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Special Issues in Medicine & Surgery
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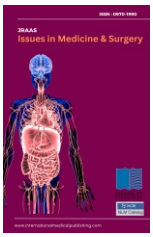

Research Article

Section: Medicine

A Study of Complications in Chronic Kidney Disease Patients on Haemodialysis at a Tertiary Care Centre

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HIGHLIGHTS

- Chronic kidney disease requires lifelong management
- Hemodialysis patients often develop serious complications
- Study focuses on risks at tertiary centre
- Clinical evaluation highlights morbidity and outcomes
- Research aids better dialysis care practices

Key Words:
Chronic kidney disease
Hemodialysis
Vascular access
Cardiovascular morbidity

ABSTRACT

Introduction: Chronic Kidney Disease (CKD) is a progressive condition frequently culminating in end-stage renal disease (ESRD), where hemodialysis serves as a life-sustaining therapy. However, dialysis is associated with a broad spectrum of complications that adversely affect patient morbidity, quality of life, and treatment outcomes. This study aimed to assess the prevalence and patterns of dialysis-related complications and their correlation with sociodemographic and clinical factors among CKD patients at a tertiary care center. **Material and Methods:** A hospital-based cross-sectional study was conducted in the Department of Medicine over two years (July 2023–June 2025). Ninety-five adult patients undergoing maintenance hemodialysis were included using purposive sampling. Data were collected on demographic details, comorbidities, laboratory findings, and dialysis-related complications. Complications were categorized into patient-related, technical, and vascular access-related groups. Statistical analysis explored associations between complications and clinical variables. **Results:** The majority of patients were aged 51–70 years (55.79%) with a slight male predominance (53.68%). Hypertension (41.05%) and diabetes mellitus (34.74%) were the most common comorbidities. Cardiovascular complications were the most frequent patient-related events (71.58%), followed by central nervous system manifestations (28.42%). Technical complications included dialyzer reactions (26.32%) and bleeding diathesis (22.11%), while vascular access-related complications comprised steal syndrome (51.58%), central venous thrombosis (18.95%), and cardiac arrest (14.74%). No statistically significant associations were observed between complications and age, gender, dialysis duration, BMI, personal history, or comorbidities, indicating multifactorial etiologies. **Conclusion:** Complications in hemodialysis patients are diverse, with cardiovascular, technical, and vascular access issues significantly contributing to morbidity. The absence of strong associations with clinical and demographic factors highlights the complexity of risk determinants. Early nephrology referral, individualized dialysis protocols, and multidisciplinary management are essential to mitigate these complications and improve patient outcomes.

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Article History: Received 23 August 2025; Received in Revised form 24 September 2025; Accepted 26 September 2025
How To Cite: Omkar Jadhav, S.S. Chavan, S.V. Birajdar & Sachin Chaudhari, A Study of Complications in Chronic Kidney Disease Patients on Haemodialysis at a Tertiary Care Centre. *JRAAS: Special Issues in Medicine & Surgery;*2025,40(2),1-9

Chronic Kidney Disease (CKD) is a growing global health challenge, not only because of its rising prevalence but also due to its significant effects on morbidity, mortality, and healthcare systems. CKD is defined by a gradual and irreversible decline in renal function that often progresses to end-stage renal disease (ESRD), at which point renal replacement therapy becomes essential for patient survival. Hemodialysis (HD) remains the most widely used form of renal replacement therapy, especially in developing countries where peritoneal dialysis and kidney transplantation are often limited by accessibility and resources. While HD is a life-sustaining treatment, it is associated with a wide range of complications-physiological, biochemical, vascular, neurological, and psychological-that make its management highly complex for both patients and healthcare providers [1].

Globally, more than two million people are estimated to undergo dialysis, and this number continues to increase annually. In India, the CKD burden has risen significantly, largely due to the growing prevalence of diabetes mellitus, hypertension, and an aging population. Hemodialysis is the most accessible modality in Indian tertiary care centers due to infrastructural and financial limitations. However, its complications remain a major concern. Studies indicate that over 50% of patients on maintenance HD develop intradialytic complications such as hypotension, muscle cramps, arrhythmias, and infections. These complications not only compromise quality of life but also increase hospitalization and mortality risks [2].

