

FREQUENCY OF NEUROLOGICAL COMPLICATIONS IN END-STAGE RENAL DISEASE PATIENTS

¹Dr Yumna Aijaz, ²Dr Abdul Manan Junejo, ³Dr Naureen Izhar, ⁴Dr Sagar Lal, ⁵Dr Hafiza Neelam Zulfiqar Lakhani, ⁶Dr Sandiya

¹Postgraduate Trainee, Nephrology Department, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan.
Email: yumna_aijaz@hotmail.com

²Head of Department, Nephrology, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan.
Email: Dramanan99@gmail.com

³The Kidney Centre, Karachi, Pakistan, Email: Naureen_aijaz@yahoo.com

⁴Postgraduate Trainee, Nephrology Department, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan.
Email: sagarlal68@gmail.com

⁵Postgraduate Trainee, Nephrology Department, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan.
Email: mneelum@yahoo.com

⁶Postgraduate Trainee, Nephrology Department, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan.
Email: Sandiawadhwa12@gmail.com

*Corresponding Author: Dr Yumna Aijaz, Email: yumna_aijaz@hotmail.com

ABSTRACT:

Objective: To determine the frequency of neurological complications in patients presented with end-stage renal disease.

Study Design: Descriptive cross-sectional study.

Place and Duration of the Study: Department of Nephrology, Jinnah Postgraduate Medical Centre (JPMC) Karachi, Sindh, Pakistan, from December 2025 to March 2026.

Methodology: A total of 144 end-stage renal disease patients undergoing hemodialysis were selected consecutively from inpatients and outpatients. Each patient's demographic information and medical history were obtained, followed by an evaluation of present signs and symptoms. All patients were clinically evaluated for neurological complications, and diagnoses were confirmed via computed tomography (CT), magnetic resonance imaging (MRI), and nerve conduction studies where necessary. Analysis was carried out using the Statistical Package for the Social Sciences (SPSS) software, version 25.

Results: There were 52 female patients (36.1%) and 92 male patients (63.9%), with a median age of 46.0 (42.0–60.0) years. Neurological complications were diagnosed in 42.4% (n=61) of ESRD patients. The most common neurological complications were intradialytic hypotension (18.0%, n=11), cerebrovascular accident (16.4%, n=10), encephalopathy (14.8%, n=9), dialysis dementia (13.1%, n=8), neuropathy (13.1%, n=8), dialysis disequilibrium syndrome (9.8%, n=6), reversible leukoencephalopathy (4.9%, n=3), central pontine myelinolysis (4.9%, n=3), autonomic dysfunction (3.3%, n=2), and myopathy (1.6%, n=1).

Conclusion: Neurological complications are common in ESRD patients undergoing hemodialysis. The most common neurological complications were intradialytic hypotension, cerebrovascular accident, and encephalopathy.

KEYWORDS: End-stage renal disease, hemodialysis, intradialytic hypotension, cerebrovascular accident, encephalopathy.

INTRODUCTION:

Chronic kidney disease (CKD) is a serious medical concern across the world, with a growing incidence and prevalence that threatens to trigger a pandemic [1]. CKD is a global public health issue that affects around 10% of the global population [2]. According to estimates, more than 850 million individuals worldwide suffer from renal disease [3, 4]. End-stage renal disease (ESRD) is considered the last stage of CKD and is an increasingly frequent chronic condition with higher prevalence and incidence throughout the world [5]. CKD and its progression to ESRD lead to severe disability and a decreased quality of life, which significantly increases the risk of early mortality [6].

Renal transplantation is a curative therapeutic option for ESRD patients; yet not all ESRD patients obtain a transplant due to a variety of factors. Renal transplantation is an expensive procedure that is not often performed in developing countries due to a lack of facilities and expenditures, which increases the risk of premature death [7, 8]. One of the most popular types of renal replacement therapy worldwide is hemodialysis. Hemodialysis provides an alternative form of renal function and is the preferred treatment for ESRD [9, 10]. In Pakistan, the incidence of ESRD is 150 per million people [11].

