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IMPACT OF HEMODIAFILTRATION ON ANEMIA IN CHRONIC KIDNEY DISEASE (CKD) IRAQI PATIENTS, SINGLE CENTER STUDY

Mohammed Ali Mohammed Rashid[1], Talib Atia Alzaidy[1]
[1] F.I.C.M.S, Medical City, Baghdad, Iraq. dr.mam21@yahoo.com

Abstract
Background: Anemia is a prevalent consequence of CKD, linked with diminished quality of life in patients (individuals receiving medical care), increased morbidity and mortality, and accelerated course of the illness.
Objective: The investigation aims to evaluate the impact of hemodiafiltration on anemia among individuals receiving medical care with chronic kidney disease.
Methods: A prospective investigation was conducted at the HDF unit of the Baghdad Teaching Hospital, Medical City Complex in Baghdad, from the 1st of January 2024 to the 1st of September. We selected a convenient sample, which included 60 individuals receiving medical care suffering from CKD who attended a hospital for hemofiltration throughout the investigation period and were selected according to specific criteria.
Results: The mean age of the subjects was 50.77±12.34 years, and 65% were male. The baseline haemoglobin, iron, and ferritin levels slightly increase with the mean of PLT decrease after three months (12.143, 34.77, 676.3, and 149.27 respectively) but without any essential various between (p=<0.05). After six months, the results showed a decrease in mean hemoglobin and iron levels (9.66 and 32.19, respectively) while a slight increase in ferritin and PLT levels (693.27 and 154.93) without any statistically essential association (p=<0.05).
Conclusion: HDF therapy among CKD individuals receiving medical care throughout six months had no statistically essential impact on anaemia
Keywords: Anemia, Chronic Kidney Disease (CKD), Hemodiafiltration.

Introduction

Chronic kidney disease (CKD) is predicted to impact 8–16% of people worldwide, and the incidence is only expected to rise in older adults, raising obesity and kind two diabetes rates, as well as other factors. In the industrialized world, kind 2 diabetes and high blood pressure are the primary contributors to CKD [1].

Anaemia is a frequently occurring complication of CKD, which is linked to an increased rate of death and a markedly elevated risk of cardiovascular illness. Individuals receiving medical care suffering from chronic kidney disease with anaemia have more healthcare expenditures than individuals receiving medical care without anaemia [2]. Thus, fatigue, lack of appetite, and decreased productivity, in addition to disabling symptoms such as depression, anxiety, and cognitive impairment, lead to poor health-related quality of life (QoL). According to estimates, the prevalence of anaemia in people with the disease is 15.4% CKD overall, rising with disease severity [3].

Definition

Anaemia is generally defined as a haemoglobin level of less than 13 g/dL in men and less than 12 g/dL in women [4]. The anaemia of CKD is normocytic and normochromic anaemia, as well as hypo proliferative anaemia, which is frequently seen in people with renal illness. Renal illness was initially associated with anaemia in 1836, according to Richard Bright, the "Father

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of Nephrology. "Anemia is more common as renal disease advances, and almost every person with stage 5 CKD experiences it [5]. Decreased erythropoietin (EPO) production, decreased gastrointestinal iron absorption resulting from chronic inflammation, and a shortened red blood cell (RBC) lifespan are the leading causes of anaemia associated with CKD, including end-stage renal disease (ESRD) [6].

Aetiology of anemia in CKD

- **Erythropoietin deficiency** is a hallmark of kidney disease. Erythropoietin is produced by peritubular kind one interstitial cells in the renal cortex and outer medulla and aids in the variolation of erythroid cells. Its absence leads to programmed apoptosis of erythroid precursors. Additionally, pro-inflammatory cytokines inhibit EPO production and decrease the proliferation of erythroid progenitor cells [4].
- **Iron deficiency** also plays an essential role in the anaemia of CKD, attributable to both absolute and relative iron deficiency caused by chronic inflammation inhibiting iron release from cellular stores. Iron is first absorbed from the gastrointestinal tract and bound by transferrin. Bound iron is then transported to the liver and spleen, stored in ferritin, or transported to the bone marrow for erythropoiesis [7].
- **Hepcidin** is a crucial hormone in iron metabolism. Synthesized by the liver, hepcidin regulates iron absorption from the gastrointestinal system and releases stored iron. Macrophages and adipocytes also release small amounts of hepcidin. Hepcidin decreases the expression of ferroprotein (the cell-surface iron exporter), and its production is upregulated by chronic inflammation, infection, and renal failure [8].
- **HIF** is a transcription factor and a key regulator of cellular responses to hypoxia. Composed of an oxygen-binding α-unit and a stable β-unit, HIF regulates EPO and other iron-metabolism genes. When oxygen levels are normal, prolyl-4-hydroxylase domain-containing proteins 1-3 (PHD 1–3) hydroxylate HIF-α, which allows the von Hippel Lindau protein complex to ubiquitinate HIF-α, leading to its degradation [9].
- **Bone marrow dysfunction** is one of the examined mechanisms that lead to anemia in CKD. Research comparing the bone marrow structure in healthy individuals and those with CKD revealed that 53.3% of CKD individuals receiving medical care had hypocellular bone marrow [10].
- **Vitamin B12 and Folic Acid:** Individuals with chronic kidney disease often lack micronutrients. Cobalamin, a water-soluble vitamin B12, is crucial for maintaining homeostasis, facilitating cellular metabolism, providing antioxidative support, and synthesizing RBCs. The body mainly obtains it from dietary sources such as liver, beef, shellfish, or milk [11].
- **Bone Morphogenetic Protein 6 (BMP-6):** The involvement of bone morphogenetic protein (BMP) signaling in CKD-associated anaemia is intricate and extensively investigated. Current research demonstrates that BMP signalling is essential for regulating hepcidin, whereas the lack of BMP signalling was illustrated to cause iron excess [12].
- **Fibroblast Growth Factor 23 (FGF-23)** is a hormone generated by osteocytes and osteoblasts. A positive link exists between FGF-23 and phosphorus levels, whereas its negative association with haemoglobin levels indicates a potential involvement in the onset of anaemia in CKD individuals receiving medical care [13].