The spectrum of complications in HD patients is broad. Acute complications include intradialytic hypotension, vomiting, and cramps, while chronic sequelae involve anemia, mineral bone disorders, and cardiovascular diseases. For instance, Rathinavelu M, et. al; 2017 reported that 56.8% of HD patients suffered from severe anemia, while more than a third developed Stage I hypertension during dialysis sessions. Such complications remain significant predictors of poor prognosis in this vulnerable group [3].

Infections, particularly those associated with central venous catheters, are another major concern. Goplani K, et. al; 2020 highlighted that infection was the most common complication in patients with dual-lumen catheter access, emphasizing the importance of vascular access monitoring and infection control protocols [4]. Cardiovascular complications are also highly prevalent and are closely linked to electrolyte imbalances, chronic inflammation, and rapid fluid shifts inherent to the dialysis process. Raja V, et. al; 2020 noted high incidences of hyperkalemia, hyperphosphatemia, and anemia in patients on maintenance HD, all of which increase cardiovascular risks [5].

Neurological complications add to the clinical burden of CKD patients on HD. These include stroke, altered mental status, and dialysis disequilibrium syndrome, with studies showing significantly higher rates among HD patients compared to those not on dialysis. Psychological issues such as depression and anxiety are also disproportionately common, driven by the chronicity of CKD, dietary and fluid restrictions, and the exhausting nature of repeated dialysis sessions. Research consistently reveals that HD patients record higher depression and anxiety scores compared to the general population, highlighting the importance of psychological support [6,7].

Sociodemographic and clinical factors strongly influence complication patterns. Age, gender, and comorbidities like diabetes and hypertension significantly affect complication frequency and severity. Observational data from a South Indian tertiary care center showed strong associations between intradialytic hypotension or cramps and underlying diabetes and hypertension, stressing the need for individualized prescriptions and careful monitoring. Furthermore, irregular dialysis attendance and poor adherence to treatment schedules are strongly linked with higher complication rates, particularly in elderly patients who face additional challenges in maintaining treatment compliance [2,8].

Considering the diverse and multifactorial nature of these complications, it is essential to investigate their prevalence, underlying risk factors, and outcomes in different populations. Tertiary care centers play a critical role in this process, as they manage advanced CKD cases and can provide valuable data on complication patterns across diverse demographics. This study, therefore, aimed to generated evidence-based insights into the spectrum of HD-related complications, with a particular focus on patient-related and procedure-related risk factors. Ultimately, the findings will contribute to better-informed clinical interventions, improved patient monitoring, and healthcare policy reforms tailored to the needs of CKD patients in resource-limited settings.

The aim of the study was to estimate the prevalence of complications in patients undergoing hemodialysis and to analyze their correlation with sociodemographic and clinical factors. The primary objective was to determine the prevalence of different complications and to assess the demographic and clinical profile of these patients. The secondary objective was to evaluate the association between the observed complications and various sociodemographic as well as clinical variables, thereby providing insights into potential risk patterns influencing patient outcomes.

MATERIAL AND METHODS

This hospital-based cross-sectional study was conducted at the Department of Medicine at SRTR Government Medical College, Ambajogai, from July 2023 to June 2025. Ethical approval had been obtained from the Institutional Ethics Committee.

Study Population

The study population comprised patients aged 18 years and

above of both genders with end-stage renal disease undergoing maintenance hemodialysis who provided informed consent. Patients younger than 18 years, those receiving temporary dialysis for acute renal failure, those on continuous ambulatory peritoneal dialysis, and those scheduled for renal transplantation were excluded. This ensured that only stable hemodialysis patients meeting the inclusion criteria were enrolled for accurate assessment of complications.

Data Analysis

Data were collected from 95 patients using a pre-designed proforma through direct interviews, clinical examinations, and review of medical records, with laboratory results documented for each participant. Dialysis-related complications were recorded in real time by healthcare professionals and subsequently cross-verified for accuracy and completeness. The validated dataset was then subjected to systematic analysis to identify the prevalence, patterns, and correlations of complications with demographic and clinical variables.