Neurological complications are common among patients presenting with ESRD. These neurological problems have a major influence on both the central and peripheral nervous systems. Neurological complications

significantly increase the risk of morbidity and mortality through multiple pathways, as well as impact the patient's quality of life. Identification of the pathophysiological mechanisms of neurological complications is very important and can help in developing appropriate treatment approaches [12–15]. A study from Pakistan by Khan et al. reported a 39.3% rate of neurological complications in ESRD patients during hemodialysis. The most common neurological complication was intradialytic hypotension (19.0%), followed by cerebrovascular accident (14.3%) and encephalopathy (14.3%), while the least common neurological complication was myopathy (3.2%) [15].

The rationale of the study is to determine the frequency as well as the most common types of neurological complications in patients presenting with end-stage renal disease. As most ESRD patients are treated with hemodialysis, this technique is becoming more common worldwide; however, it comes with a variety of undesirable complications that raise the risk of morbidity, mortality, and a significant financial burden. Therefore, early diagnosis and management of neurological complications in ESRD patients are essential. Thus, the purpose of this investigation is to determine the current frequency of neurological complications in hemodialysis-dependent ESRD patients. Early identification of neurological complications will be helpful in early management, which can help avoid serious medical conditions and death, while also decreasing hospital stays and saving resources.

METHODOLOGY:

A descriptive cross-sectional study on end-stage renal disease patients was performed on outpatients and inpatients at the Department of Nephrology, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Sindh, Pakistan, from December 2025 to March 2026. The College of Physicians and Surgeons Pakistan's Ethics Review Committee gave ethical clearance on December 9, 2025, with reference number CPSP/REU/NEP-2023-186-1033. The study followed ethical guidelines by obtaining written informed consent from participants. ESRD patients were selected for the study only after discussing the study's purpose and its potential effect on the management of ESRD and neurological complications.

The sample size for enrolling ESRD patients to evaluate neurological complications was calculated using online software (OpenEpi). A sample size of 144 was calculated using the following variables: an anticipated frequency of 39.3% from a previous study by Khan et al., who observed 39.3% neurological complications in ESRD patients during hemodialysis [15], a 95% confidence interval, and an 8% margin of error.

Patients fulfilling the following criteria were included in the study: (1) either gender, (2) aged 18–70 years, (3) diagnosed with end-stage renal disease according to the operational definition, and (4) undergoing hemodialysis for the last three months or longer. Patients fulfilling the following criteria were excluded from the study: (1) patients with a diagnosis of acute renal injury who require hemodialysis for a short period, (2) patients with a diagnosis of ESRD but on continuous ambulatory peritoneal dialysis, (3) patients with a diagnosis of ESRD but not on hemodialysis, (4) patients with a history of kidney transplant, and (5) patients who refused to take part in the study.

ESRD is the last stage of CKD (i.e., Stage 5). It was confirmed by the presence of a decreased glomerular filtration rate (GFR) < 15 ml/min/1.73 m² for three or more months. Hemodialysis is a common treatment performed in kidney failure patients that removes extra fluids and waste from the blood. Intradialytic hypotension was diagnosed by the presence of a sudden decline in systolic blood pressure (≥ 20 mmHg) or mean arterial pressure (≥ 10 mmHg). Cerebrovascular accident was diagnosed by the presence of a focal hypodense area (ischemic) or hyperdense area (hemorrhagic) in the brain on computed tomography (CT). Encephalopathy was diagnosed by the presence of swelling in the brain on CT or magnetic resonance imaging (MRI). Dialysis dementia was diagnosed by the presence of aluminum content ≥ 10 mg/l in the dialysis fluid. Neuropathy was diagnosed by the presence of slowed nerve conduction velocities, decreased sensory and motor amplitudes, and prolonged distal latencies on a nerve conduction study. Dialysis disequilibrium syndrome was diagnosed by the presence of diffuse cerebral edema in the brain on CT. Central pontine myelinolysis was diagnosed by the presence of hyperintense or bright areas in demyelinated regions of the brain on MRI. Autonomic dysfunction was diagnosed by the presence of orthostatic hypotension, feeling hot or cold, excessive or decreased sweating, gastrointestinal problems (slow digestion or constipation), salivating or eye-tearing, dizziness, light-headedness, and falls. Myopathy was diagnosed by the presence of muscle weakness, fatigue, pain, or lack of energy.