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- **Additional Factors:** Several medications might contribute to the onset of anaemia in people with CKD. Notably, often utilized angiotensin-converting enzyme inhibitors (ACEI) may impede the production of EPO and result in a further reduction of hemoglobin (Hb) levels [14].

Epidemiology

Anaemia associated with CKD often manifests when the GFR falls under 60 mL/min/1.73 m², with around 20% of those in stage 3 CKD exhibiting anaemia. At least 90% of people who need dialysis will ultimately have anaemia. Anaemia increases in prevalence and severity as the GFR declines [4]. The National Health and Nutrition Examination Survey (NHANES) conducted between 2007 and 2008 and 2009 and 2010 found that anaemia was twice as common in individuals with CKD compared to the general population [15]. Comparable findings were noted in the CKD Prognosis Consortium [16]. Research indicates essential regional heterogeneity in the frequency of anaemia among individuals with CKD. The prevalence of anaemia in CKD is 14% in the United States, 39.36% in India, 51.5% in China, 43.18% in South Africa, and 79% in Cameroon. Furthermore, the prevalence escalates with the progression of CKD stages, exhibiting overall rates of 22.4%, 41.3%, and 53.9% in CKD stages 3, 4, and 5, respectively [17].

Physiopathology of anemia in CKD

There are many causes of anemia in chronic kidney disease. The gradual decline of endogenous EPO levels has traditionally been considered essential. Additionally, various factors have been identified as contributors to anaemia in individuals receiving medical care with CKD, including absolute iron deficiency resulting from blood loss or impaired iron absorption, ineffective utilization of iron stores because of elevated hepcidin levels, systemic inflammation linked to CKD and related comorbidities, diminished bone marrow responsiveness to EPO since uremic toxins, shortened RBC lifespan, and deficiencies in vitamin B12 or folic acid [18].

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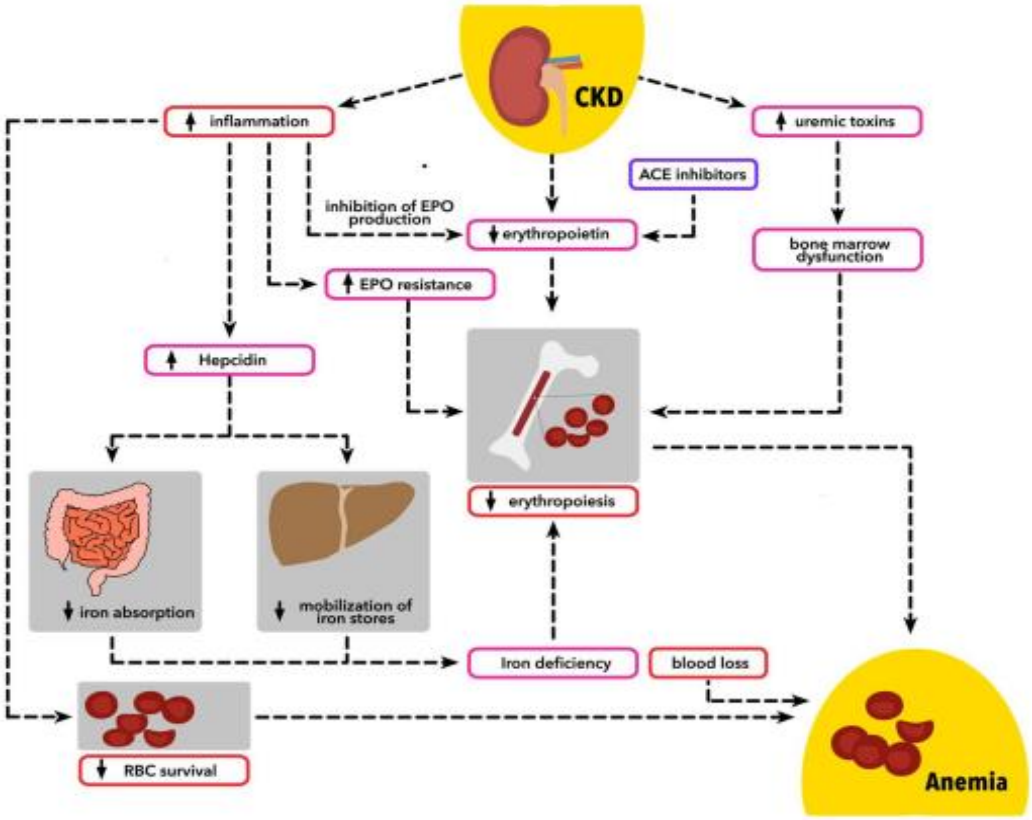

Figure 1. Pathophysiology of anemia in chronic kidney disease. CKD.