RESULTS

Table 1: Clinical and Demographic Profile of CKD Patients on Hemodialysis (N = 95)

Parameter	Category	Count (%)	Key Findings
Age Distribution	18–30 Years	1 (1.05%)	Majority (55.79%) were Aged 51–70 Years
	31–50 Years	33 (34.74%)	
	51–70 Years	53 (55.79%)	
	71–90 Years	8 (8.42%)	
Gender Distribution	Male	51 (53.68%)	Slight male predominance
	Female	44 (46.32%)	
Duration Since CKD Diagnosis	1–6 Months	12 (12.63%)	Most (38.95%) Diagnosed 1–2 years ago
	7–12 Months	23 (24.21%)	
	13–24 Months (1–2 Yrs)	37 (38.95%)	
	25–36 Months (2–3 Yrs)	15 (15.79%)	
	37–48 Months (3–4 Yrs)	8 (8.42%)	
Duration on dialysis	First Time	17 (17.89%)	Half (50.53%) on Dialysis for 1–6 Months
	1–6 Months	48 (50.53%)	
	7–12 Months	16 (16.84%)	
	13–18 Months (1–1.5 Yrs)	6 (6.32%)	
	19–24 Months (1.6–2 Yrs)	8 (8.42%)	
Comorbidities	Hypertension	39 (41.05%)	Hypertension and Diabetes Most
	Diabetes	33 (34.74%)	

	Heart Failure	7 (7.37%)	Common
	Liver Cirrhosis	3 (3.16%)	
	Encephalopathy	2 (2.11%)	
Personal History	Smoking	33 (34.74%)	Majority non-smokers and non-alcoholic
	Alcohol	34 (35.79%)	
Clinical Examination Findings	Pallor	73 (76.84%)	Pallor and Oedema Most Frequent
	Oedema	50 (52.63%)	
	Clubbing	34 (35.79%)	
	Icterus	14 (14.74%)	
	Cyanosis	14 (14.74%)	
	Lymphadenopathy	0 (0%)	
Pulse	Normal	79 (83.16%)	Majority had Normal Pulse
	Bradycardia	9 (9.47%)	
	Tachycardia	7 (7.37%)	
Blood Pressure (Systolic)	≤120 MMHG	48 (50.53%)	Nearly Equal Distribution
	>120 MMHG	47 (49.47%)	
Blood Pressure (Diastolic)	≤80 MMHG	63 (66.32%)	
	>80 MMHG	32 (33.68%)	
BMI (kg/m²)	<18.5 (Underweight)	8 (8.42%)	Most Patients Normal BMI (45.26%)
	18.5–24.9 (Normal)	43 (45.26%)	
	25–29.9 (Overweight)	31 (32.63%)	
	≥30 (Obese)	13 (13.68%)	
Systemic	Normal Respiratory	84 (88.42%)	Small Proportions
Examination	Shortness Of Breath	5 (5.26%)	Showed Abnormal Findings
	Respiratory Distress	6 (6.32%)	
	Normal Cardiovascular	88 (92.63%)	
	Tachycardia	6 (6.32%)	
	LVH (Asymptomatic)	1 (1.05%)	
	Normal Abdomen	88 (92.63%)	
	Tense Abdomen	7 (7.37%)	

Hematological Findings	Normal Hb	1 (1.05%)	Moderate Anemia Most Common
	Mild Anemia	31 (32.63%)	
	Moderate Anemia	52 (54.74%)	
	Severe Anemia	11 (11.58%)	
	Leukocytosis	28 (29.47%)	
	Leukopenia	0 (0%)	
	Platelets	Normal In All	
	Iron/Ferritin ↓	11 (11.58%)	
	Tibc ↑	22 (23.16%)	
Biochemical Findings	Urea ↑	90 (94.74%)	Severe Biochemical Derangements
	Creatinine ↑	91 (95.79%)	
	Uric Acid ↑	95 (100%)	
	Potassium ↑	75 (78.95%)	
	Calcium ↑	89 (93.68%)	
	Phosphorus ↑	39 (41.05%)	
	Sodium ↑	27 (28.42%)	
	Albumin ↓	72 (75.79%)	
Ultrasound Findings	Decreased renal perfusion	6 (6.32%)	
Lipid Profile	Hypercholesterolemia	95 (100%)	Elevated LDL (76.84%) & low HDL (62.11%)
	LDL ↑	73 (76.84%)	
	HDL ↓	59 (62.11%)	
	Triglycerides ↓	Present	
ECG Findings	Normal	Majority	7.37% Showed Tall T-waves
	Tall T-waves	7 (7.37%)	

Most CKD patients on hemodialysis were aged 51–70 years, with a slight male predominance. The majority had been diagnosed within 1–2 years and were undergoing dialysis for 1–6 months. Hypertension and diabetes were the most frequent comorbidities, while smoking and alcohol use were reported by about one-third of patients. Common clinical findings included pallor, edema, anemia, electrolyte imbalances, and abnormal biochemical parameters, with many showing overweight or normal BMI and lipid abnormalities.

