Indonesian Journal of Kidney & Hypertension

InaKidney

e-ISSN : 2654-4253
p-ISSN : 3047-0765

Vol. 2, Issue 3, December 2025

Editorial

Original Article

Review Article

Case Report

Published by
Indonesian Society of Nephrology (InaSN)
Perhimpunan Nefrologi Indonesia (Pernefri)

TABLE OF CONTENT

VOL. 2 ISSUE 3, DECEMBER 2025

About InaKidney

Indonesian Journal of Kidney Disease and Hypertension is an open accessed online scientific journal managed and published by ***Perhimpunan Nefrologi Indonesia*/Indonesian Society of Nephrology (Pernefri/InaSN).** This journal aims to publish internationally peer-reviewed and edited scientific articles to provide novel scientific information in nephrology and hypertension. Authors are encouraged to submit research articles, case reports, evidence-based case report, and review articles that focus in the field of nephrology and hypertension. The subjects eligible for publication include, but not limited to chronic kidney disease, electrolyte and pH imbalance, hyperparathyroidism, CKD-MBD, renal anemia, acute kidney injury renal replacement therapy (dialysis, transplantation), hypertension, onconephrology, nephrotic and nephrtitic syndromes, glomerulonephritis and other glomerulopathies.

Further information regarding copyrights, publication, and article submmission can be accessed through **www.inakidneyhypertension.co.id**

Published by:
Perhimpunan Nefrologi Indonesia/Indonesian Society of Nephrology (Pernefri/InaSN)
Jl. Salemba Raya No.22, Kenari, Senen, Central Jakarta 10430
(021) 3149208
inakidney.journal@gmail.com
Journal manager: Luluk Rahmadani

Available online at http://inakidneyhypertension.co.id Official Journal of the Indonesian Society of Nephrology
Indonesian Journal of Kidney & Hypertension InaKidney

Editorial

The Impact of Icodextrin on Mortality of Peritoneal Dialysis Patients

Nur Samsu[1]

[1]**Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia**

Corresponding Author:
Nur Samsu, Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine, Universitas Brawijaya, dr. Saiful Anwar-General Hospital, Malang, Indonesia, nur_samsu.fk@ub.ac.id

Icodextrin is a water-soluble, high-molecular-weight glucose polymer that acts as a colloidal osmotic agent. It contains lactate rather than glucose, has a low pH value, and a low concentration of glucose degradation products (GDP). This solution is absorbed at a slower pace than glucose by the peritoneal cavity, primarily through the lymphatic vessels, thus maintaining the resulting colloidal osmotic pressure over a longer dwell time (8–16 hours).[1] Therefore, icodextrin is an important therapeutic option for optimizing fluid status, especially in patients with high transporter status. In addition, icodextrin also has beneficial effects on the metabolic profile[2,3], peritoneal membrane function[4], maintaining electrolyte balance, and improving nutritional status, which further contribute to improving the patient's quality of life.[5] In this edition of InaKidney, Budiman et al. found a prevalence of high transporters of 14.7%[6] , which is similar to that documented from the Australian and New Zealand Dialysis and Transplant (ANZDATA) registry of 16.7%.[7]

However, based on available evidence, the effect of icodextrin on patient survival remains unclear, likely due to small study sizes and limited follow-up durations. A meta-analysis of 10 RCTs involving 1,106 patients showed no significant difference in all-cause mortality and technical survival between icodextrin and PD solution.[8] Other studies have shown that icodextrin is associated with a lower risk of death and a first episode of peritonitis.[9] Although it significantly improves UF and reduces fluid overload with high certainty, icodextrin appears to reduce mortality modestly.[10] Based on analysis of data derived from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS), icodextrin failed to benefit patient survival (HR = 1.03; 95% CI, 0.72 to 1.48) or technical survival excluding death (HR = 1.20; 95% CI, 0.92 to 1.57).[11]

With its large sample size, the strength of the PDOPPS study is undeniable. However, it has several limitations. Icodextrin is generally used in patients with diabetes, higher transporter status, and hypoalbuminemia, which may indicate selection bias. Patients with these conditions have been associated with poorer outcomes.[12,13] Another limitation relates to the observational nature of the study itself, namely the difficulty in controlling and measuring salt and fluid intake, which also affect final volume status. Further, because of the large number of missing data (>50%), the potential influence of UF and peritoneal membrane function on clinical outcomes, if any, could not be examined, constituting an additional limitation of this study.

Cite this as:
Samsu N. The Impact of Icodextrin on Mortality of Peritoneal Dialysis Patients. InaKidney. 2025;2(3):98-100. doi:10.32867/inakidney.v2i3.225

Another factor associated with mortality outcomes that remains unclear is the duration of the study, which is generally less than 1 year. This is supported by retrospective cohort studies with a mean duration of more than 2 years, which have shown significant reductions in the risk of death and technique failure[14,15], suggesting the potential continuing benefits of icodextrin in real-world setting.