Diagnosis of anaemia of CKD

- Iron (serum iron level): Normal 60 to 170 mcg/dL for adults
- Ferritin (serum ferritin level): Normal 11 to 300 ng/mL
- TIBC (calculated as transferrin × 1.389): Normal 240 to 450 mcg/dL
- TSAT (calculated as serum iron/TIBC × 100): Normal 20% to 40% [19].

The **clinical presentation** of anaemia of chronic renal disease is similar to anaemia from other causes.

- Common symptoms include**:** (Generalized weakness, Fatigue, Dyspnea, Decreased concentration, Dizziness, Chest pain (mostly with severe anaemia), Headaches, Dyspnea and Reduced exercise tolerance).
- Commonly observable signs include**: (**Skin and conjunctival pallor, Respiratory distress, Tachycardia and Heart failure (usually with chronic and severe anaemia) [20].

Evaluation: Common tests required to diagnose anaemia of chronic renal disease include a complete blood count (CBC) with various Peripheral smears, Vitamin B12, folate, haptoglobin, and thyroid studies (to rule out other causes of anaemia) and Iron indices (iron, ferritin, total-iron binding capacity [TIBC], and transferrin saturation [TSAT]) include [21]:

Measuring serum EPO levels in CKD is generally discouraged, and hepcidin levels are not typically measured as they do not affect treatment options. Bone marrow biopsy is not commonly performed but is considered the gold standard for diagnosing iron deficiency anaemia [20].

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Management

- **Anemia Treatment with Iron**

The treatment of anaemia in CKD individuals receiving medical care must concentrate on medications that promote erythrocyte synthesis while providing sufficient iron levels for haemoglobin production. The National Institute for Health and Care Excellence (NICE) states that the management of anaemia in CKD individuals receiving medical care necessitates the utilization of either iron or erythropoiesis-stimulating drugs, or a combination thereof, to rectify both absolute and functional iron deficiency. The KDIGO guideline 2012 states that correcting iron deficiency with oral or intravenous iron supplementation may alleviate the severity of anaemia in individuals with CKD [22].

- **Anemia Treatment with ESA**

Before commencing proper therapy, excluding causes of anaemia other than CKD, such as iron and other hematinic shortages, chronic inflammation, cancer, and pharmacological agents, is essential. After excluding the reversible reasons for anaemia, the injection of additional EPO (epoetin) may be contemplated. Prior to commencing and sustaining ESA medication, the prospective advantages of diminishing blood transfusions and alleviating anaemia-related symptoms must be evaluated versus the possible risks of adverse impacts in specific individuals (including hypertension, loss of vascular access, and stroke) (1B) [23].

- **New Strategies for Anemia Treatment**

Novel therapeutics aimed at suppressing hepcidin production are under investigation as prospective treatments for anaemia. Research is conducted to evaluate the effectiveness and safety of anti-IL-6 antibodies, including Tocilizumab, and IL-6 monoclonal antibodies, including sultuximab. The latter was previously illustrated to elevate haemoglobin levels; nevertheless, it concurrently increased the infection risk [24].

- **Novel Iron Therapies**

Ferric citrate, FDA-approved for treating iron-deficiency anaemia in individuals receiving medical care with CKD or ESRD, also functions as a phosphate binder. This compound forms insoluble complexes with phosphates in the stomach's acidic environment and releases ferric ions in the alkaline duodenum. The oral formulation allows a more physiological repletion of iron, and its dual role as a phosphate binder may reduce the total pill burden for individuals receiving medical care [25].

- **Hypoxia-Inducible Factor–Prolyl Hydroxylase Inhibitors**

HIF–prolyl hydroxylase inhibitors (HIF–PHIs) are a novel class of therapeutic agents that raise EPO levels by stabilizing HIF levels, thereby increasing endogenous EPO production. HIF–PHIs also decrease hepcidin levels. In 2023, daprodustat was approved by the FDA for use in individuals receiving medical care on dialysis for longer than four months. This compound is not approved for use in non-dialysis individuals receiving medical care [26].

Hemodiafiltration

Hemodiafiltration (HDF) is a renal replacement treatment that utilizes diffusion and convection principles to remove uremic toxins. A substantial and growing population of end-stage renal disease (ESRD) individuals receiving medical care receive therapy with HDF despite the lack of definitive and compelling evidence about survival and anaemia management. Nonetheless, its impact on the physiological characteristics of RBCs has not been well investigated [27].

At now, post-dilution HDF (Post-HDF) is regarded as the most effective method. This replacement strategy may provide difficulties in some patient populations, particularly those

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with elevated predialysis hematocrit levels or diminished vascular access blood flow. Elevated hematocrit levels may be attained inside the dialyzer capillaries to facilitate ultrafiltration and generate substantial convective volumes [28]. Hemoconcentration, hyper-viscosity, elevated shear stress, and high pressure inside the dialyzer are recognized risk factors for RBC destruction and hemolysis. In mixed-HDF, a feedback control system modulates the pre-and post-dilution substitution rates to achieve the optimal filtration fraction while maintaining safe pressure and hydraulic parameters, averting increasing hemoconcentration [29].

Impact of HDF on Outcomes

Many investigations have illustrated that HDF facilitates superior clearance of small and medium molecules compared to great-flow hemodialysis. Indeed, individuals receiving HDF saw enhanced elimination of uremic toxins, including ß2-microglobulin, phosphorus, leptin, advanced glycation end products (AGEs), and inflammatory cytokines. These compounds are linked to an elevated risk of cardiovascular incidents and mortality [30,31].

