ORIGINAL ARTICLE

Unplanned Hemodialysis Initiation in Tunisia: Clinical Profile and Predictors of Early Mortality in a Prospective Cohort

Début non planifié de l'hémodialyse en Tunisie: profil clinique et prédicteurs de la mortalité précoce dans une cohorte prospective

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Abstract

Aim: Unplanned hemodialysis (HD) initiation is associated with increased mortality. This study aimed to characterize clinical profiles and identify predictors of early mortality in Tunisian HD patients.

Methods: A prospective cohort study was conducted at Tahar Sfar University Hospital, Mahdia, Tunisia, between June 2022 and June 2023, with follow-up until June 2024. A total of 125 adult patients initiating chronic HD were enrolled. Data on demographic, clinical, biochemical, and dialysis-related parameters were collected. Survival analysis was performed using Kaplan–Meier and Cox regression methods.

Results: The mean age was 59 ± 15years, with male predominance (57.6%). Diabetic nephropathy (36.8%) and chronic tubulointerstitial nephropathy (26.4%) were the leading causes of ESRD. Only 13.2% of patients-initiated HD in a planned manner; 50.4% started due to uremic symptoms and 28.1% due to volume overload. Vascular access was predominantly central venous catheters (70.4%), with only 20% having a mature arteriovenous fistula (AVF). The mean eGFR at HD initiation was 6.2 ± 2.4 mL/min/1.73 m². During follow-up (median: 15 months), 20.8% of patients died, with 34.6% of deaths occurring within the first three months. On univariate analysis, heart failure, AVF thrombosis, fewer than three HD sessions per week, and lack of prior nephrology referral were associated with higher mortality. Multivariate analysis identified dialysis frequency <3 sessions/week as the sole independent predictor of mortality (HR: 0.19; 95% CI: 0.042–0.9; p = 0.036).

Conclusion: Unplanned HD initiation remains common in our setting, with high early mortality. Inadequate dialysis frequency significantly impacts survival. These findings highlight the importance of timely nephrology referral and adequate dialysis delivery to improve outcomes in ESRD patients transitioning to HD.

Keywords: Hemodialysis initiation; unplanned dialysis; mortality; vascular access; early nephrology referral; CKD progression.

Résumé

Objectif : Le début non planifié de l'hémodialyse (HD) est associé à une mortalité accrue. Cette étude visait à décrire le profil clinique et à identifier les facteurs prédictifs de mortalité précoce chez des patients tunisiens débutant la HD.

Méthodes : Une cohorte prospective a été menée à l'Hôpital Universitaire Tahar Sfar de Mahdia entre juin 2022 et juin 2023, avec un suivi jusqu'en juin 2024. Cent vingt-cinq adultes initiant une HD chronique ont été inclus. Les données démographiques, cliniques, biologiques et liées à la dialyse ont été recueillies. L'analyse de survie a reposé sur les méthodes de Kaplan–Meier et la régression de Cox.

Résultats : L'âge moyen était de 59 ± 15 ans, avec 57,6 % d'hommes. Les principales étiologies d'insuffisance rénale terminale étaient la néphropathie diabétique (36,8 %) et la néphropathie tubulo-interstitielle chronique (26,4 %). Seuls 13,2 % des patients ont commencé la HD de manière planifiée, contre 50,4 % pour symptômes urémiques et 28,1 % pour surcharge hydrosodée. L'accès vasculaire reposait majoritairement sur un cathéter veineux central (70,4 %), alors que 20 % disposaient d'une fistule artérioveineuse fonctionnelle. Le DFG moyen au début de la HD était de 6,2 ± 2,4 mL/min/1,73 m². Après une médiane de suivi de 15 mois, 20,8 % des patients étaient décédés, dont 34,6 % durant les trois premiers mois. En analyse univariée, l'insuffisance cardiaque, la thrombose de FAV, moins de trois séances hebdomadaires et l'absence de suivi néphrologique préalable étaient associés à une mortalité accrue. L'analyse multivariée a retenu une fréquence <3 séances/semaine comme unique prédicteur indépendant (HR : 0,19 ; IC 95 % : 0,042–0,9 ; p = 0,036).

Conclusion : Le début non planifié de la HD reste fréquent en Tunisie et associé à une mortalité précoce élevée. L'optimisation de la fréquence de dialyse et l'orientation néphrologique précoce apparaissent essentielles pour améliorer le pronostic.