Finally, patient-centered outcomes associated with icodextrin use is important to evaluate. In high-risk patients, those with faster PSTR, a greater cardiovascular burden, and lower residual renal function, icodextrin is likely to improve clinical outcomes. Similarly, if icodextrin is initiated preventively in this subgroup of high-risk patients before volume overload occurs, it may improve clinical outcomes. However, it is important to understand that optimal volume management in PD patients must be multifaceted and cannot solely dependent on a specific PD solution. Further studies are therefore needed to evaluate patient-centered outcomes and to assess the cost-effectiveness of the preventive use of icodextrin.

Declarations

Competing interest

The author declares no conflict of interest.

References

1. Ha H, Yu MR, Choi HN, Cha MK, Kang HS, Kim MH, et al. Effects of Conventional and New Peritoneal Dialysis Solutions on Human Peritoneal Mesothelial Cell Viability and Proliferation. Perit Dial Int. 2000;20(5):S10–8. doi:10.1177/089686080002005s03
2. Han NM, Prasad N, Meyyappa J, Veeranki V, Kaul A, Patel M, et al. WCN25-4136 Outcomes of CAPD Patients Between Icodextrin and Non-Icodextrin Peritoneal Dialysis Fluid Usages. Kidney Int Reports. 2025;10(2):S723. doi:10.1016/j.ekir.2024.11.1283
3. Li PKT, Culleton BF, Ariza A, Do JY, Johnson DW, Sanabria M, et al. Randomized, controlled trial of glucose-sparing peritoneal dialysis in diabetic patients. J Am Soc Nephrol. 2013;24(11):1889–900. doi:10.1681/asn.2012100987
4. Davies SJ, Phillips L, Naish PF, Russell GI. Peritoneal glucose exposure and changes in membrane solute transport with time on peritoneal dialysis. J Am Soc Nephrol. 2001;12(5):1046–51. doi:10.1681/asn.v1251046
5. Li Y, Yang C, Zhou Z. Clinical benefits of icodextrin in peritoneal dialysis: Evidence from a multicenter, prospective, randomized controlled trial. J Int Med Res. 2025;53(9):1–12. doi:10.1177/03000605251379205
6. Budiman MF, Afiatin A, Andhika R. Differences in Type Characteristics of Peritoneal Membrane Using Peritoneal Equilibrium Test in End Stage Renal Disease Patients Undergoing Peritoneal Dialysis at Hasan Sadikin Hospital, Bandung. Indones J Kidney Hypertens. 2025;2(3):101–7. doi:10.32867/inakidney.v2i3.192
7. Wiggins KJ, McDonald SP, Brown FG, Rosman JB, Johnson DW. High membrane transport status on peritoneal dialysis is not associated with reduced survival following transfer to haemodialysis. Nephrol Dial Transplant. 2007;22(10):3005–12. doi:10.1093/ndt/gfm324
8. Wang IK, Chan CI, Lin AHF, Yu TM, Yen TH, Lai PC, et al. The impact of icodextrin on the outcomes of incident peritoneal dialysis patients. PLoS One. 2024;19(3):1–12. doi:10.1371/journal.pone.0297688
9. Kanno A, Tsujimoto Y, Fujii T, Fujikura E, Watanabe K, Yuasa H, et al. Comparison of clinical effects between icodextrin and glucose solutions on outcomes of peritoneal dialysis: systematic review and meta-analysis of randomized controlled trials. Ren Replace Ther. 2020;6(7):1–11. doi:10.1186/s41100-019-0253-4
10. Goossen K, Becker M, Marshall MR, Bühn S, Breuing J, Firanek CA, et al. Icodextrin Versus Glucose Solutions for

the Once-Daily Long Dwell in Peritoneal Dialysis: An Enriched Systematic Review and Meta-analysis of Randomized Controlled Trials. Am J Kidney Dis. 2020;75(6):830–46. doi:10.1053/j.ajkd.2019.10.004

11. Davies S, Zhao J, McCullough KP, Kim YL, Wang AYM, Badve S V., et al. International Icodextrin Use and Association with Peritoneal Membrane Function, Fluid Removal, Patient and Technique Survival. Kidney360. 2022;3:872–82. doi:10.34067/kid.0006922021

12. Han SH, Ahn SV, Yun JY, Tranaeus A, Han DS. Effects of icodextrin on patient survival and technique success in patients undergoing peritoneal dialysis. Nephrol Dial Transplant. 2011;27:2044–50. doi:10.1093/ndt/gfr580

13. Yang JY, Chen L, Peng YS, Chen YY, Huang JW, Hung KY. Icodextrin Is Associated with a Lower Mortality Rate in Peritoneal Dialysis Patients. Perit Dial Int. 2019;39(3):252–60. doi:10.3747/pdi.2018.00217