The HDF experiment illustrated substantial decreases in serum phosphorus, indoxyl sulfate, and p-cresyl sulfate concentrations, enhancing urea reduction rate (URR) and KTV. Subsequent analysis of the HDF experiment revealed that online HDF altered the profiles of 16 metabolites across several pathways linked to the progression of cardiovascular disease compared to HD. Another aspect noted in the HDF investigation was preserving haemoglobin levels with a reduced need for EPO. As noted by other authors, the reduced need for EPO is likely attributable to the enhanced elimination of inflammatory cytokines and uremic toxins utilizing this dialysis method, hence diminishing EPO resistance [32,33].

Research indicates that individuals receiving medical care undergoing HDF exhibit fewer manifestations of uremia and dialysis, achieving superior scores in quality-of-life assessments. The therapeutic advantages of HDF were initially obtained from a post-hoc analysis of two substantial clinical trials: The Convective Transport Investigation and the Turkish investigation. The comparison of post-dilution online hemodiafiltration with hemodialysis was made. In the CONTRAST experiment, the individuals receiving medical care receiving HDF with a convection volume above 22 litres saw a 39% decrease in mortality risk compared to those undergoing low-flow hemodialysis. In the Turkish HDF Investigation, individuals receiving medical care undergoing HDF with convection volumes over 17 litres saw a decrease of 46% in the overall mortality risk and a 71% drop in cardiovascular mortality in comparison with those receiving great-flow hemodialysis [33].

The aim of the investigation

To identify the impact of hemodiafiltration on anemia among CKD individuals receiving medical care in Baghdad.

Specific Objective

- This study aims to identify the change in hematocrit measurement after three months and six months of hemodiafiltration therapy in CKD individuals receiving medical care.

Methodology

Investigation design & Setting:

Prospective research was carried out in the HDF section of Baghdad Teaching Hospital, Medical City Complex, from January 1, 2024, to September 1, 2024. The research objective

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was to ascertain the impact of hemodiafiltration on anemia in individuals with chronic kidney disease who receive medical care in Baghdad.

Investigation population

This research recruited all individuals receiving medical care diagnosed with end-stage renal disease and undergoing regular hemodialysis. Both genders (male and female) were included throughout the research period and chosen based on specific criteria.

Inclusion Criteria

- This research included individuals receiving medical care with end-stage renal disease who were undergoing continuous hemodiafiltration for a duration exceeding three months but less than one year.
- The maintenance HDF regimen consisted of three weekly sessions, each lasting four hours.
- All participants received hemodialysis utilizing a biocompatible Fresenius Polysulfone® dialysis membrane via an arteriovenous fistula (AVF) for vascular access.
- All individuals receiving medical care were administered EPO alfa at 50–100 IU/kg biweekly and oral folate at 5 mg daily.
- All individuals receiving medical care received intravenous iron naïve. Relevant clinical and biochemical data were extracted from the medical care records. None of the trial participants were administered angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers.

Exclusion Criteria

- Hemodialysis for less than three months
- Individuals receiving medical care with vascular access, excluding AVF
- History of therapy with immunosuppressive agents
- Active inflammatory conditions
- Clinical manifestations of acute infection
- Existence of hepatic illness
- Existence of malignancy
- Evidence of haemorrhage or gastrointestinal bleeding.

Sampling size

A convenient sample was selected, including 50 individuals receiving medical care from CKD and attending a medical city dialysis centre for hemofiltration.

Sample methods

- Initially, all individuals receiving medical care underwent testing for CBC and iron variables, including platelet count, total iron binding capacity (TIBC), ferritin, and serum iron.
- Subsequently, all individuals receiving medical care were further evaluated for serum albumin and susceptible C-reactive protein (CRP).

Sample collection and determination

Blood specimens were collected prior to the initiation of HDF. EDTA anticoagulant tubes were utilized for haematological samples, but no anticoagulants were employed for other biochemical assays. The CBC was subjected to testing. It involved haemoglobin (Hb), mean cell volume, mean cell haemoglobin concentration, and red cell distribution width (RDW). Iron

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investigations included serum iron, total iron-binding capacity (TIBC), and serum ferritin. TSAT was determined using the formula serum iron multiplied by 100 divided by TIBC.

Data collection

A systematic questionnaire is created to gather information from the participants. The researcher performed the subtending.

Questionnaire

A systematic questionnaire, prepared by the researcher and evaluated by the supervisor, serves as the foundation for data collection and comprises the following demographic information:

- Please provide the code number, age, date of birth, sex, length of illness, address, and phone number for follow-up.
- This includes illness information encompassing patient complaints, duration, prior medical history (which involves anaemia and thyroid illness), and previous medication history.
- Hemodiafiltration information: duration per week, duration of HDF, blood loss and fluid drainage.
- Measurement information: For all tests (CBC, s. ferritin…, etc.), we take three readings (baseline reading, after three months, and after six months).

Statistical Analysis

The data was converted into a digital database format. Statistical analyses were conducted with SPSS (Statistical Package for the Social Sciences)—version 26 of the computer program for Windows. Data are presented as mean ± standard deviation (SD), along with frequencies (number) and proportions (%). Student's t-test and one-way analysis of variance were utilized to compare means. The Chi-square test was utilized to compare frequencies and assess the significance of the correlation between categories of variables, with P magnitudes considered. A magnitude of < 0.05 was statistically essential.