Mots-clés : hémodialyse, initiation non planifiée, mortalité, accès vasculaire, suivi néphrologique, progression de la MRC

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DOI: 10.62438/tunismed.v104i01.6368

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Introduction

Chronic Kidney Disease (CKD) represents a major global public health issue, largely due to its silent progression and frequently asymptomatic presentation in early stages. Clinical symptoms typically manifest only in advanced disease, highlighting the critical need for early detection and effective management strategies. Patients with end-stage renal disease (ESRD) require renal replacement therapy (RRT), which includes kidney transplantation, peritoneal dialysis, or hemodialysis (HD). The global demand for maintenance dialysis is increasing (1,2), and hemodialysis remains the predominant RRT modality worldwide (3), particularly in Tunisia (4,5).

The initiation of HD marks a pivotal transition in the care of CKD patients. Evidence suggests that the timing and modality of dialysis initiation, as well as the type of vascular access used, significantly influence patient outcomes and overall experience (1). This transition necessitates comprehensive patient preparation, therapeutic education, and multidisciplinary coordination. Early referral to nephrology services has been associated with improved survival rates—particularly during the first year of dialysis—as well as better preparation for RRT. Unplanned hemodialysis initiation was defined as the start of chronic hemodialysis in an emergency setting, without prior creation of a permanent vascular access and/or without regular nephrology follow-up during the preceding three months.

Identifying predictive factors for early mortality following dialysis initiation is essential and should consider both clinical parameters at the start of dialysis and the trajectory of pre-dialysis care. Numerous studies have highlighted the critical role of early nephrology referral and structured pre-dialysis management in improving long-term survival. Baseline clinical and laboratory markers at dialysis initiation have also been shown to influence prognosis and survival rates (2–4). Close monitoring of patients in the early stages of CKD facilitates better clinical outcomes and longer survival.

In this prospective longitudinal cohort study, we aimed to characterize the demographic, clinical, and biochemical profiles of patients at the initiation of hemodialysis and to identify predictors of early mortality following dialysis commencement.

Methods

Study Design and Settings

This is a longitudinal prospective cohort study, single-center study investigating the clinical status of patients at the initiation of HD and their subsequent survival outcomes. The study was conducted at the Nephrology and HD Department of Taher Sfar Mahdia University Hospital in Tunisia. Patient recruitment was carried out over a 12-month period from June 2022 to June 2023. Enrolled participants were prospectively followed until June 2024 for the assessment of survival outcomes.

Study Population

Inclusion Criteria:
Adults ≥18 years old initiating chronic hemodialysis during the study period.

Exclusion Criteria:
Patients with acute kidney injury (AKI) requiring temporary hemodialysis were excluded.

Data Collection:
Data were recorded using a structured worksheet derived from medical records and patient interviews, encompassing:

Demographic and Clinical Data:
Basic demographic, initial nephropathy, CKD duration, comorbidities (e.g., Hypertension, diabetes, cardiovascular diseases), Nephrology referral status and cardiovascular events were collected from patients and their medical records.

Biochemical Parameters (Measured at HD initiation):
Renal function markers (Creatinine, estimated glomerular filtration rate (eGFR), blood urea nitrogen (BUN)), Electrolytes and mineral metabolism: potassium, sodium, phosphorus, calcium, parathyroid hormone (PTH) and nutritional markers: Albumin, ferritin and hemoglobin.

Dialysis-Related Parameters:
Indication for HD initiation, dialysis parameter and Vascular access type: Arteriovenous fistula (AVF) or central venous catheter (CVC).

Patients were classified as initiating hemodialysis in a planned or unplanned manner according to whether they had undergone pre-dialysis nephrology follow-up and had a functioning arteriovenous fistula at the time of dialysis initiation

Patient Outcomes :
- Survival status: Mortality rate and cause of death.
- Survival time (in months), calculated from dialysis initiation to death or the final follow-up date (June 30, 2024).

Statistical Analysis

Statistical analyses were conducted using SAS/STAT software, version 15.3 (SAS Institute Inc., Cary, NC, USA).

Descriptive Statistics:
Quantitative variables were presented as mean ± standard deviation (SD) for normally distributed data or as median and interquartile range (IQR) for skewed distributions, assessed using the Kolmogorov-Smirnov normality test. Qualitative variables were expressed as frequencies and percentages.