14. Ng JKC, Kwan BCH, Chow KM, Pang WF, Cheng PMS, Leung CB, et al. Asymptomatic fluid overload predicts survival and cardiovascular event in incident Chinese peritoneal dialysis patients. PLoS One. 2018;1–11. doi:10.1371/journal.pone.0202203

15. Biesen W Van, Verger C, Heaf J, Vrtovsnik F, Britto ZML, Do JY, et al. Evolution Over Time of Volume Status and PD-Related Practice Patterns in an Incident Peritoneal Dialysis Cohort. Clin J Am Soc Nephrol. 2019;14:882–93. doi:10.2215/cjn.11590918

Indonesian Journal of Kidney & Hypertension InaKidney

Original Article

Differences in Type Characteristics of Peritoneal Membrane Using Peritoneal Equilibrium Test in End Stage Renal Disease Patients Undergoing Peritoneal Dialysis at Hasan Sadikin Hospital, Bandung

Muhammad Fitriandi Budiman[1], Afiatin Afiatin[2], Rizky Andhika[2]

[1]Department of Internal Medicine, Universitas Padjadjaran, Bandung, Indonesia
[2]Division of Nephrology, Hasan Sadikin General Hospital, Universitas Padjadjaran, Bandung, Indonesia

ARTICLE INFO

Article history:
Received: May 27, 2025
Accepted: December 19, 2025
Published Online: December 24, 2025

Corresponding Author:
Muhammad Fitriandi Budiman, Department of Internal Medicine, Universitas Padjadjaran, Bandung, Indonesia,
andifitriandibudiman@gmail.com

ABSTRACT

Background: Peritoneal dialysis (PD) clears solutes and removes fluids from the patient's body. PD failure is primarily due to the clearing of solutes and the removal of fluids. Due to overhydration, the high peritoneal equilibrium test (PET) group is at greater risk of technical failure and death than other groups.
Objective: This study aimed to to determine the characteristics of PET in patients with end-stage renal failure undergoing peritoneal dialysis (PD) at Hasan Sadikin Hospital, Bandung.
Methods: This study is a retrospective, descriptive, and cross-sectional investigation.
Results: Of the 34 PD patients, the PET results were as follows: 47.1% for high average, 14.7% for high, 35.3% for low average, and 2.9% for low. There were no significant differences in most variables analyzed between the PET groups, including age, gender, etiology, comorbid diseases, history of hemodialysis (HD), residual renal function, and laboratory parameters such as hemoglobin, urea, creatinine, and albumin. The current blood glucose and body mass index (BMI) levels in the high PET group showed higher values and significant differences ($p = 0.019$ and $p = 0.043$, respectively).
Conclusion: Blood glucose and BMI may be important factors that distinguish patients with high PET from other PET groups.
Keywords: Peritoneal Equilibrium Test, Peritoneal Dialysis, End Stage Renal Disease.

Introduction

Peritoneal dialysis (PD) is a method used to remove waste products and excess fluids from the patient's body. PD failure is mainly in removing solutes and fluids. Ultrafiltration failure can be seen with clinical findings of volume overload. Several factors should be considered when assessing ultrafiltration failure, including non-compliance with the diet or dialysis regimen, as well as abnormalities at the dialysis access site.[1]

Many studies have found that patients in the high transporter group have a higher chance of death than the other groups. A recent study in China found that patients who were high transporters had a higher chance of death than others, reaching 2.35 times (95% CI 1.30-4.25, p = 0.01). As mentioned by the CANUSA Study, the 2-year survival rates for the low transporter, low average, high average, and high transporter groups were 91%, 80%, 72%, and 71%, respectively. The high PET group had a higher risk of technical failure and mortality compared with the other groups due to decreased water withdrawal and overhydration.[2]

The CANUSA study in high transporter found a rate of 15.311%, while studies in

Cite this as:
Budiman MF, Afiatin A, Andhika R. Differences in Type Characteristics of Peritoneal Membrane Using Peritoneal Equilibrium Test in End Stage Renal Disease Patients Undergoing Peritoneal Dialysis at Hasan Sadikin Hospital, Bandung. InaKidney. 2025;2(3):101-107. doi:10.32867/inakidney.v2i3.192

Australia and New Zealand found rates of 15.2%. A recent study in the United States also found a high transporter rate of 15.4%. A study involving a dialysis patient group monitored in the Netherlands showed a significant rate of technique failure, as merely 64% of participants remained on peritoneal dialysis 2 years later. The predictors identified among the free determinants included excretion capacity, peritoneal ultrafiltration, and systolic blood pressure. Research conducted in Japan revealed that ultrafiltration failure was recognized as the primary cause for subjects interrupting continuous ambulatory peritoneal dialysis (CAPD).