Ethical consideration

1. Agreement between the Ministry of Health of Iraq and the Directorate of Health of the Medical City.
2. The data gathering was confidential and shall not be disclosed except for the investigation's objective.
3. The Participant's consent will be acknowledged, and they will be notified that participation is optional and that they may withdraw from the research after consenting to participate.

Results

The total sample of the investigation was 60 individuals receiving medical care with an average age of 50.77±12.34 years. The most prevalent set was those over 45 years old, who constituted 61%, while 65% of the investigation participants were male and 35% were female. As illustrated in Table 1 and Figure 1.

Table 1: The investigation specimen distribution based on sociodemographic characteristic n=60

gender	Frequency	Percent
female	21	35
male	39	65

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Total	60	100
age	Frequency	Percent
≤ 45years	23	38.3
>45years	37	61.7
Total	60	100

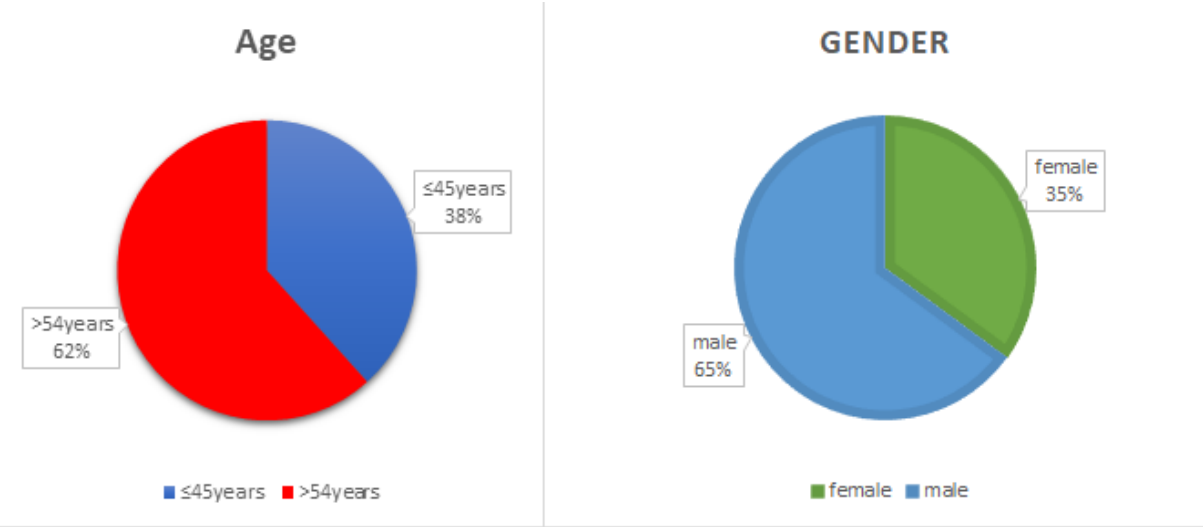

Figure 2. The distribution of investigation specimens is based on age and gender. n=60

In the current investigation, we compared the haemoglobin levels of participants during the investigation. Initially, the mean haemoglobin level was (10.388 mg/dL), and we found an increase in the mean of haemoglobin levels after three months (12.143 mg/dL), while after six months, there was a decrease in the mean of haemoglobin level to (9.633 mg/dL). Without any statistically essential correlation (p=<0.05). As illustrated in Table 2.

Table 2: The differences in participants' mean of HB level throughout the investigation duration. n=60

HB (mg/dl) measurement	N	Min	Max	Mean	Std. Deviation	P magnitude
At baseline	60	6.3	13.6	10.388	1.7783	----
After three months	60	6.3	194	12.143	23.9179	0.566
After six months	60	5.4	12.8	9.633	1.603	0.416
Paired Samples T Test		df= 59		statically essential*		

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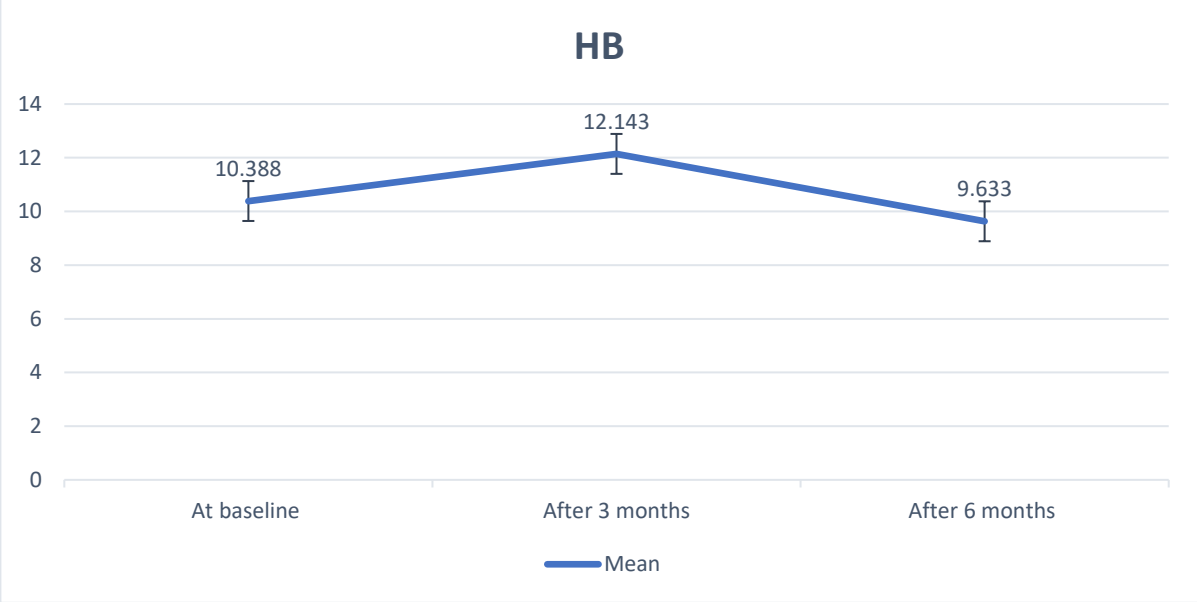

