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Emergency vs. Planned Hemodialysis Initiation: Effects on Vascular Access and Treatment Practices

Tuba Turgut[1], Cebrail Karaca[2*]

[1]Department of Internal Medicine, Van Yuzuncu Yil University Faculty of Medicine, Van, Turkey
[2]Division of Nephrology, Department of Internal Medicine, Van Yuzuncu Yil University Faculty of Medicine, Van, Turkey

ABSTRACT

Hemodialysis (HD) is commonly used for end-stage renal disease, but there is a rising trend in initiating HD as an emergency rather than a planned procedure. This study investigates the clinical effects of emergency versus programmed HD initiation.

This retrospective study analyzed patients starting their first HD between January 2021 and December 2023. Data on laboratory parameters, vascular access, and medications were collected. Patients were divided into emergency and programmed HD initiation groups and compared.

The study included 136 patients (mean age 59.6 years). Emergency HD patients were more likely to use non-tunneled central venous catheters (CVCs) and had lower eGFR levels compared to those with programmed HD (102 [99%] vs. 5 [15.2%]; p<0.001 and 7.8 ± 3.3 mL/min/1.73 m² vs. 9.4 ± 2.7 mL/min/1.73 m²; p=0.010). While hemoglobin levels were lower in the emergency group (9.3 ± 2.0 g/dL vs. 9.9 ± 1.5 g/dL; p=0.156), the difference was not significant. IV iron and ESA use was significantly lower in the emergency group (28 [27.2%] vs. 22 [66.7%]; p<0.001 and 11 [10.7%] vs. 8 [25%]; p=0.045).

Emergency HD initiation is linked to increased use of non-tunneled CVCs, lower eGFR, and reduced use of IV iron and ESA. Improved planning and early intervention are needed for better patient outcomes.

Keywords: Hemodialysis, end-stage renal disease, emergency hemodialysis, programmed hemodialysis, central venous catheter, anemia

Introduction

Chronic kidney disease (CKD) represents a significant issue with an increasing prevalence both nationally and globally, characterized by a progressive and irreversible decline in kidney function (1-3). In Turkey, the prevalence of CKD has been reported as 15.7% (4). Although CKD generally exhibits higher prevalence in women, poorer outcomes are more commonly associated with the male gender (2-4).

Hemodialysis (HD) is the most widely utilized form of renal replacement therapy (RRT) globally (5). According to the United States Renal Data System (USRDS), approximately 84% of patients initiating RRT in the United States in 2021 began HD treatment (6). Similarly, the Turkish Society of Nephrology (TSN) 2022 registry reported that, in Turkey in 2022, this proportion was 74.9% (7). HD necessitates reliable and consistent vascular access. Arteriovenous fistulas (AVFs) are generally preferred for vascular access due to their high long-term patency rates, association with reduced mortality, and lower incidence of complications (8-11). However, the increasing frequency of acute HD initiation among incident HD patients has raised concerns about the use of tunneled or non-tunneled central venous catheters (CVCs) instead of AVFs. This trend is linked to a greater prevalence of anemia and a reduced rate of anemia management during the predialysis phase (6, 7). Additionally, the increased reliance on catheters has been associated with a rise in complications related to their use, particularly catheter-associated infections and dysfunctions (8).

In this study, we aimed to examine the impact of emergency versus planned initiation of HD on vascular access methods and other clinical characteristics in incident HD patients who began HD as their first form of RRT.

Materials and Methods

Study Design and Participants: This study was conducted on patients with CKD who began RRT with HD at the Nephrology Clinic of Van

*Corresponding Author: Cebrail Karaca, Assoc. Prof of Nephrology, Van Yuzuncu Yil University Faculty of Medicine, Department of Nephrology
E-mail: cebrailkaraca@gmail.com, Phone: (+90-432) 215 04 70
ORCID ID: Tuba Turgut: 0009-0003-5514-4642, **Cebrail Karaca:** 0000-0003-0969-7708
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Yuzuncu Yil University Faculty of Medicine between January 2021 and December 2023. The study included patients aged 18 years and older who were treated either on an outpatient or inpatient basis. Patients who started RRT with modalities other than HD and those under 18 years of age were excluded from the study. Patients without mature vascular access who began their first HD without prior RRT planning were classified into the emergency HD group. Conversely, patients with mature vascular access who initiated their first HD as part of a planned RRT were classified into the programmed HD group.