Table 2: Complications of CKD Patients on Hemodialysis (N = 95)

Complication Category	Sub-category	Count (%)	Key Findings
Patient-related complications	Cardiovascular system (CVS)	68 (71.58%)	Most frequent complication overall
	Central Nervous System (CNS)	27 (28.42%)	Less Common, Peaking in 51–70 Years (13.68%) and in Males (15.79%)
Technical complications	Dialyzer reaction	25 (26.32%)	Most Common Technical Complication, Highest in 51–70 Years and males
	Bleeding Diathesis+ Dialyzer Reaction	21 (22.11%)	Second Most Common
	Heparin-induced thrombocytopenia	15 (15.79%)	Notable in males, 1–6 Months Dialysis Group, and Hypertensive Patients
	Bleeding Diathesis (alone)	8 (8.42%)	Less Frequent
	Hemolysis	7 (7.37%)	Moderate Occurrence
	Exsanguinations	7 (7.37%)	Moderate Occurrence
	Hemolysis + Bleeding Diathesis + Neutropenia	7 (7.37%)	Moderate occurrence
	Air Embolism	5 (5.26%)	Least common technical complication
Vascular access-related complications	Steal syndrome	49 (51.58%)	Most Common Vascular Access Complication; Highest In 51–70 Years, Males, Smokers, And Diabetics
	Central Venous Thrombosis and Stenosis	18 (18.95%)	Second most frequent vascular complication
	Cardiac arrest	14 (14.74%)	Significant Vascular Complication
	Developed During Catheter Placing	11 (11.58%)	Moderate frequency
	AV fistula induced	3 (3.16%)	Least Common Vascular Access Complication

Among CKD patients on hemodialysis, cardiovascular complications were the most common (71.58%), followed by central nervous system issues (28.42%). Technical problems were frequent, with dialyzer reactions (26.32%) leading, followed by bleeding with dialyzer reaction (22.11%) and heparin-induced thrombocytopenia (15.79%), while air embolism was rare (5.26%). Vascular access complications were dominated by steal syndrome (51.58%), with central venous thrombosis/stenosis (18.95%) and cardiac arrest (14.74%) occurring less often. Middle-aged males, patients with normal BMI, smokers, and those with hypertension or diabetes showed higher complication rates, especially for CVS, dialyzer reactions, and steal syndrome. However, statistical tests showed no significant associations, indicating that demographic and clinical factors did not strongly predict complication patterns.

DISCUSSION

Chronic Kidney Disease (CKD) is a progressive and long-term condition that has wide-reaching consequences for patients, healthcare systems, and societies. Hemodialysis (HD) has improved survival for those with end-stage renal disease (ESRD), yet it carries a substantial burden of complications. This two-year study at a tertiary care center provides an overview of the demographic characteristics, clinical background, and complication spectrum among patients on maintenance HD. Its findings resonate with both global and Indian literature, highlighting the challenges of managing CKD in resource-limited settings [9,10].

The demographic profile revealed that 55.79% of patients undergoing HD were between 51–70 years, consistent with global and Indian epidemiology, as older adults are more vulnerable due to cumulative exposure to diabetes, hypertension, and cardiovascular disease. Similar age distributions were observed in studies by Agarwal SK & Srivastava RK. 2009, as well as data from the USRDS and European Dialysis and Transplant Association, which report median initiation ages of 60–65 years. Gender distribution showed mild male predominance (53.68%), which aligns with national and international data. This may reflect higher CKD prevalence in men due to occupational exposures and smoking, while gender disparities in healthcare access further reduce female representation, a concern previously noted by Agarwal SK & Srivastava RK. 2009 [11].