Figure 3. **The linear shape clarifies the HB level's mean throughout the investigation.**

The present investigation's findings indicated a reduction in the mean platelet count (PLT) at baseline (163.678), which decreased to (149.27) after three months. After six months, there was a slight rise in the mean platelet level, reaching (154.93). Moreover, it has no statistically essential link ($p>0.05$), as seen in Table 3.

Table 3: The differences in the mean of PLT level of participants throughout the investigation duration n=60

PLT Measurement	N	Min	Max	Mean	Std. Deviation	P magnitude
At baseline	60	2.7	282	163.678	55.7281	----
After three months	60	13	270	149.27	53.898	0.076
After six months	60	59	360	154.93	52.724	0.573
Paired Samples T Test		df= 59		statically essential*		

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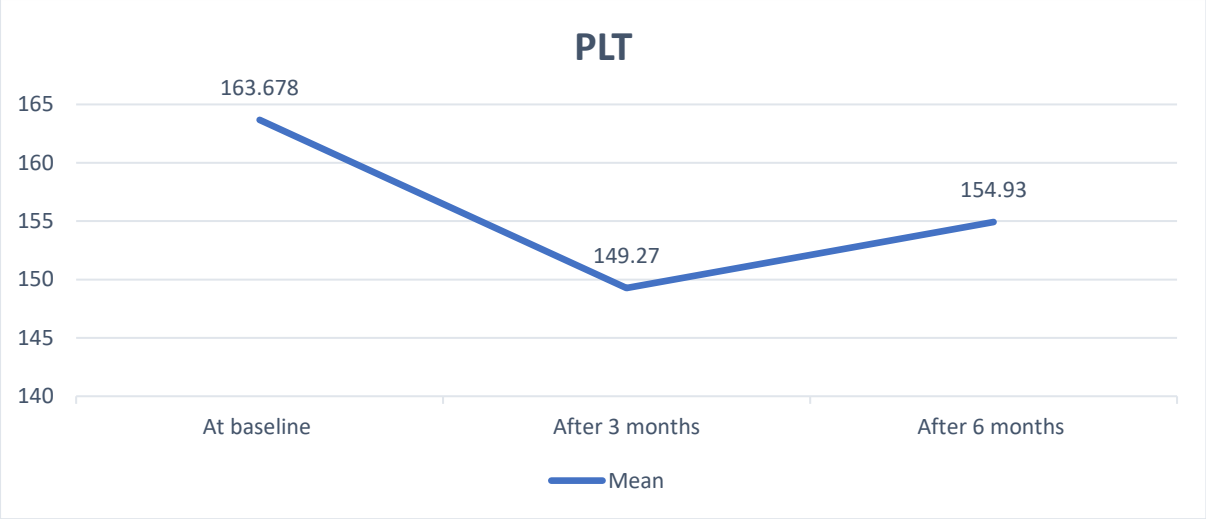

Figure 3: The liner shape clarifies the PLT level's mean throughout the investigation duration.

In the current investigation, we compared participants' mean iron levels during the investigation. Initially, the mean iron level was (27.115 mcg/dL), and we found an increase in the mean of iron levels after three months (34.77 mcg/dL), while after six months, there was a decrease in the mean of iron level to (32.197 mcg/dL). And without any statistically essential correlation (p=<0.05), as illustrated in Table 4

Table 4: The participants' mean PLT level differences throughout the investigation duration. n=60

IRON (mcg/dl) Measurement	N	Min	Max	Mean	Std. Deviation	P magnitude
At baseline	60	3.7	127	27.115	29.652	----
After three months	60	4.6	705	34.7708	90.01757	0.519
After six months	60	4.7	561	32.197	71.8176	0.856
Paired Samples T Test df= 59 statically essential*						