The study was approved by the local ethics committee in our institution (2022/12-16) and conducted by the 1975 Declaration of Helsinki and its later amendments. All patients enrolled in the study provided informed consent.

Data Collection: Data were collected by reviewing patient files and accessing the hospital's electronic database. Demographic and clinical data were recorded, including age, gender, body mass index (BMI), CKD etiology (diabetes mellitus [DM; both type 1 and type 2], hypertension [HT], obstructive uropathies, chronic glomerulonephritis [GN], amyloidosis, tubulointerstitial nephritis, cystic kidney diseases), comorbid conditions (HT, DM, coronary artery disease [CAD], chronic obstructive pulmonary disease [COPD], malignancy, heart failure, rheumatological disease, cerebrovascular disease), HD vascular access (AVF, tunneled or non-tunneled CVC), and the method of HD initiation (emergency or programmed).

Laboratory data recorded for the patients included venous blood gas pH and bicarbonate, hemoglobin (Hb), serum creatinine, estimated glomerular filtration rate (eGFR), transferrin saturation, ferritin, parathyroid hormone (PTH), albumin, uric acid, potassium, phosphorus, calcium.

Data on antihypertensive drug use were documented, including calcium channel blockers, diuretics, beta blockers, alpha blockers, angiotensin-converting enzyme inhibitors (ACEIs), and angiotensin receptor blockers (ARBs). Additionally, the use of oral sodium bicarbonate, oral phosphorus binders (calcium carbonate/acetate), oral potassium binders (polystyrene sulfonate), allopurinol, intravenous (IV) iron, and erythropoiesis-stimulating agents (ESAs) during the predialysis period was recorded.

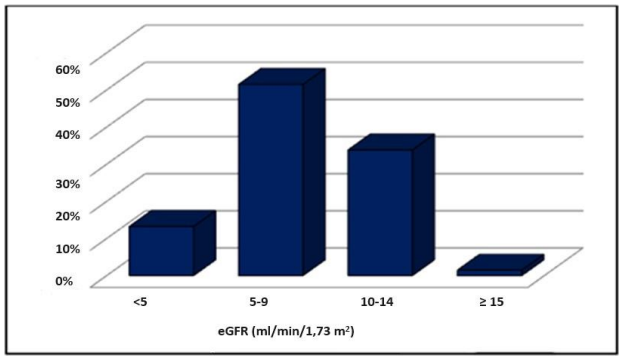
Definitions: The emergency HD group was defined as patients who commenced their first HD under life-threatening conditions such as severe hyperkalemia, severe metabolic acidosis, fluid overload refractory to diuretic therapy, or uremic manifestations. The programmed HD group comprised patients who began their first HD in the absence of life-threatening indications, as part of a planned RRT. DM diagnosis was determined based on the criteria established by the World Health Organization (12). HT was defined as having a systolic blood pressure (BP) of ≥140 mmHg and/or a diastolic BP of ≥90 mmHg, or being on antihypertensive medication (13). CKD was classified according to the KDIGO 2012 guidelines (1). The eGFR was computed using the CKD-EPI formula (14).

Statistical Analysis: Descriptive statistics for categorical variables were expressed as frequencies and percentages, whereas continuous variables were reported as medians (interquartile range [IQR]), and mean ± standard deviation (SD). The Kolmogorov-Smirnov and Shapiro-Wilk tests were employed to assess data normality, both indicating a non-normal distribution. To compare the emergency HD and programmed HD groups, an independent t-test was utilized. Additionally, the chi-square test was applied to examine relationships between categorical variables. Statistical analyses were conducted using SPSS software, version 27.0 for Windows, with results presented with 95% confidence intervals. A p-value of less than 0.05 was considered statistically significant.

Results

The study included 136 patients, of whom 79 were male (58.1%). The mean age of the cohort was 59.6 ± 15.7 years, and the mean BMI was 24.4 ± 4.1 kg/m². DM was identified as the most prevalent etiology of CKD, accounting for 39% of cases, followed by HT at 16.9%, and obstructive uropathies at 8.1%. During the initial hemodialysis (HD), 107 patients (78.7%) used non-tunneled CVC for vascular access, 21 patients (15.4%) used AVF, and 8 patients (5.9%) used tunneled CVC. Among the patients, 103 (75.7%) started HD on emergency basis, whereas 33 patients (24.3%) initiated HD on programmed basis (Table 1)

Table 2 presents the patients' classifications based on levels of creatinine, albumin, potassium, calcium, phosphorus, and Hb. HD was typically initiated when serum creatinine levels exceeded 4 mg/dL in 95.6% of patients. Additionally, 61% of



eGFR: estimated glomerular filtration rate.