The duration since CKD diagnosis indicated that 38.95% of patients had been diagnosed within 1–2 years, with 17.89% starting dialysis for the first time and more than half on HD for less than six months. This suggests late referrals to nephrology services and frequent emergency dialysis initiations, unlike structured pre-dialysis care models in Western nations. O'Hare AM, et. al; 2007 confirmed that the early dialysis period is marked by heightened risks of complications and mortality [12].

Comorbidities such as hypertension (41.05%) and diabetes (34.74%) were highly prevalent, consistent with their established roles as leading CKD causes. Heart failure (7.37%) and liver cirrhosis (3.16%) further complicated management. Tinoco M, et. al; 2025, reported significant associations between comorbidities and dialysis-related complications. The interplay of anemia, hyperphosphatemia, and electrolyte imbalance compounds cardiovascular risks, which remain the leading cause of mortality in HD patients [13].

Lifestyle factors such as smoking (34.74%) and alcohol consumption (35.79%) were notable. Smoking worsens vascular disease, oxidative stress, and dialysis inefficiency, while alcohol contributes to fluid imbalance, hepatic dysfunction, and malnutrition. saravanan underscored the need for behavioral interventions to address these modifiable risks [14].

Clinical findings showed that pallor was present in 76.84% of patients, reflecting the high burden of anemia in CKD. Studies by saravanan reported similar anemia prevalence, highlighting its multifactorial causes-erythropoietin deficiency, blood loss, inflammation, and malnutrition. Less common but important signs included icterus (14.74%), cyanosis (14.74%), and clubbing (35%), indicating hepatic dysfunction, hypoxia, or chronic cardiopulmonary disease [3,5].

Hemodialysis-related complications were categorized as patient-related, technical, and vascular access-related. Patient-related complications predominated, with intradialytic hypotension (IDH) being most frequent, consistent with global data showing 20–30% session prevalence. Flythe JE, et. al; 2015 emphasized that IDH results from rapid ultrafiltration and autonomic dysfunction [15]. Indian studies reported IDH rates ranging from 26.8% to nearly 68%. Muscle cramps affected over 50% of patients, comparable to Tinoco M, et. al; 2025, who reported 74.5% prevalence [13]. Fatigue was another dominant symptom, with Jhamb M, et. al; 2008, noting moderate-to-severe fatigue in 60–70% of HD patients, linked with poor quality of life. Pruritus, nausea, and vomiting, though less frequently reported, were also significant, correlating with hyperphosphatemia, histamine release, or disequilibrium syndrome [16].

Technical complications were less common but serious, including machine malfunction, dialyzer membrane reactions, and water contamination. While improved technology has reduced such events in high-income countries, inadequate maintenance in resource-constrained settings poses ongoing risks. Bioincompatibility reactions, although reduced with synthetic membranes, can still trigger inflammation [17].

Vascular access-related complications remained highly prevalent, including infections, thrombosis, and aneurysms. Catheter-related bloodstream infections (CRBSI) are

particularly concerning, with Goplani K, et. al; 2020, in India and Fisher M & Mokrzycki MH. 2023 internationally identifying them as leading causes of hospitalization and mortality. Thrombosis and stenosis compromise access survival, requiring surgical or radiological intervention. Proper cannulation, early AV fistula creation, and routine surveillance are critical preventive strategies [4,18].

Smyth B, et. al; 2019, compared with other studies, the complication prevalence in this cohort aligns with broader literature, though variations are evident due to differences in population characteristics and dialysis protocols. For example, hypotension prevalence ranged from 26.8% to 68%, cramps from 18% to 74.5%, and fatigue from 30% to 82%. These findings underscore that, while complications are universal in HD populations, their distribution varies with clinical context and resources [19].

CONCLUSION

This study highlighted the prevalence and patterns of complications in chronic kidney disease patients undergoing hemodialysis, showing most were aged 51–70 years with a slight male predominance, and hypertension and diabetes as common comorbidities. Cardiovascular issues were the most frequent complications, followed by neurological, gastrointestinal, and technical problems, with vascular access complications significantly affecting morbidity. No strong associations with demographic or clinical factors were observed, indicating multifactorial risks. The findings stress early nephrology referral, individualized monitoring, and policy reforms to improve care in resource-limited settings.

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