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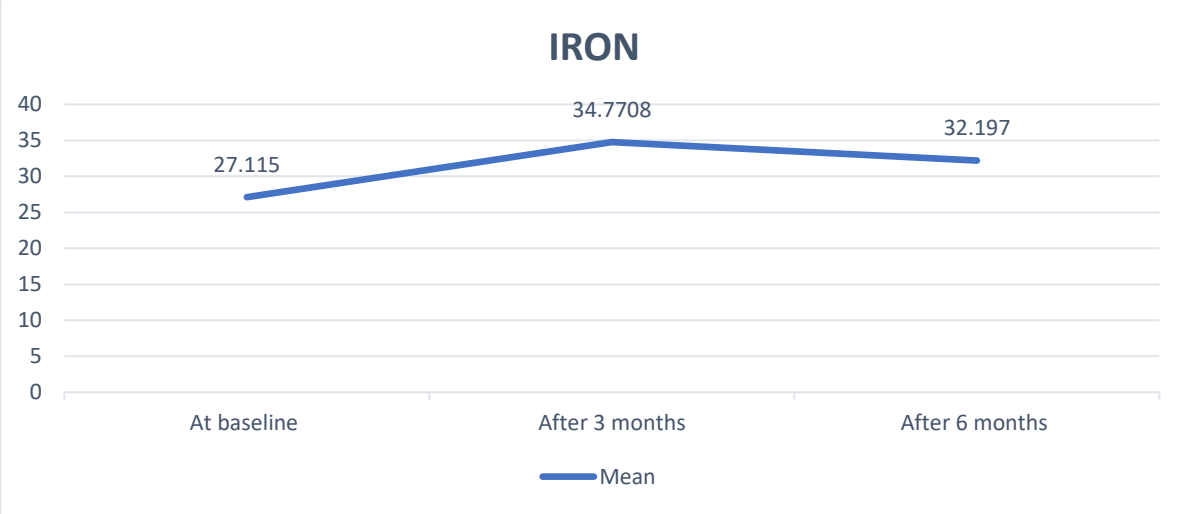

Figure 4: Liner shape clarifies the mean iron level throughout the investigation duration.

Regarding ferritin measurement among the investigation participants, the results showed at the beginning of the investigation that the mean of ferritin in the blood was (637.35 ng/ml). However, after three months, the mean of ferritin was increased to (676.3 ng/ml). There was a noticeable increase in the level of ferritin in the blood after six months of the investigation periods to become (693.27), but without any essential correlation (P=<0.05) as illustrated in Table 5

Table 5: The participants' mean PLT level differences throughout the investigation duration. n=60

Ferritin (ng/ml) Measurement	N	Min	Max	Mean	Std. Deviation	P magnitude
At baseline	60	140	2000	637.35	371.706	----
After three months	60	108	1700	676.3	373.312	0.263
After six months	60	10	2000	693.27	422.996	0.803
Paired Samples T Test		df= 59		statically essential*		

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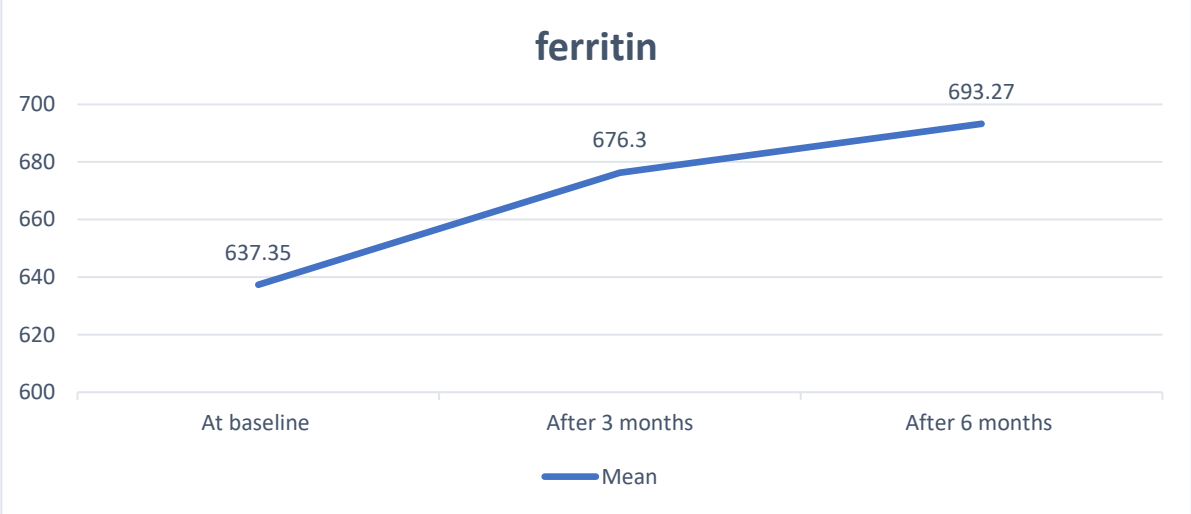

Figure 5: Liner shape clarifies the mean ferritin level throughout the investigation duration.

Discussion

Anaemia is an essential feature of end-stage renal disease (ESRD) and a critical prognostic indicator for individuals with ESRD. Uremic toxins essentially contribute to the accelerated degradation of RBCs [34]. Recent extensive observational studies and multicenter randomized controlled trials have illustrated that hemodiafiltration (HDF), which more effectively eliminates medium and large uremic toxins from plasma compared to conventional hemodialysis, can diminish the necessity for EPO therapy and facilitate RBC replenishment [35,36]. In vitro evidence indicates that medium- and large-molecule uremic toxins, including indophenol sulfate (IS) and acrolein, promote eryptosis and RBC mortality, suggesting that HDF-mediated elimination of uremic toxins could mitigate RBC destruction [37]. Any disturbance of this process results in anaemia, a disorder characterized by reduced circulating RBCs and, therefore, a diminished quantity of haemoglobin. Additional possible reasons for anaemia in CKD are iron deficiency, ferritin levels, and inflammation [38]. In our investigation, most hematologic variables exhibited no statistically essential modifications ($p<0.05$), consistent with the findings of Maduell F et al. [39], which indicated no essential association of hemodiafiltration after 3 and 6 months. Only ferritin levels decreased from 473 ± 263 ng/mL at baseline to 312±147 ng/mL after three months of treatment ($P < 0.01$) and to 290 ± 177 ng/mL after six months ($P < 0.01$). Conversely, a separate investigation by Buoncristiani et al. [40] found that haemoglobin increased from 8.1 ± 2 g/dL to 13.8 ± 3.8 g/dL. Kooistra et al. [41] and Pierratos et al. [42] did not disclose any alterations in anemia management in their first findings.