Fig. 1. eGFR levels of patients before the first hemodialysis.

patients had serum albumin levels below 3.5 g/dL, 33.8% had potassium levels exceeding 5 mmol/L, 72.1% had serum calcium levels below 8.4 mg/dL, 37.5% had serum phosphorus levels above 5.5 mg/dL, and 66.2% had Hb levels below 10 g/dL.

Before the first HD, 18 patients (13.2%) had eGFR values below 5 mL/min/1.73 m², 70 patients (51.5%) had eGFR values between 5 and 9 mL/min/1.73 m², 46 patients (33.8%) had eGFR values between 10 and 14 mL/min/1.73 m², and 2 patients (1.5%) had eGFR values above 15 mL/min/1.73 m² (Figure 1).

The most commonly used drug class was antihypertensives. Specifically, 58.1% of patients were using calcium channel blockers, 34.6% were using diuretics, 26.5% were using beta blockers, 26.5% were using alpha blockers, 6.6% were using ARBs, and 5.9% were using ACEIs. The rate of predialysis IV iron therapy use was 36.8%, and predialysis ESA use was 14% (Table 3).

In the emergency HD group, the indications for HD were as follows: severe hyperkalemia in 32 patients (31%), fluid overload refractory to diuretic therapy in 31 patients (30%), uremic manifestations in 26 patients (25.4%), and severe metabolic acidosis in 14 patients (13.6%). Comparison of patients according to the initiation of dialysis is presented in Table 4. There were no differences between emergency HD and programmed HD groups in terms of gender, age, BMI, Hb, transferrin saturation, Ferritin, PTH, uric acid, potassium, calcium. However, in the Emergency HD group, almost all patients (99%) had HD vascular access as non-tunneled CVC, whereas in the programmed HD group, 63% had AVF, and this difference was statistically significant ($p<0.001$).

Emergency HD group had statistically significantly lower pH and bicarbonate levels compared to the programmed HD group (7.30±0.10 vs. 7.37±0.06, p= 0.002; 17.2±4.7 vs. 19.9±3.3, p= 0.003; respectively). Additionally, the Emergency HD group had higher serum creatinine levels and consequently lower eGFR levels compared to the programmed HD group (7.9±3.6 vs. 6.2±1.9, p: 0.014; 7.8±3.3 vs. 9.4±2.7, p= 0.010; respectively). Moreover, the Emergency HD group had statistically significantly lower serum albumin and higher phosphorus levels compared to the programmed HD group (3.1±0.7 vs. 3.5±0.6, p= 0.017; 5.6±1.5 vs. 4.9±0.9, p= 0.014; respectively).

Although the Emergency HD group had lower serum Hb levels compared to the programmed HD group, this difference was not statistically significant. However, the Emergency HD group statistically significantly used less IV iron and ESA 28 (27.2%) vs. 22 (66.7%), $p<0.001$; 11 (10.7%) vs. 8 (25%), p= 0.045; respectively).

Discussion

This study is the first significant research to highlight the impact of HD initiation on vascular access and treatment practices among incident HD patients in Van province. Although the TSN publishes annual reports on incident and prevalent HD patients, regional differences can be observed. In our region, the insufficient number of nephrologists may lead to inadequate pre-dialysis patient monitoring and preparation. Our findings are supported by data indicating that emergency HD initiation is an increasingly prevalent issue among incident HD patients (6, 7).

In our study, it was observed that emergency HD initiation reflects inadequate pre-dialysis monitoring. This situation leads to a higher frequency of initial dialysis with non-tunneled CVCs rather than AVFs compared to programmed HD. Additionally, these patients exhibit poorer renal function, more pronounced metabolic acidosis, higher phosphorus levels, lower albumin levels, and reduced use of IV iron and ESA.

The CREDIT study reported a CKD prevalence of 18.4% in women and 12.8% in men (4). However, data on incident HD patients present a contrasting trend (6, 7). According to the USRDS (6) and TSN (7) registries, men are more prevalent in both ESRD and incident HD populations. Our findings are consistent with these observations.