Each patient's demographic information and medical history were obtained, followed by an evaluation of present signs and symptoms. Blood samples were evaluated for hemoglobin, white blood cell count, platelets, urea, creatinine, uric acid, and electrolytes, including aluminum where necessary. All patients were clinically evaluated for neurological complications, and diagnoses were confirmed via computed tomography (CT), magnetic resonance imaging (MRI), and nerve conduction studies where necessary. Analysis was carried out using the Statistical Package for the Social Sciences (SPSS) software, version 25. The Shapiro-Wilk test was used to determine the normal distribution of continuous variables. Mean ($\pm$ SD) and median (IQR) were computed for normal and non-normal variables, respectively. Chi-square and Fisher's exact tests were used for the comparison of neurological complications with different risk factors. A p-value of ≤ 0.05 was used for statistical significance.

RESULTS:

The ESRD group under evaluation consisted of 144 patients with a median age of 46.0 (42.0–60.0) years. There were 52 female patients (36.1%) and 92 male patients (63.9%). The median BMI of the ESRD patients was 26.0 (22.5–29.0) Kg/m². The majority of the ESRD patients presented with hypertension (84.0%, n=121), followed by diabetes mellitus (38.2%, n=55), heart failure/myocardial infarction (26.4%, n=38), smoking (16.7%, n=24), asthma (3.5%, n=5), and hyperthyroidism (2.1%, n=3). The median duration and frequency of hemodialysis were 21.5 (13.0–37.0) months and 2.0 (2.0–3.0) per week, respectively. Fatigue was the most common symptom in ESRD patients (82.6%, n=119), followed by muscle cramps (75.7%, n=109), dizziness (63.2%, n=91), pruritus (52.1%, n=75), and headache (46.5%, n=67) [Table 1].

Neurological complications were diagnosed in 42.4% (n=61) of ESRD patients [Figure 1]. The majority of the ESRD patients with neurological complications were diagnosed with intradialytic hypotension (18.0%, n=11), cerebrovascular accident (16.4%, n=10), encephalopathy (14.8%, n=9), dialysis dementia (13.1%, n=8), neuropathy (13.1%, n=8), dialysis disequilibrium syndrome (9.8%, n=6), reversible leukoencephalopathy (4.9%, n=3), central pontine myelinolysis (4.9%, n=3), autonomic dysfunction (3.3%, n=2), and myopathy (1.6%, n=1) [Figure 2].

Neurological complications were significantly more frequent among those >40 years of age (p=0.015), the overweight/obese (p=0.006), and those with diabetes mellitus (p<0.001), heart failure/myocardial infarction (p=0.024), smoking (p=0.029), a hemodialysis duration >2 years (p<0.001), fatigue (p<0.001), dizziness (p=0.024), and headache (p=0.010) [Table 2]

Table 1: Baseline Characteristics in ESRD Patients (n=144)			
Baseline Characteristics		Frequency	Percentage
Gender	Female	52	36.1%
	Male	92	63.9%
Age (Years)	Media (IQR)	46.0 (42.0-60.0)	
	<40	24	16.7%
	41-60	86	59.7%
	>60	34	23.6%
BMI	Media (IQR)	26.0 (22.5-29.0)	
	Normal Weight	57	39.6%
	Overweight	55	38.2%
	Obese	32	22.2%
Medical History	HTN	121	84.0%
	DM	55	38.2%
	HF / MI	38	26.4%
	Asthma	5	3.5%
	Hyperthyroidism	3	2.1%
	Smoking	24	16.7%
Duration of Hemodialysis (months)	Media (IQR)	21.5 (13.0-37.0)	
	≤ 2 Years	80	55.6%
	> 2 Years	64	44.4%
Frequency of Hemodialysis (/months)	Media (IQR)	2.0 (2.0-3.0)	
	2 times	98	68.1%
	3 times	46	31.9%
Sign & Symptoms	Fatigue	119	82.6%
	Muscle Cramps	109	75.7%
	Dizziness	91	63.2%
	Pruritus	75	52.1%
	Headache	67	46.5%