Research by Jiang Y et al. [43] illustrated a decrease in the anaemic process utilizing HDF, which corroborates the results of Sirolli et al. [44], which indicated that peripheral erythrocyte degradation was reduced in individuals receiving medical care undergoing improved HDF treatment. Consequently, it is plausible to infer that the mechanism via which HDF decreases the requirement for EPO treatment, thereby facilitating the correction of anaemia, is superior to that of traditional dialysis. [45].

In a research conducted by Lee YH et al. [46], Out of 179 HD individuals receiving medical care monitored for over 24 months, only 44 transitioned to HDF and were sustained for more

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than 12 months and observed a considerable rise in Hgb levels in individual receiving medical care after their conversion to HDF. Despite several studies indicating minimal changes in anaemia management among individuals receiving medical care receiving OL-HDF [47,48], issues such as inadequate dialysis dosage and short session duration may be contributory. Recent cross-sectional research indicated that individuals receiving medical care undergoing OL-HDF had enhanced iron status and improved anaemia management compared to those receiving standard HD [49]. Pedrini et al. [50] proposed that great-efficiency convective OL-HDF mitigated uremia-related disturbances, regenerated iron reserves, decreased the required EPO dosage, and enhanced anaemia [51].

Numerous observational and crossover studies indicate that individuals receiving medical care undergoing HDF exhibit reduced anaemia or an improved reaction to erythropoiesis-stimulating agents (ESAs), potentially since the substantial elimination of medium-sized pro-inflammatory molecules, such as hepcidin, which also aids in iron mobilization [35,52]. Nonetheless, clinical studies provide equivocal outcomes. Although the CONTRAST research indicated a declining trend in the utilization of ESA that did not achieve statistical significance [53], the Turkish OL-HDF research illustrated an essentially reduced weekly EPO dosage in individuals receiving medical care receiving HDF [54]. The ESHOL trial found no essential variations in transferrin saturation index, haemoglobin levels, or ferritin levels, and the dosages of ESA were comparable between individuals receiving medical care undergoing great-volume HDF and those in the HF-HD set [55].

A separate investigation indicated that the mode in Mixed-HDF may positively influence anaemia, as individuals receiving medical care exhibited stable haemoglobin levels with reduced ESA use. Post-HDF individuals receiving medical care exhibited a little, but not statistically essential, reduction in haemoglobin levels despite increased ESA use, with no considerable changes in iron metabolism markers or iron supplementation. The disparity in haemoglobin levels is evident after 1–2 months of therapy; nevertheless, the variations in Hb trends and ESA use between the two treatment sets did not achieve statistical significance [56].

A prospective investigation of observation was undertaken at the nephrology dialysis units of the National Institute of Nephrology and Urology at Al-Azhar Hospitals, where research was conducted on 80 ESRD-investigated cases in Hemodialysis. All investigated cases were separated into two sets: set A: 40 HDF investigated cases with anaemia Hb <10g% and set B: 40 HD patients with anaemia Hb<10g%. The HDF set's baseline magnitudes were 8.4 ± 0.7 g/dl, 9.6 ± 3.3 ng/ml and 11.2 ± 4.4% for haemoglobin, ferritin and TSAT, respectively. The HD set's baseline magnitudes were 8.2 ± 1.0 g/dl, 9.5 ± 3.2 ng/ml, and 11.0 ± 4.4% for haemoglobin, ferritin, and TSAT, respectively. No statistical variation was illustrated among sets regarding baseline anaemia parameters [57]. After 12 months, the anaemia parameters varied between sets in favour of HDF. The mean Hgb was higher in the HDF set than the HD set, and the mean ferritin was 37.8 ± 8.1 ng/ml in the HDF set and 29.7 ± 8.1 ng/ml in the HD set. Mean TSAT was 32.3 ± 7.1% in the HDF set and 23.6 ± 7.2% in the HD set [57]. Furthermore, Ibrahim et al. [58] illustrated a statistically essential increase in haemoglobin levels and serum albumin in the hemodiafiltration set compared to the great flux and low flux dialysis sets.

Moreover, Georgatzakou et al. [59] described that mean Hb was not essentially increased after therapy in the HD set. However, the HDF set was essentially increased after treatment. Hamzagic et al. [49] revealed that HDF has a more significant positive impact on anaemia parameters when compared to HD treatment. However, Kashgary et al. [60] described no

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essential variation in anaemia parameters; the same results were reported by Smith et al. [61]. The difference in findings might result from the variances in specimen size and inclusion criteria and the differences in investigation settings.
An essential disadvantage of this research is that it was performed at a single site with a limited specimen size. The restricted specimen size and substantial variability in haemoglobin levels among individuals receiving medical care are probable variables influencing statistical significance. Subsequent investigation might require the examination of more significant samples across various age sets.

Conclusion

HDF therapy among CKD individuals receiving medical care throughout six months had no statistically essential impact on anaemia.

Recommendation:

The authors encourage investigating more individuals receiving medical care on HDF in various dialysis centres in Iraq with prolonged follow-up periods to investigate the impact of HDF on anaemia and other factors that impact the CKD individuals receiving medical care and their response.

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