In the etiology of ESRD, as observed worldwide, DM was the leading cause in our study as well (6, 7). HT, the second most common cause of ESRD (15). In the United States, HT has been detected

Table 1: Demographic and Clinical Findings of The Patients

Features	Whole group n=136 mean±SD (median) / n (%)
Gender (male)	79 (58.1)
Age (years)	59.6±15.7 (61.5)
BMI (kg/m²)	24.4±4.1 (23.9)
CKD etiology	
Diabetes mellitus	53 (39)
Type 1 diabetes mellitus	3 (2.2)
Type 2 diabetes mellitus	50 (36.8)
Hypertension	23 (16.9)
Obstructive uropathies	11 (8.8)
Chronic glomerulonephritis	6 (4.4)
Amyloidosis	3 (2.2)
Tubulointerstitial nephritis	2 (1.5)
Cystic kidney diseases	1 (0.7)
Other	7 (5.1)
Unknown	30 (22.1)
Comorbid diseases	
Hypertension	93 (68.4)
Diabetes mellitus	57 (41.9)
Coronary artery disease	29 (21.3)
Chronic obstructive pulmonary disease	25 (18.4)
Malignancy	14 (10.3)
Heart failure	8 (5.9)
Rheumatological disease	8 (5.9)
Cerebrovascular disease	6 (4.4)
HD vascular access	
Non-tunneled CVC	107 (78.7)
Arteriovenous fistula	21 (15.4)
Tunneled CVC	8 (5.9)
First HD oncet	
Emergency HD	103 (75.7)
Programmed HD	33 (24.3)
pH	7.3±0.1 (7.3)
Bicarbonate (mmol/L)	17.8±4.6 (18)
Hemoglobin (g/dL)	9.4±1.9 (9.4)
Hemoglobin (g/dL)	
≥10 mg/dL	46 (33.8)
<10 mg/dL	90 (66.2)
Creatinine (mg/dL)	7.5±3.3 (6.8)
eGFR (mL/min/1.73 m²)	8.2±3.2 (8)
Transferrin saturation (%)	32.1±46.8 (23.5)
Ferritin (pg/L)	477.6±687.5 (259)
Parathyroid hormone (ng/L)	468.3±332.1 (406)
Albumin (g/dL)	3.2±0.7 (3.3)
Uric acid (mg/dL)	7.8±2.2 (7.6)
Potassium (mmol/L)	4.8±0.8 (4.8)
Phosphate (mg/dL)	5.4±1.4 (5.1)
Calcium (mg/dL)	7.8±1.1 (7.9)

SD: standard deviation, BMI: body mass index, CKD: chronic kidney disease, HD: hemodialysis, CVC: central venous catheter, eGFR: estimated glomerular filtration rate

Table 2: Grouping of Patients According To Laboratory Findings Before The First Hemodialysis

Features	n %	n %	n %	n %	n %	Total
Serum creatinine (mg/dL)	<4.0	4.0-5.99	6.0-7.99	8.0-9.99	≥10.0	136
	6 4.4	46 33.8	41 30.1	23 16.9	20 14.7	
Serum albumin (gr/dL)	<2.5	2.5-3.49	3.5-3.99	4.0-4.49	≥4.5	128
	18 13.2	65 4.8	26 19.1	16 11.8	3 2.2	
Serum potassium (mmol/L)	<3.5	3.5-5.00	5.01-6.5	6.51-7.5	>7.5	135
	6 4.4	83 61	41 30.1	5 3.7	0 0	
Serum calcium (mg/dL)	<7.5	7.5-8.39	8.4-9.5	9.51-10.2	>10.2	136
	45 33.1	53 39	30 22.1	6 4.4	2 1.5	
Serum phosphorus (mg/dL)	<3.5	3.5-4.6	4.61-5.5	5.51-7.5	>7.5	126
	6 4.4	32 23.5	37 27.2	41 30.1	10 7.4	
Hemoglobin (gr/dL)	<8.0	8.0-9.99	10.0-10.99	11.0-11.99	≥12.0	136
	25 18.4	65 47.8	20 14.7	12 8.8	14 10.3	

in 72% of prevalent HD patients, whereas in our country it has been observed in 61.6% (16). In our study, HT was present in 68.4% of incident HD patients. Given the high prevalence of HT among HD patients, the administration of antihypertensive medications is also frequently observed (16). In our country, the most frequently used antihypertensive drugs among HD patients were calcium channel blockers, followed by diuretics (7). A similar pattern was observed in our patients, who were often using multiple antihypertensive drugs.