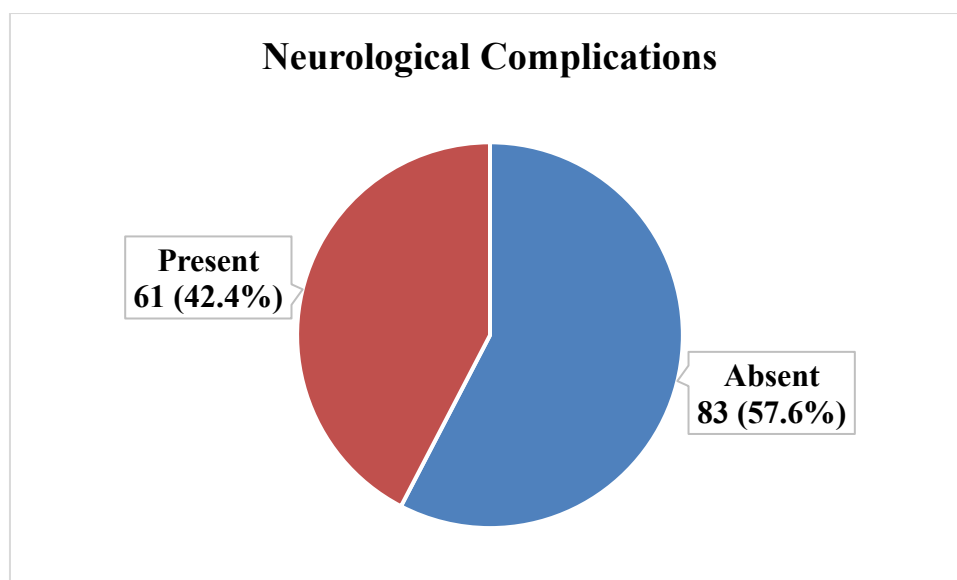


Figure 1: Neurological Complications in ESRD Patients (n=144)

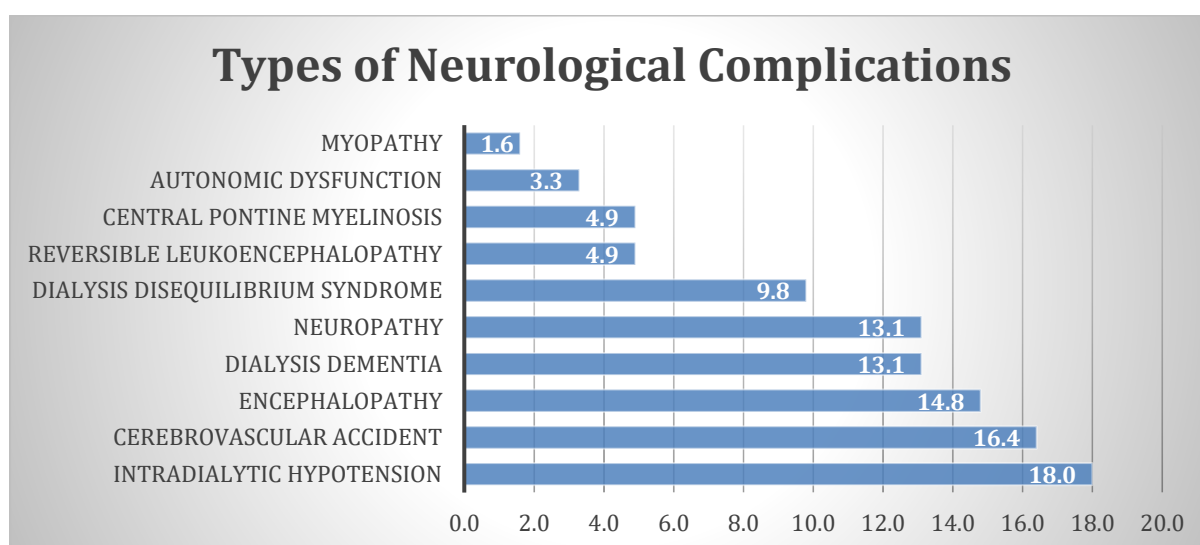


Figure 2: Types of Neurological Complications in ESRD Patients (n=144)