Survival Analysis:
Kaplan–Meier survival curves were performed to evaluate patient survival over time. Univariate survival

analyses were performed using the Kaplan–Meier method, and differences between survival curves were assessed with the log-rank test. Variables demonstrating a p-value < 0.20 in univariate analysis were subsequently included in a multivariate analysis, which was conducted using Cox proportional hazards regression models to identify independent predictors of mortality. All group comparisons were assessed using the log-rank test. Statistical significance was defined by a p-value < 0.05.

Ethical Considerations

The study was approved by the Tahar Sfar Hospital Ethics, and all patients gave informed consent to be enrolled in this study.

Results

Baseline demographic and clinical characteristics of the patients

During the study period, a total of 125 patients-initiated HD therapy and were subsequently enrolled. The cohort comprised 72 men (57.6%) and 53 women (42.4%), yielding a slight male predominance with a sex ratio of 1.35. Regarding comorbid conditions, arterial hypertension was the most prevalent and the leasing etiology of ERSD was this cohort were diabetic nephropathy (36.8%). The duration of CKD prior to renal RRT was available for 95 patients (76%). The median duration from CKD diagnosis to dialysis initiation was 39 months [14-59]. Importantly, 68% of patients had been under nephrology follow-up before commencing HD.
The main clinical and demographic characteristics of participants are summarised in Table 1.

Table 1. Baseline demographic and clinical characteristics of study population (N= 125)

Baseline characteristics	n (%)
Age (years) Mean±SD	59 ± 15
Comorbidities (n, %)	
Diabetes mellitus	61 (48.8%)
Hypertension	107(85.6%)
Atrial fibrillation	7(5.6%)
Heart failure	26(20.8%)
Ischemic heart disease	(22.6%)
Hypothyroidism	5(4%)
Stroke	(9.6%)
Renal lithiasis	8(6.4%)
Initial nephropathy (n, %):	
Diabetic nephropathy	**46(36.8%)**
Chronic interstitial nephropathy	**33 (26.4%)**
Undetermined	**17 (13.6%)**
Nephroangiosclerosis	**14 (11.2%)**
Cardiorenal syndrome	**5 (4%)**
Cast Nephropathy	2(1.6%)
Duration of CKD (months) Median [IQR]	39 (14,59)

CKD: Chronic Kidney Disease; **SD**: standard deviation; **IQR**: interquartile range

Patient Admission Characteristics, Hemodialysis Indications, and Dialysis Frequency Distribution

In this study, only 13.2% of patients had a planned initiation of HD. Prior to dialysis initiation, 44% of patients were admitted via the Emergency Department and the main indications for starting HD were uremic symptoms (50.4%) and volume overload (27.2%) (Table2).
Among patients with prior nephrology follow-up, the median delay between the first nephrology consultation and hemodialysis initiation was 2.5 months (IQR: 1–6 months).
Concerning vascular access preparation, only 23.2% of patients had an AVF at the start of dialysis, and just 20% had a mature AVF ready for use. As a result, CVC were predominantly used: femoral catheters in 70.4%, jugular catheters in 5.6%, and tunneled catheters in 4% of patients.

Table 2. Distribution of patients according to the department of admission, indication for initiating hemodialysis, and dialysis frequency per week (N=125).

Variables		N (%)
Department of admission	Emergency	55(44%)
	Nephrology	36(28.8%)
	Consultation	34(27.2%)
Hemodialysis indication	Uremia	63(50.4%)
	Volume overload	34(27.2%)
	Metabolic acidosis	6(4.8%)
	Planned	13.2%
Number of dialysis sessions:	Once a week	28(22.4%)
	Twice a week	39(31.2%)
	Thrice a week	58(46.4%)

Data are expressed as number and percentage (N (%))

Laboratory Characteristics at the Onset of Hemodialysis

In our cohort, hemodialysis was initiated at a mean eGFR of 6.2 ± 2.4 mL/min/1.73 m². Notably, 61.6% of patients began dialysis at an eGFR above 5 mL/min/1.73 m². The median PTH level was 426 pg/mL (range: 222–677), with 34.7% of patients presenting a PTH level exceeding nine times the upper limit of normal. The median serum ferritin concentration was 123 ng/mL (IQR 56–228). Laboratory analyses are summarized in Table 3.