The peritoneal equilibration test (PET) is used to rapidly assess peritoneal function and to monitor changes in peritoneal function under various conditions. Changes in the peritoneal membrane may necessitate adjustments to the break-up medicine. A common problem is when fluid is not removed as it should be, which can be caused by a fast peritoneal solute transfer rate. Another problem is membrane dysfunction, which occurs when the peritoneal membrane fails to function properly. If membrane dysfunction worsens over time, the individual may need to switch to hemodialysis treatment. Regular evaluation of membrane function is required.[2–4]

Prolonged exposure to hypertonic glucose solutions alters the transport characteristics of the peritoneal membranes. Those classified as low or average transporters may transition to a high transporter status, potentially leading to an increased use of high-strength dextrose solutions. Factors contributing to volume overload can include not only dysfunction of the peritoneal membrane but also dietary choices, inadequate dialysis prescriptions, excessive sodium and fluid intake, and a decline in remaining kidney function without corresponding adjustments in dialysis treatment. Issues with catheters are frequently responsible for inadequate volume management.[5]

Diabetes mellitus represents the most critical risk factor for mortality in dialysis, including those in PD. A high peritoneal transport rate has likewise been revealed to be associated with mortality. Still, its role seems to be related to permeability and mortality in PD caused by diabetes mellitus. The role of higher serum creatinine in predicting better survival may be related to better nutritional status.

The process of selecting a peritoneal dialysis modality is complex. It depends on the patient's individual physical characteristics and the transporter status of the peritoneal membrane, not only on lifestyle considerations. Several key determinants must be considered when selecting the right PD formula for a patient. These factors include the patient's lifestyle, transporter status, body size and habitus, and degree of residual renal function, as well as specific contraindications or indications favouring one modality more than another. In patients with significant residual renal function, periodic measurement is essential to adjust the appropriate dialysis prescription. The transporter characteristics of the peritoneal membrane are unknown when the initial DP prescription is chosen. Consequently, the initial prescription is empirically assumed that the patient is an 'average' transporter.[6]

Patients with a high-transporter membrane type (4-hour dialysate/plasma creatinine [D/P] > 0.81) typically achieve adequate peritoneal clearance when using a standard PD regimen, but often experience impaired ultrafiltration (UF). This occurs due to rapid glucose reabsorption, which reduces the osmotic gradient required for UF. In this case, if the dwell times are prolonged, there will be sufficient fluid absorption such that the net UF during the dwell becomes minimal or even negative.[7,8]

Non-infectious complications were observed in 40% of PD patients, with ultrafiltration failure being the most frequent (15.5%). Patients who develop ultrafiltration failure switch to hemodialysis or undergo renal transplantation. The majority of complications (62%) do not affect catheter survival. Ultrafiltration failure and volume overload are the main causes of PD failure. Ultrafiltration failure can be caused by various factors such as decreased filtration rate, increased salt and water intake, and excessive weight gain. The reported prevalence of ultrafiltration failure as a reason for PD discontinuation varies from 1.7% to 13.7%.[9,10]

Methods

This study is a retrospective, descriptive, cross-sectional study to determine the characteristics of the type of peritoneal membrane using the PET in patients with end-stage renal disease undergoing PD at Hasan Sadikin Hospital, Bandung.

Results

In a study conducted at Hasan Sadikin Hospital related to end-stage renal disease patients undergoing PD, Baseline characteristics between groups were compared with the PET.

From the 34 PD patients, the results of PET were low in one person (2.9%), low average in 12 people (35.3%), high in 5 people (14.7%), and high average in 16 people (47.1%). The age range in low PET was 23 years old, the average age in low PET was 39.4 ± 9.5 years old, the average age in high PET was 41.8 ± 27.0, and the average age in high PET was 42.3 ± 20. There was no significant difference in the age criteria on PET results in each group. From the gender perspective, a high average PET was observed in 12 (35.3%) of the 23 male patients, and 6 (17.6%) of the patients had a low average PET; however, there was no significant difference between the groups. Based on the education level criteria, there is no significant difference among the groups. Etiology: End-stage renal disease (ESRD) was accounted to diabetic nephropathy in 6 (17.6%) patients, and non-diabetic nephropathy in 28 (82.3%) patients. There were no significant differences between the groups. Patients underwent hemodialysis (HD) for <3 months before converting to PD, 28 (82.3%) patients were found.

The KT/V data were highest in the low average PET with a value of 1.9 ± 0.5, but there was no significant difference when compared to the other groups. Similarly, the highest urine volume was observed in the low average PET group, at 95.8 ± 213.7 ml/day, but there was no significant difference compared to the other groups. Hemoglobin laboratory examination in the high PET group was found to be 9.2 ± 7.5, with no significant difference compared to the other groups. The results of the urea examination on high PET were as follows: 146 ± 129, creatinine 13.3 ± 7.1, sodium 136.2 ± 133.0, potassium 4.5 ± 3.5, albumin 3.0 ± 2.5, serum iron 84.2 ± 27.0, and TIBC 186.8 ± 135.0. No significant difference was observed in any of the PET groups.