According to the TSN 2022 registry, 31.1% of incident HD cases in our country begin with an emergency procedure (7). In contrast, our data show a much higher rate of 75.7%. This difference may be attributed to the fact that national data are derived from multiple centers, including a substantial proportion of private dialysis facilities. Additionally, it should be noted that emergency HD initiations may have been more prevalent during the severe phase of the COVID-19 pandemic. The presence of a major oncology center in our hospital is another contributing factor to the high rate of emergency initiations.

Our results indicate that obstructive nephropathies are the third most common etiology of CKD, following DM and HT, accounting for 8.1% of cases. In contrast, the TSN 2022 registry reports this rate as only 0.8% among incident HD patients (7). Furthermore, factors such as the shortage of nephrologists, harsh winter conditions impeding access to healthcare services, and patients' lower socioeconomic status may also contribute to the increased rate of emergency HD initiations.

The use of CVCs for incident HD patients is increasingly common both in our country and worldwide. According to USRDS data, the proportion of incident HD patients starting with

Table 3: Drug use of Patients Before The First Hemodialysis

Features	Whole group n=136 n (%)
Antihypertensive drugs	
Calcium channel blocker	79 (58.1)
Diuretic	47 (34.6)
Beta blocker	36 (26.5)
Alpha blocker	36 (26.5)
Angiotensin receptor blocker	9 (6.6)
Angiotensin converting enzyme inhibitor	8 (5.9)
Oral sodium bicarbonate	71 (52.2)
Oral phosphate binders	
Calcium carbonate/acetate	34 (259)
Oral Potassium Binder	
Polystyrene sulfonate	29 (21.3)
Allopurinol	15 (11)
IV iron	50 (36.8)
ESA	19 (14)

IV: intravenous, ESA: erythropoiesis-stimulating agent

CVCs, regardless of whether they have vascular access, increased by 4.6% from 2018 to 2021, reaching 85.4%. In 2013, approximately 60% of incident patients began HD with CVCs, while this rate rose to 74% by 2021. Additionally, the proportion of patients starting dialysis with an AVF decreased from 17% in 2013 to around 12% in 2021 (6). Similarly, reports indicate that most patients in India begin HD using CVCs (17). A recent multicenter survey by Bansal et al., revealed that over 75% of patients commenced HD using tunneled CVCs (18). In our country, in 2022, 71.1% of patients (51.6% with tunneled CVCs and 19.5% with non-tunneled CVCs started HD with catheters (7). Our study corroborates these findings, showing that 84.6% of patients initiated HD using CVCs, with 78.7% using non-tunneled CVCs and 5.9% using tunneled CVCs.

According to USRDS data, the mean eGFR at the initiation of RRT in 2021 was 9.9 mL/min/1.73 m². In 46.9% of patients, the starting eGFR value ranged from 5 to 10 mL/min/1.73 m² (6). TSN 2022 data indicate that approximately 40% of incident HD patients had a serum creatinine level of 6 mg/dL or higher at the time of HD initiation. This corresponds to an estimated eGFR of approximately 11 mL/min/1.73 m² for a 50-year-old male and 7 mL/min/1.73 m² for a female (7). Our study supports these findings, with a mean starting eGFR of 8.2 ± 3.2 mL/min/1.73 m². The IDEAL study, 828 patients were randomized into early initiation (eGFR 8-13 mL/min/1.73 m²) and late initiation groups (eGFR 3-5 mL/min/1.73 m²) based on their timing of dialysis initiation. The mean time to dialysis initiation was 2 months for the early group and 7 months for the late group. Despite this, after a mean follow-up of approximately four years, the incidence of cardiovascular events, infections, dialysis complications, and survival rates were similar between the two groups (19). The timing of RRT initiation should be individually planned for each patient. Our data indicate a trend towards later initiation of dialysis in our patient cohort. In our study, patients in the emergency HD group had statistically significantly lower eGFR levels compared to those in the programmed HD group.