Survival Outcomes and Predictive Factors of Mortality in Hemodialysis Patients

During the follow-up period, the median overall survival was 15 months (95% CI: 13.77–16.22). A total of 26 deaths (20.8%) were recorded. Notably, 34.6% of these deaths occurred within the first three months following the initiation of dialysis. Among these, one patient died during a dialysis session, while seven others died during hospitalization. Infectious causes accounted for 26.9% of deaths.
Cardiovascular causes accounted for 23% of deaths in this cohort, mainly due to heart failure and sudden cardiac arrest.

The Kaplan–Meier survival curve for the entire cohort, along with survival curves stratified by associated factors, is presented in Figure 1.

On univariate analysis, the presence of heart failure, receiving fewer than three dialysis sessions per week, AVF thrombosis, and lack of prior referral to a nephrologist were identified as predictors of mortality in patients on HD.

However, in multivariate analysis, receiving fewer than three dialysis sessions per week emerged as the only independent predictor of increased mortality (Hazard Ratio [HR]: 0.19; 95% CI: 0.042–0.9; P = 0.036).

Table 3. Laboratory Characteristics at the Onset of Hemodialysis

Variables	Mean±SD (Ranges)
Creatinine (µmol/l)	820 ±276 (350-1700)
eGFR (mL/min/1.73 m2)	6.2± 2.4 (2.6-13 .7)
Uremia (mmol/L)	38±10 (16-78)
Potassium (mmol/l)	4.7±0.7 (3.4-7)
Calcium (mmol/l)	2.04±0.22 (1.42-2.5)
Phosphate (mmol/l)	1.7±0.46 (0.68-3.6)
Albumin (g/l)	33.9±6 (20-49)
Haemoglobin (g/dl)	8.4±1.8 (4.8-14)
Protides (g/dl)	67±8(53-84)

SD: standard deviation; **eGFR**: estimated glomerular filtration rate

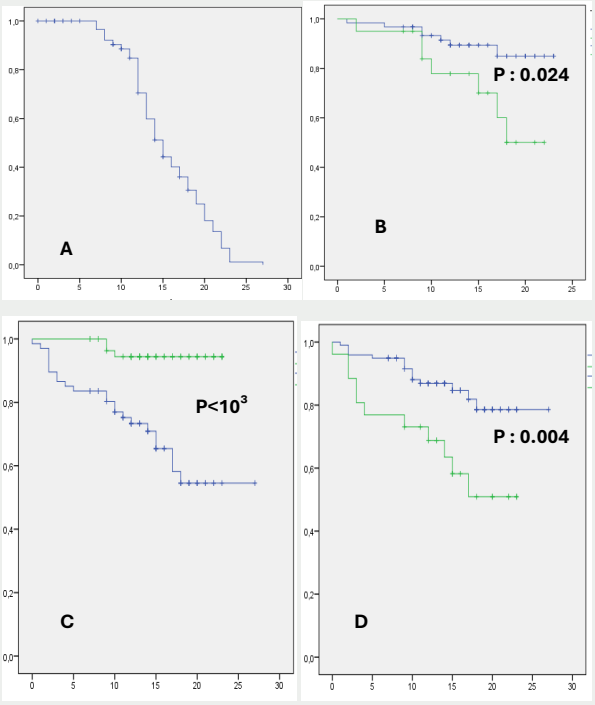


Figure 1. Kaplan-Meier Survival Curves illustrating mortality predictors in Hemodialysis

A: Overal Survival **B:** Survival analysis by AVF Thrombosis **C:** Survival analysis by number of HD sessions **D:** survival analysis by nephrology referral status
AVF: arteriovenous fistula; HD: Hemodialysis

Discussion

End-stage renal disease (ESRD) requiring renal replacement therapy (RRT) remains a significant global health concern, associated with notably high mortality rates, particularly during the first year of treatment. In this prospective cohort study conducted in Tunisia, we characterized patients initiating hemodialysis (HD) and identified clinical and organizational factors associated with early mortality.

Principal Findings

The mean age at HD initiation in our cohort was 59 ± 15 years, which is notably younger compared to that reported in European registries such as the REIN registry (70.7 years) and the EDTA registry (63.1 years) (3). This may reflect differences in demographic profiles and healthcare access across populations. Diabetic nephropathy and chronic tubulointerstitial nephritis were the leading causes of ESRD in our cohort, consistent with global epidemiological trends. Diabetes accounted for approximately 45% of ESRD cases globally in 2010 (2), underscoring its role as a major driver of CKD progression to ESRD.