Blood glucose levels in the high PET group, ranging from 98 to 616, were the highest compared to all other groups and showed a significant difference between groups ($p = 0.019$). The BMI obtained in the high PET group was 25.6 ± 20.2, which tended to be higher than in the other groups ($p = 0.043$). Additionally, the BMI criteria also showed a significant difference between groups ($p = 0.047$). Peritonitis was observed in 18 (52,9%) patients during the study, but there was no significant association between the groups. (Table 1)

Table 1. Differences in PET Characteristics in End-stage Renal Disease Patients with PD at Hasan Sadikin Hospital

Variables	PET				p
	Low n=1	Low Average n=12	High Average n=16	High N=5	
Age (years), Mean ± SD	23.0	39.4 ± 9.5	42.3 ± 20.0	41.8 ± 27.0	0.545[a]
Age Criteria, n (%)					0.672[c]
<55 years	1 (100)	11 (91.7)	12 (75)	4 (80)	
≥55 years	0 (0)	1 (8.3)	4 (25)	1 (20)	
Gender, n (%)					0.403[c]
Male	1 (100)	6 (50)	12 (75)	4 (80)	
Female	0 (0)	6 (50)	4 (25)	1 (20)	
Education level, n (%)					0.100[c]
High School	1 (100)	5 (41.7)	13 (81.3)	2 (40)	
College	0 (0)	7 (58.3)	3 (18.8)	3 (60)	
Etiology of ESRD, n (%)					0.672[c]
Diabetic Nephropathy	0 (0)	1 (8.3)	4 (25)	1 (20)	
Non Diabetic nephropathy	1 (100)	11(91.7)	12 (75)	4 (80)	
HD History, n (%)					0.763[c]
≤3 months	1 (100)	8 (66.7)	14 (87.5)	5 (100)	0.307[c]
>3 months	0 (0)	4 (33.3)	2 (12.5)	0 (0)	
Dialysis Adequacy, Mean ± SD					
Kt/V, n=30	0.5	1.9 ± 0.5	1.8 ± 0.8	1.8 ± 1.3	0.059[a]
Urine Volume (mL/day), Mean ± SD	0.0	95.8 ± 213.7	46.9 ± 0.0	0.0 ± 0.0	0.708[a]
Residual kidney function, n (%)					
Urine Volume ≥250 ml/day	0 (0)	2 (16.7)	1 (6.3)	0 (0)	0.653[c]
Urine Volume <250 ml/day	1 (100)	10 (83.3)	15 (93.8)	5 (100)	
Laboratory, Mean ± SD					
Haemoglobin (gr/dL)	9.5	9.2 ± 1.3	9.3 ± 5.5	9.2 ± 7.5	0.998[a]
Blood glucose (mg/dL), n=30	63	87 (77 – 117)	94 (73 – 255)	132 (98 – 616)	**0.019*[a]**
Urea (mg/dL)	149.7	88.6 ± 38.5	127.1 ± 43.5	146.4 ± 129.0	0.072[a]
Creatinine (mg/dL)	18.7	10.2 ± 3.2	11.7 ± 5.6	13.3 ± 7.1	0.093[a]
Sodium (mEq/L)	136.0	135.8 ± 4.7	136.4 ± 130.0	136.2 ± 133.0	0.970[a]
Potassium (mEq/L)	2.9	3.5 ± 0.8	4.0 ± 2.6	4.5 ± 3.5	0.141[a]
Albumin (gr/dL)	3.4	3.2 ± 0.5	3.2 ± 2.0	3.0 ± 2.5	0.853[a]
Serum iron (ug/dL), n=30	83.0	68.4 ± 23.9	74.1 ± 23.0	84.2 ± 27.0	0.890[a]

Variables	PET				p
	Low n=1	**Low Average n=12**	**High Average n=16**	**High N=5**	
TIBC (ug/dL), n=30	220.0	216.6 ± 46.2	226.4 ± 168.0	186.8 ± 135.0	0.441[a]
Anemia, n (%)					0.402[c]
Yes (Hemoglobin ≤9 gr/dL)	0 (0)	9 (75)	12 (75)	3 (60)	
No (Hemoglobin >9 gr/dL)	1 (100)	3 (25)	4 (25)	2 (40)	
BMI (kg/m2), Mean ± SD	19.6	19.6 ± 1.4	20.9 ± 17.6	25.6 ± 20.2	**0.043*[b]**
BMI criteria, n (%)					**0.047*[c]**
<20 kg/m2	1 (100)	8 (66.7)	6 (37.5)	0 (0)	
≥20 kg/m2	0 (0)	4 (33.3)	10 (62.5)	5 (100)	
Incidence of Peritonitis, n (%)					0.895[b]
No	1 (100)	5 (41.7)	8 (50.0)	2 (40.0)	
Yes	0 (0)	7 (58.3)	8 (50.0)	3 (60.0)	

