ±0.13	4.8 ±0.21	0.426	0.692
	Range	4.6 – 5.3	4.7 – 5.3		
TIBC	Mean ±SD	284.4±43.41	310.6±42.6	0.858	0.439
	Range	240 - 400	260 – 400		
ALT	Mean ±SD	15.4±5.64	16.07±6.83	0.314	0.769
	Range	11 - 20	10 - 20		
BILIRUBIN	Mean ±SD	0.4±0.09	0.5±0.1	1.287	0.267
	Range	0.1 – 1.1	0.1 – 1.2		
FOLLOW UP AFTER 3 MONTHS					
SERUM IRON	Mean ±SD	193.5 ± 25.16	186.3 ± 20.0	0.448	0.689
	Range	250 - 350	250 - 345		
TSAT	Mean ±SD	20.6 ± 5.1	22.56 ± 4.23	0.521	0.630
	Range	11 - 45	12 - 47		
SERUM FERRITIN	Mean ±SD	574.3 ± 49.6	554.6 ± 44.3	0.498	0.644
	Range	250 - 590	250 - 670		
SERUM NA	Mean ±SD	115.6 ± 3.05	120.5 ± 4.36	2.279	0.045*
	Range	112 – 140	115 - 142		
SERUM ALBUMIN	Mean ±SD	4.13 ± 0.23	4.02 ± 0.26	0.727	0.507
	Range	3 – 5	3 – 5		
SERUM K	Mean ±SD	4.82 ±0.07	5.02 ±0.42	0.781	0.478
	Range	4.6 – 5.3	4.7 – 5.2		
TIBC	Mean ±SD	284.6±35.0	310.8±40.51	0.826	0.455
	Range	240 – 400	260 – 390		
ALT	Mean ±SD	20.83±1.85	17.26±4.65	1.234	0.285
	Range	12 - 20	11 - 21		
BILIRUBIN	Mean ±SD	0.43±0.06	0.56±0.10	1.929	0.126
	Range	0.1 – 1.1	0.1 – 1.2		
FOLLOW UP AFTER 6 MONTHS					
SERUM IRON	Mean ±SD	193.7 ± 25.34	186.27 ± 20.0	0.510	0.624
	Range	251 - 342	250 - 340		
TSAT	Mean ±SD	20.6 ± 5.1	22.5 ± 4.22	0.521	0.630
	Range	9 - 35	8 - 30		
SERUM FERRITIN	Mean ±SD	573.1 ± 50.3	554.86 ± 43.1	0.498	0.644
	Range	250 - 430	250 – 420		
SERUM NA	Mean ±SD	116.7 ± 7.50	122.3 ± 2.1	3.048	0.038*
	Range	108 - 136	110 - 133		
SERUM ALBUMIN	Mean ±SD	4.11 ± 0.21	4.08 ± 0.30	0.581	0.592
	Range	3 - 5	3 – 5		
SERUM K	Mean ±SD	4.9 ±0.18	5.21 ±0.30	0.020	0.985
	Range	4.4 – 5.5	4.5 – 5.2		
TIBC	Mean ±SD	283.7±38.01	311.8±40.3	0.821	0.446
	Range	243 - 391	265 – 410		
ALT	Mean ±SD	15.8±5.89	18.5±3.0	0.960	0.391
	Range	10- 21	10 - 22		
BILIRUBIN	Mean ±SD	0.41±0.09	0.58±0.12	1.851	0.154

Range	0.1 – 1.1	0.1 – 1.3

Using: U=Mann-Whitney test for non-parametric data "Median (IQR)"

4. Discussion

Our research revealed that there were no significant differences in gender distribution (X2=0.107, P=0.774). The mean Age, height, weight, and BMI show no significant variations between the groups. Kidney disease prevalence also demonstrated no significant difference (X2=1.450, P=0.694)

In the same line, research done by Locatelli et al.[10] discovered that the distribution of patients undergoing different modalities of renal replacement therapy, specifically hemodialysis (HD) and hemodiafiltration (HDF), revealed no significant variances among the two groups in terms of gender distribution and Age.

In comparing Group A and Group B for the duration of dialysis, the mean durations were 5.3 ± 1.5 and 5.6 ± 1.8, respectively. The t-test for independent samples reveals a test value of 0.227 with a corresponding p-value of 0.538. As the p-value exceeds 0.05, the difference in the duration of dialysis among the two groups was considered insignificant.

This aligns with the general understanding from a study done by Locatelli et al.[10], which also suggests that while HDF may offer some benefits over HD, particularly in terms of clearance of larger middle molecules potentially impacting patient outcomes, the basic procedural time does not significantly change. For example, the Dialysis Outcomes and Practice Patterns Study (DOPPS) did not find a definitive advantage of HDF over HD in terms of patient survival.

There was a significant increase in hemoglobin (Hb) and hematocrit (HCT) levels in Group B at the 6-month follow-up (p=0.039 and p=0.029, respectively). No significant variations were observed in other parameters, such as red blood cell (RBC) count, white blood cell (WBC) count, and platelet levels.

Consistent with current study results, Vaslaki et al.[11] investigated the efficacy and comparative outcomes of online hemodiafiltration (oHDF) versus traditional hemodialysis (HD) in 70 patients over a two × 24-week period. Patients were treated in a cross-over design, starting with either HD or oHDF and switching to the other modality. Demonstrated advantages in terms of higher hematocrit levels and lower erythropoietin doses, indicating potential benefits for managing anemia.

No significant variations were found in serum iron, transferrin saturation (TSAT), serum ferritin, serum albumin, serum potassium (K), total iron-binding capacity, alanine transaminase (Alt), and bilirubin at any time point. However, a notable increase in serum sodium (Na) was observed in Group B at the 3-month (p=0.045*) and 6-month (p=0.038*) follow-ups. Other parameters show consistent values between the groups across the observation period.

This aligns with Locatelli et al.[10] and the broader literature, which suggests that while HDF might offer some advantages in specific areas, such as potentially improved cardiovascular outcomes and reduced inflammatory markers, it may not dramatically differ from HD in all biochemical parameters.

In contrast with current study results, Vilar et al.[12] presented an analysis of anemia and erythropoietin treatment parameters in cases predominantly treated with high-flux hemodialysis (HD) and hemodiafiltration (HDF) over a period of 60 months. When comparing hemoglobin levels among HD and HDF, no significant variation was observed at the 3-month and 6-month marks ($p > 0.05$). However, at 12 months and beyond, HDF patients showed a statistically significant higher hemoglobin level compared to HD cases ($p < 0.05$), indicating better management of anemia over time with HDF.

The contrasting results between the current study and Vilar et al.[12] regarding the management of anemia could be attributed to several factors. Firstly, differences in study design, including sample size, patient population characteristics, and follow-up duration, may contribute to disparate findings.

4. Conclusion

The study found that transitioning from hemodialysis to hemodiafiltration (HDF) did not significantly impact the duration of dialysis sessions. However, HDF showed superior efficacy in improving hematologic parameters, particularly hemoglobin and hematocrit levels, over a 6-month follow-up period. It also improved serum sodium levels, suggesting enhanced electrolyte balance. These findings suggest HDF may offer advantages in managing anemia and controlling electrolytes in hemodialysis patients with anemia.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

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