Hypertension was the most prevalent comorbidity among patients initiating HD, present in 85.6% of our cohort. This aligns with findings from recent studies where hypertension was reported in 80–85% of patients starting dialysis (5,6). Hypertension not only contributes to the development and progression of CKD but also exacerbates cardiovascular complications in patients with advanced kidney disease.

Only 68% of patients had been referred to a nephrologist prior to HD initiation, indicating suboptimal pre-dialysis care. These figures are comparable to those reported in other studies, including a French cohort (39.45%) and another Tunisian study (58%) (5,6). According to KDIGO guidelines, patients with an eGFR < 60 mL/min/1.73 m² should ideally receive nephrology care, and referral becomes essential when eGFR drops below 30 mL/min/1.73 m². Early referral has been consistently linked to improved outcomes, including reduced mortality, fewer hospitalizations, and timely creation of vascular access (7). Moreover, early referral has been consistently associated with lower mortality, reduced hospitalization rates, and timely creation of vascular access, particularly AVF (8,9).

In our cohort, only 13.2% of patients initiated HD in a planned manner, while the majority began dialysis due to uremic symptoms (50.4%) or volume overload (28.1%). This is consistent with findings from Mesbahi et al., who reported that 56.8% of patients started dialysis urgently, primarily due to similar indications (5). The literature consistently shows that unplanned HD initiation is associated with poorer prognosis and higher mortality compared to elective starts (10). Urgent HD initiation is recognized as an independent risk factor for reduced survival, highlighting the importance of early preparation for RRT, including timely nephrology referral, appropriate vascular access planning, and scheduling

The mean estimated glomerular filtration rate (eGFR) at dialysis initiation in our study was 6.2 ± 2.4 mL/min/1.73 m², closely aligning with previous reports, such as the 6.06 ± 2.33 mL/min/1.73 m² reported by Mesbahi et

al. (5). While KDIGO guidelines recommend initiating dialysis generally within the eGFR range of 5–10 mL/min/1.73 m², several studies have shown that eGFR alone does not independently predict mortality (12). Clinical manifestations, such as uremic symptoms, remain critical indicators for dialysis initiation.

Vascular access remains a key determinant of HD quality and patient outcomes [1]. However, multiple studies have reported that most patients with ESRD initiate HD via a CVC [5,6]. In our study, only 20% of patients initiated dialysis with a mature arteriovenous fistula (AVF), while over half (57%) started with a central venous catheter (CVC). This trend mirrors data from the 2016 REIN registry (13) and the Dialysis Outcomes and Practice Patterns Study (DOPPS), where CVC use was predominant in incident dialysis patients (14). AVF remains the gold standard for vascular access due to its lower complication rates and better long-term outcomes, yet its underutilization reflects systemic challenges in pre-dialysis planning and access creation.

Mortality Outcomes

Our study revealed a high mortality rate during the first year of HD, affecting 20.8% of incident patients. Notably, 34.6% of these deaths occurred within the first three months after initiation, emphasizing the critical nature of the early post-initiation period. The DOPPS study, conducted across several countries, also documented the highest mortality rates during the initial months following dialysis initiation (14). Infectious and cardiovascular causes were the leading contributors to mortality, consistent with findings from multiple international studies (5). Cardiovascular mortality represented nearly one-fourth of all deaths, underlining the major role of cardiac complications in this population.

On univariate analysis, heart failure, receiving fewer than three HD sessions per week, AVF thrombosis, and lack of prior nephrology referral were all associated with increased mortality. However, multivariate analysis identified receiving fewer than three HD sessions per week as the sole independent predictor of mortality (HR: 0.19; 95% CI: 0.042–0.9; p = 0.036). This finding underscores the importance of adequate dialysis frequency in improving survival. It may reflect underlying socioeconomic barriers, poor patient adherence, or limited access to services—factors that warrant further investigation.

However, on multivariate analysis, only the frequency of dialysis sessions fewer than three per week remained statistically associated with mortality. These findings are in line with recent literature (Table 4).

These results are supported by published literature. For instance, Mosbahi et al. found that receiving fewer than three HD sessions per week significantly increased mortality risk (HR: 1.25; 95% CI: 1.01–2.50) (5). Similarly, Haarhaus et al. demonstrated that early nephrology referral was associated with improved survival (HR: 0.58; 95% CI: 0.35–0.98) (8), reinforcing the need for timely multidisciplinary intervention.