Note: n = frequency, %=percentage, SD = Standard Deviation, Analysis using [a] One Way ANOVA, [b]Chi Square, [c]Fisher Exact, *significant p<0.05

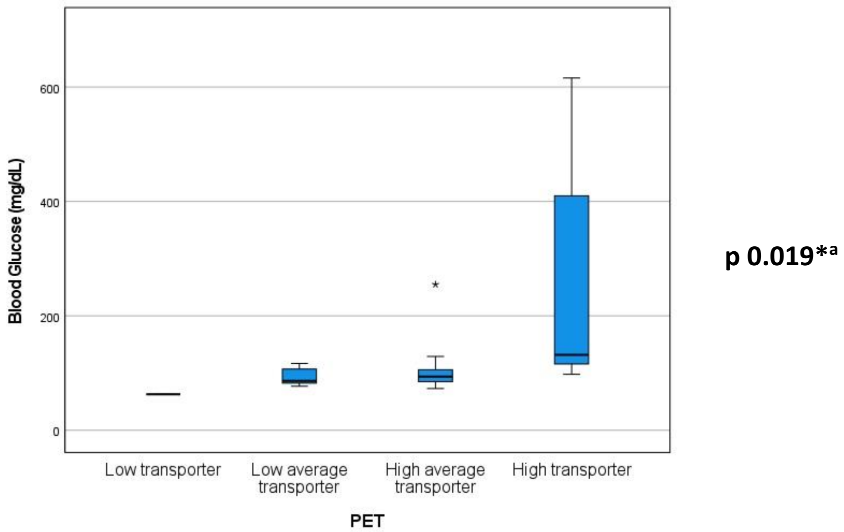


Figure 1. Blood Glucose in the PET Group

Discussion

The results obtained in this study were as follows: low PET, 2.9%; low average, 35.3%; high, 14.7%; and high average, 47.1%. The CANUSA study in high transporters PET found 15.3% of research in Australia and New Zealand, and a recent study in the United States found high transporters at 15.4%. This study demonstrated no significant differences among the groups for most analyzed variables, including age, gender, education level, ESRD etiology, comorbid diseases, history of dialysis, residual renal function, and specific laboratory parameters such as hemoglobin, urea, creatinine, and albumin. Some of the variables showed significant differences; for example, baseline blood glucose ($p = 0.019$) exhibited an essential difference between the groups, with the PET high group having higher values. BMI ($p = 0.043$) and BMI criteria ($p = 0.047$) also showed significant differences, with the high PET group having a higher BMI. The CANUSA study identified a risk factor for high PET as an 11% decrease in blood albumin value. However, studies in Turkey and China found other risk factors, including male gender, high albumin levels, low blood count, diabetes, and vascular disease. Research conducted by Intarawongchot in Thailand found that age over 60 years was the only factor significantly associated with high transporters ($p = 0.003$, odds ratio 18.127, 95% CI 2.697-121.835).[2]

Research conducted by Edmund J. Lamb showed that diabetes can affect peritoneal membrane transport, and ultrafiltration will be lower in diabetic patients if there is no adequate glucose control. Factors that affect PD success include systolic blood pressure, urine volume, and peritoneal ultrafiltration rate.[11]

Studies have indicated that ultrafiltration failure is the primary cause for discontinuing CAPD in patients who have been on PD for an additional 6 years. Long-term exposure to hypertonic dextrose solution may alter the peritoneum' characteristics, thereby affecting the transport of substances across the peritoneal membrane. Additionally, volume overload can also be caused by other factors such as dietary inattention, excessive fluid and sodium intake, inadequate dialysis prescription, and catheter damage. Ultrafiltration failure/volume status, glucose, and an osmotic agent in standard PD solutions cause progressive membrane changes that ultimately result in membrane failure. More recent biocompatible solutions without dextrose have shown reduced membrane damage and may contribute to improved preservation of the peritoneal membrane. In a Japanese cohort of over 7000 patients, the PD failure rate among those using Icodextrin (8.9%) was significantly lower than that of those using dextrose (14.5%) ($P < 0.0001$) [43]. In a double-blind randomized trial, DP patients were treated with Icodextrin for a prolonged period compared to standard treatment.[10]

Conclusion

Blood glucose and body mass index (BMI) may be important factors that distinguish patients with high PET from other PET groups.

Limitations of the Study

The weakness of this study is the small number of patients studied, 34 patients; more patients are needed so that each PET group has an adequate number. The patient's BMI is calculated solely based on weight and height, so it is not known whether the patient is in a state of excess body fluid. A bio-electrical Impedance Analysis (BIA) examination is recommended to confirm the patient's body composition.