Table 2: Neurological Complications in ESRD Patients (n=144)				
		Neurological Complications		P-Value
		Absent (%)	Present (%)	
Gender	Female	30 (36.1%)	22 (36.1%)	0.992
	Male	53 (63.9%)	39 (63.9%)	
Age (Years)	Media (IQR)	45.0 (42.0-50.0)	53.0 (44.0-64.0)	<0.001
	<40	18 (21.7%)	6 (9.8%)	0.015
	41-60	52 (62.7%)	34 (55.7%)	
	>60	13 (15.7%)	21 (34.4%)	
BMI	Media (IQR)	24.0 (21.0-28.0)	27.0 (25.0-32.0)	0.001
	Normal Weight	42 (50.6%)	15 (24.6%)	0.006
	Overweight	27 (32.5%)	28 (45.9%)	
	Obese	14 (16.9%)	18 (29.5%)	
Medical History	HTN	67 (80.7%)	54 (88.5%)	0.207
	DM	20 (24.1%)	35 (57.4%)	<0.001
	HF / MI	16 (19.3%)	22 (36.1%)	0.024

	Asthma	3 (3.6%)	2 (3.3%)	1.000
	Hyperthyroidism	2 (2.4%)	1 (1.6%)	1.000
	Smoking	9 (10.8%)	15 (24.6%)	0.029
Duration of Hemodialysis (months)	Media (IQR)	17.0 (10.0-24.0)	32.0 (21.0-42.0)	<0.001
	≤ 2 Years	63 (75.9%)	17 (27.9%)	<0.001
	> 2 Years	20 (24.1%)	44 (72.1%)	
Frequency of Hemodialysis (/months)	Media (IQR)	2.0 (2.0-3.0)	2.0 (2.0-3.0)	0.854
	2 times	57 (68.7%)	41 (67.2%)	0.853
	3 times	26 (31.3%)	20 (32.8%)	
Sign & Symptoms	Fatigue	60 (72.3%)	59 (96.7%)	<0.001
	Muscle Cramps	60 (72.3%)	49 (80.3%)	0.266
	Dizziness	46 (55.4%)	45 (73.8%)	0.024
	Pruritus	42 (50.6%)	33 (54.1%)	0.678
	Headache	31 (37.3%)	36 (59.0%)	0.010

DISCUSSION:

In this descriptive cross-sectional study of 144 end-stage renal disease patients, neurological complications were diagnosed in 42.4% (n=61) of ESRD patients. The high prevalence of 42.4% for neurological complications in our Sindh-based study highlights a significant public health problem. In Pakistan, ESRD presents a complicated neurological landscape characterized by metabolic derangements and vascular fragility; the high burden in our study highlights the systemic nature of uremia [14–16]. Similarly, various studies on neurological complications in ESRD patients show a high burden; for instance, studies from Pakistan by Khan et al. reported rates of 48.4% [14] and 39.3% [15], while Hanan et al. reported 40.2% [17] neurological complications in ESRD patients during hemodialysis. This high burden across Pakistan is primarily caused by the accumulation of nitrogenous waste that penetrates the blood-brain barrier, as well as frequent hemodynamic instability during dialysis, which impairs cerebral perfusion in patients who are already vulnerable due to long-standing diabetes and hypertension [14–17]. In our study, the median age of ESRD patients was 46.0 years (range: 42.0–60.0 years), which is significantly young. A similarly young age for those suffering from ESRD has been reported in various Pakistani studies and globally, where median ages frequently fall below 50 years [14, 16, 18, 19]. This younger ESRD group is indicative of the South Asian demographic, likely caused by the early development of diabetic nephropathy as well as poorly controlled hypertension [14, 16, 18]. Similarly, the male dominance in our study (63.9%, n=92) aligns with local and international studies where males more frequently suffer from ESRD and are represented in dialysis centers due to both biological predisposition and socioeconomic variables influencing healthcare access [14–19].

In our study, the most common neurological complications were intradialytic hypotension (18.0%, n=11), cerebrovascular accident (16.4%, n=10), and encephalopathy (14.8%, n=9). These findings are similar to Pakistani studies by Khan et al. [15] and Hanan et al. [17], whereas the pooled prevalence of intradialytic hypotension was lower (12%) in a systematic review from Europe [20]. The increased rates of intradialytic hypotension observed in our ESRD group could be due to delayed dialysis initiation, inadequate ultrafiltration techniques, and a high prevalence of concomitant cardiovascular diseases and smoking. The high incidence of cerebrovascular accident and encephalopathy is caused by a vascular-metabolic 'crossfire' in which advanced arterial stiffness and microvascular fragility are brought on by long-term, poorly controlled diabetes and hypertension [20, 21]. These findings are also supported by our study, where neurological complications were significantly higher in patients with heart failure/myocardial infarction (p=0.024), diabetes mellitus (p<0.001), and smoking (p=0.029), whereas they were non-significantly high in those with hypertension (p=0.207).