Anemia is a significant challenge in CKD, contributing to poorer health outcomes and increased risk of complications (20, 21). Examining Hb levels at the initiation of HD, USRDS data indicated that the mean Hb at initiation in 2021 was 9.4 g/dL (6). According to TSN data, in 2022, 53.2% of patients had Hb levels in the range of 8-9.9 g/dL at the start of dialysis (7). Our results are consistent with these findings. In our center, 66.2% of patients had hemoglobin levels <10 g/dL at the time of their first HD. Despite these low hemoglobin levels at dialysis initiation, the use of ESA during the predialysis period is relatively low. Predialysis ESA use has been reported as 15.4% in USRDS data (6). Predialysis ESA use at our center matches these reports. Although patients in the emergency HD group had lower Hb levels compared to those in the programmed HD group, the difference was

Table 4: Demographic and Clinical Characteristics of Patients According To HD Onset

Features	Emergency HD group n=103	Programmed HD group n=33	p
Gender (male), n (%)	61(59.2)	18(54.5)	0.391
Age (years), mean±SD	59.3±15.1	60.5±17.7	0.689
BMI (kg/m²), mean±SD	24.3±4.1	24.5±4.1	0.827
HD vascular Access			
Non-tunneled CVC, n (%)	102 (99)	5(15.2)	
Arteriovenous fistula, n (%)	0(0)	21(63.6)	<0.001
Tunneled CVC, n (%)	1(1)	7(21.2)	
Ph, mean±SD	7.30±0.10	7.37±0.06	0.002
Bicarbonate (mmol/L), mean±SD	17.2±4.7	19.9±3.3	0.003
Hemoglobin (g/dL), mean±SD	9.3±2.0	9.9±1.5	0.156
Hemoglobin (g/dL)			
≥10 mg/dL, n (%)	34(33)	12(36.4)	0.439
<10 mg/dL, n (%)	69(67)	21(63.6)	
Creatinine (mg/dL), mean±SD	7.9±3.6	6.2±1.9	0.014
eGFR (mL/min/1.73 m²), mean±SD	7.8±3.3	9.4±2.7	0.010
Transferrin saturation (%), median (IQR)	22 [14-36]	27 [18-31]	0.534
Ferritin (pg/L), median (IQR)	258.5 [148.8-514.3]	260 [99-464]	0.781
Parathyroid hormone (ng/L), median (IQR)	400 [207-668]	409 [285-714.5]	0.501
Albumin (g/dL), mean±SD	3.1±0.7	3.5±0.6	0.017
Uric acid (mg/dL), mean±SD	7.9±2.2	7.6±2.2	0.494
Potassium (mmol/L), mean±SD	4.9±0.9	4.6±0.7	0.118
Phosphate (mg/dL), mean±SD	5.6±1.5	4.9±0.9	0.014
Calcium (mg/dL), mean±SD	7.8±1.1	8.0±1.0	0.236
IV iron use, n (%)	28(27.2)	22(66.7)	<0.001
ESA use, n (%)	11(10.7)	8(25)	0.045

HD: hemodialysis, SD: standard deviation, BMI: body mass index, CVC: central venous catheter, eGFR: estimated glomerular filtration rate, IV: intravenous, ESA: erythropoiesis-stimulating agent, IQR: interquartile range

not statistically significant. However, the frequency of IV iron and ESA use during the predialysis period was significantly lower.

Van Province, situated at an elevation of 1730 meters above sea level, provides a unique setting to observe the potential beneficial effects of altitude on anemia in HD patients. A previous study by Karaca et al., found that HD patients residing in the high-altitude region of Van had higher Hb levels and required lower doses of ESA and IV iron compared to patients at sea level (22). However, the beneficial effects of altitude on anemia observed in prevalent HD patients may not extend to those in the predialysis stage. This issue needs investigation through long-term observational studies that account for various factors affecting anemia.

Our study has several limitations. First, due to its retrospective design, some patient data were obtained from medical records, which may impact accuracy. Second, we lack data on the frequency of follow-up during the predialysis period. Additionally, we do not have information on sociodemographic factors, such as educational level and income status, which could influence patient adherence.

In conclusion, the majority of incident HD patients at our center initiate dialysis through emergency procedures and non-tunneled CVCs, which increases their risk of long-term catheter-related complications. Anemia remains a critical factor impacting survival in CKD. Our study demonstrated that, despite a significant proportion of patients presenting with severe anemia during the predialysis period, the utilization of ESA and IV iron therapies was markedly low. Effective management during the predialysis period, increasing the use of programmed HD initiation, and initiating dialysis with mature AVFs are essential for improving patient outcomes and managing anemia.

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Conflict of Interest: The authors declare no competing interest.

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