Declarations

Ethics approval and consent to participate

This study received approval from the Ethics Committee of the Hasan Sadikin Hospital Bandung under reference number DP.04.03/D.XIV.6.5/371/2024.

Competing interests

There are no conflicts of interest in writing this article.

Funding source

Not applicable.

Acknowledgments

None.

Author's Contribution

Idea/concept: MFB. Design: MFB. Control/supervision: AFT, RA. Data collection/ processing: MFB. Analysis/interpretation: MFB, AFT, RA. Literature review: - Writing the article: MFB. Critical review: - All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Teitelbaum I. Ultrafiltration failure in peritoneal dialysis: a pathophysiologic approach. Blood Purif. 2015;39(1–3):70–3. doi:10.1159/000368972

2. Intarawongchot P. Factors Associated with High Peritoneal Transport in End-Stage Kidney Disease on Peritoneal Dialysis. J Heal Sci Thail. 2022;31(Supplement 1):146– 154.

3. Dewi M, Bachtiar A. Peritonitis Rate dan Angka Kematian pada Pasein CAPD di Asia Tenggara: Protokol Systematic Review. J Med Hutama [Internet]. 2022;3(2):2135–42. Available from: http://jurnalmedikahutama.com

4. Hansson JH, Watnick S. Update on Peritoneal Dialysis: Core Curriculum 2016. Am J Kidney Dis. 2016;67(1):151–64. doi:10.1053/j.ajkd.2015.06.031

5. Yeekian C, Booncharoeni P. Analysis of Peritoneal Equilibration Test and Risk Factors of High Transporter in Patients Undergoing Continuous Ambulatory Peritoneal Dialysis. TRC Nurse J. 2022;15(1):144–60.

6. Morelle J, Stachowska-Pietka J, Öberg C, Gadola L, Milia V, Yu Z, et al. ISPD recommendations for the evaluation of peritoneal membrane dysfunction in adults: classification, measurement, interpretation and rationale for intervention. Perit Dial Int. 2021;41(4):352–72. doi:10.1177/0896860820982218

7. Daugirdas JT, Blake PG, Ing TS. Handbook of Dialysis. 5th ed. LWW; 2015. 1–844 p.

8. Willis K, Cheung M, Slifer S. KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Kidney Int [Internet]. 2013 Apr 1;3(1):1–163. Available from: https://doi.org/10.1016/j.kint.2023.10.018doi:10.1016/j.kint.2023.10.018

9. Prakash J, Singh LS, Shreeniwas S, Ghosh B, Singh T. Non-infectious complications of continuous ambulatory peritoneal dialysis and their impact on technique survival. Indian J Nephrol. 2011;21(2):112–5. doi:10.4103/0971-4065.82125

10. Chaudhary K. Peritoneal Dialysis Drop-out: Causes and Prevention Strategies. Int J Nephrol. 2011;2011:434608. doi:10.4061/2011/434608

11. Lamb JE, Worral J, Buhler R, Harwood S, Cayi'ell WR, Dawnay AB. Effect of diabetes and peritonitis on the peritoneal equilibration test. Kidney Int. 1995;47(6):1760–1767. doi:10.1038/ki.1995.243

ndonesian Journal of Kidney & Hypertension InaKidney

Original Article

Associated Factors with Erectile Dysfunction in Hemodialysis Patients at Dr. Reksodiwiryo Hospital Padang

Achmad Vidiansyah[1], Mindy Pasuma Putra[1], Evelin Veronike[2], Harnavi Harun[2]

[1]Dialysis Unit RST dr. Reksodiwiryo, Padang, Indonesia
[2]Nephrology Division RSUP Dr. M. Djamil, Padang, Indonesia

ARTICLE INFO

Article history:
Received: October 31, 2025
Accepted: December 10, 2025
Published Online: December 24, 2025

Corresponding Author:
Harnavi Harun,
Nephrology Division
RSUP Dr. M. Djamil,
Padang, West Sumatra,
Indonesia,
harnavi@med.unand.ac.id