Table 4. Summary of Published Studies Reporting Risk Factors for Mortality in Hemodialysis Patients

Author	Country (year)	Study design (n)	Survival/mortality rate	Mortality-Associated Factors HR (95%CI ; p -value)
Reindl-Schwaighofer et al (15)	Austria (2017)	Multicenter retrospective (n=8,622 patients over the age of 65 years)	Median survival 26.9 years (95% CI, 25.8-28.0)	
MosbahiTasnim et al(5)	Tunisia (2021)	Prospective study (n=229)	1-year mortality rate : 25.2%	**Volume overload:** HR 3.44 (95% CI: 1.25–9.44), *p* = 0.016 **Hemodialysis < 3 sessions/week:** HR 1.25 (95% CI: 1.01–2.50)
Mathias Haarhaus (8)	Romania (2024)	Retrospective study (n=254)	Mortality rate: 45%	**Early referral to nephrologist:** HR 0.58 (95% CI: 0.35–0.98), *p* = 0.04 **Age (per year increase):** HR 1.044 (95% CI: 1.023–1.066), *p* < 0.001
Juliette Piveteau (11)	France (2023)	Retrospective study (n=8856)	3-year mortality rate: 37%	**Emergency dialysis with catheter:** HR 1.40 (95% CI: 1.30–1.60)
Helbert do Nascimonto Lina (16)	Brazil (2023)	Retrospective study (n=8295)		**Predialysis nephrological care:** HR 0.65 (95% CI: 0.50–0.84), *p* = 0.001 **Age** 1.05 (1.04-1.06) P<0.001 **Sex** 0.67 (0.48-0.92) P:0.015
Araceli Caro Martınez (17)	Spain (2019)	Retrospective study (n=10,692)	Median survival 6.25 years (95% CI 6.06–6.51)	**Optimal hemodialysis start:** HR 0.635 (95% CI: 0.598–0.674) **Active employment status:** HR 0.626 (95% CI: 0.545–0.719)
Ying Liu(18)	China (2020)	Prospective multicentric study (*n* = 1,674)		**Age > 70 years:** HR 2.868 (95% CI: 2.036–4.040), *p* < 0.001 **Diabetes:** HR 1.334 (95% CI: 1.028–1.729), *p* = 0.030 **Hypoalbuminemia:** HR 1.471 (95% CI: 1.164–1.859), *p* = 0.001 **Uremic encephalopathy:** HR 1.817 (95% CI: 1.201–2.750), *p* = 0.005

Implications for Clinical Practice

Our findings highlight the critical impact of pre-dialysis care on HD outcomes. Late presentation, inadequate vascular access, and insufficient dialysis frequency represent modifiable risk factors that can be addressed through:
Early nephrology referral , especially for patients with eGFR < 30 mL/min/1.73 m^2;
Timely creation of AVFs to reduce reliance on CVCs;
Optimization of dialysis frequency to ensure adequate clearance and volume management;
Enhanced coordination between primary care providers and nephrology services to improve detection and management of progressive CKD.
These interventions could significantly reduce the incidence of unplanned HD initiations and improve early survival rates.

Study limitations

This study has several notable strengths, including a relatively large cohort and a prospective design that facilitated data collection and longitudinal follow-up. Nonetheless, certain limitations should be considered. First, as a single-center study, the generalizability of our findings to other populations and healthcare settings may be limited. Second, we did not obtain detailed data on the timing of nephrology referral prior to dialysis initiation a recognized factor that can significantly affect patient outcomes.
Despite its limitations, this study provides valuable insights into early outcomes in patients initiating HD. Further large-scale, multicenter, prospective studies are warranted to validate and expand upon these findings (5, 8, 11, 15, 16, 17, 18).

Conclusions and recommendations

This study highlights the significant impact of the clinical and organizational circumstances surrounding HD initiation on early patient outcomes. Consistent with international data, the immediate post-initiation period remains a critical, high-risk phase for mortality in patients with ESRD. Our findings emphasize the importance of early and coordinated nephrology referral, timely preparation for RRT, and planned dialysis initiation through appropriate vascular access to optimize patient prognosis. Collaboration between primary care providers and nephrologists is essential to improve the identification and management of patients with advanced chronic kidney disease. Such multidisciplinary coordination could reduce the incidence of unplanned dialysis starts, minimize the reliance on CVC, and ultimately enhance survival, prognosis, and quality of life for this vulnerable population.

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