Furthermore, other known complications in ESRD patients were dialysis dementia (13.1%, n=8), neuropathy (13.1%, n=8), and dialysis disequilibrium syndrome (9.8%, n=6). These findings are similar to other Pakistani studies where these rates are high in ESRD patients [15, 17]. Chronic neurovascular injury and inadequate dialysis kinetics are the main causes behind the high prevalence of these neurological complications. Dementia and neuropathy result from accelerated brain atrophy and axonal degradation induced by long-term diabetes, as well as the accumulation of uremic toxins from less frequent dialysis treatments. Furthermore, the high rate of dialysis disequilibrium syndrome is associated with late clinical presentation and elevated urea levels, where aggressive initial clearance causes rapid osmotic changes and consequent cerebral edema [15, 17].

Additionally, we found cases of reversible leukoencephalopathy (4.9%, n=3) and central pontine myelinolysis (4.9%, n=3). These findings are also similar to Pakistani studies [15, 17], although these rates are somewhat higher than those seen in studies conducted in more developed regions. While these complications are globally rare, with frequencies in Western developed countries typically reported from 0.8% to 2.5% [22, 23], this discrepancy could

be explained in the Pakistani setting by late clinical presentation. Patients frequently present with severe electrolyte imbalances where the immediate adjustment of hyponatremia (a risk factor for central pontine myelinolysis) or acute hypertensive crises (a driver for reversible leukoencephalopathy) occurs during emergency stabilization [16, 18, 19].

This study offers a detailed analysis of neurological phenotypes, including uncommon presentations that are frequently missed in general nephrology surveys, such as central pontine myelinolysis and autonomic dysfunction. By identifying smoking and heart failure as major predictors, we provide clinicians with practical targets to stratify high-risk patients before they sustain irreparable brain or nerve damage. Despite the significant findings and the association of neurological complications with various risk factors, this study has several limitations, such as single-center bias, its cross-sectional design, a lack of advanced imaging for all ESRD patients, and missing nutritional confounders.

CONCLUSION:

Neurological complications are common in ESRD patients undergoing hemodialysis. The most common neurological complications were intradialytic hypotension, cerebrovascular accident, and encephalopathy. The high rates of intradialytic hypotension and cerebrovascular accident necessitate stricter blood pressure management as well as more patient education regarding salt and fluid consumption. It is crucial to evaluate for peripheral nerve and cognitive impairment early, especially for those receiving dialysis for longer than two years.

REFERENCES:

1. Campese VM. The unresolved epidemic of chronic kidney disease of uncertain origin (CKDu) around the world: a review and new insights. *Clin Nephrol*. 2021 Feb 1;95(2):65.
2. Rovin BH, Ayoub IM, Chan TM, Liu ZH, Mejía-Vilet JM, Floege J. KDIGO 2024 Clinical Practice Guideline for the management of lupus nephritis. *Kid Int*. 2024 Jan 1;105(1):S1-69.
3. Bello AK, Okpechi IG, Levin A, Ye F, Damster S, Arruebo S, et al. An update on the global disparities in kidney disease burden and care across world countries and regions. *Lancet Glob Health*. 2024 Mar 1;12(3):e382-95.
4. Jadoul M, Aoun M, Imani MM. The major global burden of chronic kidney disease. *Lancet Glob Health*. 2024 Mar 1;12(3):e342-3.
5. Hashmi MF, Benjamin O, Lappin SL. End-stage renal disease. In: *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan.
6. AlRashed H, Miele J, Prasad J, Adenikinju D, Iloegbu C, Patena J, et al. Systematic review of end stage renal disease in Pakistan: Identifying implementation research outcomes. *PLoS One*. 2023 Dec 27;18(12):e0296243.
7. Tamara F, Fajar JK, Susanto A, Enggriani YT, Beluan MI, Mirino R, et al. Global prevalence and potential factors influencing willingness for renal transplantation in end-stage renal disease patients: a systematic review and meta-analysis. *Narra J*. 2024 Sep 3;4(3):e964.
8. Hyodo T, Hirawa N, Kuragano T, Takemoto Y, Urabe S, Adiya S, et al. The present status of dialysis patients in Asian countries as of 2022 from a medical economic point of view. *Ren Replace Ther*. 2025 Jan 6;11(1):3.
9. Khanin Y. Hemodialysis. A medication guide to internal medicine tests and procedures. E-Book. 2022:149-52.
10. Iqbal MS, Iqbal Q, Iqbal S, Ashraf S. Hemodialysis as long term treatment: patients satisfaction and its impact on quality of life. *Pak J Med Sci*. 2021 Mar-Apr;37(2):398-402.
11. Hamid A, Dhrolia MF, Qureshi R, Imtiaz S, Ahmad A. Clinical characteristics of patients on long-term hemodialysis. *J Coll Phy Surg Pak*. 2019 Apr 1;29(4):328-32.
12. Choudhary RK, Singh AK, Raman R, Perwaz A. End-stage renal disease and neurological connection. *EMJ Nephrol*. 2024;12(1):81-9.
13. Chen HJ, Wen J, Qi R, Zhong J, Schoepf UJ, Varga-Szemes A, et al. Re-establishing brain networks in patients with ESRD after successful kidney transplantation. *Clin J Am Soc Nephrol*. 2018;13(1):109-17.
14. Khan AM, Afridi MA, Asghar M, Ikram M, Muhammad R. Complications during hemodialysis in end stage renal disease patients in a teaching hospital. *J Postgrad Med Inst* 2019;33(3):204-9.
15. Khan AM, Nowsherwan S, Sabir Rehman S. Frequency of Neurological Complications among Patients with End Stage Renal Disease on Hemodialysis. *Sch J App Med Sci*. 2022 Mar;10(3):417-20.
16. Ahmad T, Jan MS, Zaidi M, Khan ZA, Sultan S. Spectrum of intradialytic complications in end-stage renal disease patients on maintenance hemodialysis. *J Health Wellness Community Res*. 2025 May;3(5):e743.
17. Hanan S, Sardar W, Khan RM, Haseeb A, Khan SA, Khan MY. A descriptive investigation of the prevalence of neurological disorders in people treated hemodialysis for end-stage renal disease. *Pak J Med Health Sci*. 2022;16(07):917-8.
18. Saeed F, Sardar M, Rasheed K, Naseer R, Epstein RM, Davison SN, et al. Dialysis decision making and preferences for end-of-life care: perspectives of Pakistani patients receiving maintenance dialysis. *J Pain Symptom Manage*. 2020 Aug;60(2):336-45.

19. Halle MP, Tchouamou EG, Fouda H, Gams Massi D, Ngamby VE, Tewafeu D, et al. Spectrum of neurological disorders amongst patients on maintenance haemodialysis in Douala, Cameroon: a cross-sectional study. *Open J Nephrol.* 2022;12(1):112-23.
20. Kuipers J, Verboom LM, Ipema KJR, Paans W, Krijnen WP, Gaillard CAJM, et al. The prevalence of intradialytic hypotension in patients on conventional hemodialysis: a systematic review with meta-analysis. *Am J Nephrol.* 2019;49(6):497-506.
21. Anwar MS, Mahmood A, Saeed H, Raza ZA, Hussian R. Chronic kidney disease CKD/END stage renal disease (ESRD) global and national perspective. *Esculapio J.* 2025 Dec;21(04):562-6.
22. Shajan N, Mikšytė G, Sukackienė D, Žulpaitė G, Lukšaitė-Lukštė R, Rimševičius L, et al. Posterior reversible encephalopathy syndrome in peritoneal dialysis patients: a four-case series. *J Clin Med.* 2026 Mar 5;15(5):2003.
23. Yu Z, Wang C. Osmotic demyelination syndrome: Case report and literature retrospect. *Medicine (Baltimore).* 2024 Dec 20;103(51):e41031.s