ABSTRACT

Background: Erectile dysfunction (ED) is a common condition affecting a significant number of men worldwide, with its prevalence particularly high among patients with chronic kidney disease (CKD).
Objective: This study aims to investigate the association between ED and CKD in patients undergoing hemodialysis.
Methods: This study used a survey approach, designed with cross-sectional involving 24 male patients undergoing hemodialysis at the hospital from January to July 2024. Data were gathered using the IIEF-5 questionnaire as well as patient records. The severity of ED was classified based on IIEF-5 scores, and data analysis was conducted using SPSS.
Results: Most respondents (58.3%) were under 60 years old, with 58.3% having hemoglobin levels below 10 g/dL and 79.2% with a KT/V ratio under 1.8. ED prevalence was high at 95.8%, with severe ED affecting 54.2%. A significant correlation existed between KT/V and ED severity $p<0.05$, while hemoglobin levels showed no significant association $p>0.05$. The high prevalence of ED in CKD patients undergoing hemodialysis highlights the importance of regular screening and early intervention. The study indicates that sufficient hemodialysis, as measured by the Kt/V ratio, could be essential in reducing the severity of ED in this group. However, hemoglobin levels did not show a significant connection to ED severity, which contrasts with certain earlier research findings.
Conclusion: Erectile dysfunction is common among CKD patients undergoing hemodialysis, with insufficient dialysis being a key contributing factor. This highlights the need to maintain adequate dialysis to reduce the severity of ED in these individuals.
Keywords: Chronic Kidney Disease, Erectile dysfunction, Hemodialysis.

Introduction

Erectile dysfunction (ED) is a condition characterized by difficulty in achieving or maintaining an erection sufficient for satisfactory sexual activity. The disorder is relatively common and is estimated to affect around 150 million men worldwide, with incidence rates continuing to rise. It is projected that by 2025, the number of men experiencing ED could reach 300 million, almost double the current number. The factors contributing to this condition are diverse, ranging from ageing to metabolic disorders such as hypertension, diabetes, and hyperlipidemia, as well as smoking, which has long been associated with sexual dysfunction. In addition, recent studies have shown that chronic kidney disease (CKD) also acts as a significant risk factor in the development of ED, adding complexity to its treatment and prevention. Therefore, understanding the various factors that trigger ED is important to devise more effective prevention and treatment strategies.[1] In uremic patients, vascular issues, along with decreased libido due to hormonal changes and fluctuations, such as a

Cite this as:
Vidiansyah A, Putra MP, Veronike E, et al. Associated Factors with Erectile Dysfunction in Hemodialysis Patients at Dr. Reksodiwiryo Hospital Padang. InaKidney. 2025;2(3):108-113. doi:10.32867/inakidney.v2i3.218

reduced frequency of sexual activity, are significant contributing factors. Erectile dysfunction has emerged as a significant concern for patients with compromised renal function, as evidenced by recent research that relates hormonal and erectile problems with renal function. Similar to the cardiovascular system, renal function is frequently correlated with hormonal and ED.[2]

Navaneethan et al., in their meta-analysis, revealed that the average prevalence of ED in patients with CKD is as high as 70%, suggesting that this condition is a common complication. Furthermore, a study conducted by Mesquita et al. found that the prevalence rate of ED varied based on the stage of CKD, with 72.3% in stage 3 patients, increasing to 81.5% in stage 4, and reaching 85.7% in stage 5. Similar results were also reported by Nassir, who noted that 82.7% of patients newly starting dialysis therapy had erectile dysfunction. These findings indicate that the more advanced the stage of CKD, the higher the risk of erectile dysfunction, which in turn can impact patients' quality of life.[3–5]

Chronic kidney disease causes serious health problems and puts a heavy strain on healthcare budgets as more patients are diagnosed over time.[6] The standard test for CKD, measuring serum creatinine levels, may not detect the disease early because the kidneys can handle damage for a while. Even when creatinine levels start to rise, noticeable symptoms usually do not appear until kidney function falls to 20–30%.[7] Early diagnosis is important because simple measures can significantly slow the disease's progress. Thus, there is a need for better early detection markers to diagnose CKD early and prevent it from reaching advanced stages.

This study seeks to assess whether ED can function as an early clinical indicator of CKD. Patients with ED will be evaluated for CKD to determine if ED could signal an early warning, with the objective of preventing or delaying the advancement to end-stage renal failure.

Methods

Design and participants

The study employed a cross-sectional approach to examine the association between ED and different factors in male patients receiving hemodialysis. Carried out at Dr. Reksodiwiryo Hospital, the research took place over a period of seven months, from January to July 2024. Participants were chosen through a consecutive sampling method to achieve a thorough representation of the target population.

Data in this study were obtained through the International Index of Erectile Function (IIEF-5) questionnaire, which classifies erectile dysfunction (ED) into five categories based on a score scale, namely normal (26-30), mild (22-25), mild to moderate (17-21), moderate (11-16), and severe (0-10). This questionnaire was used to assess the severity of ED in respondents more systematically and measurably. This study aims to explore the relationship between ED and various clinical factors, such as age, hemoglobin (Hb) level, and KT/V ratio, which play a role in measuring the effectiveness of the hemodialysis process in patients.

Study Covariate

The study examined various covariates to determine their relationship with ED in male patients undergoing hemodialysis. Age was identified as a key factor and was divided into two groups: those younger than 60 years and those 60 years or older. Hemoglobin levels, a crucial measure of oxygen transport in the blood, were categorized as either below 10 mg/dl or 10 mg/dl and above. Hemodialysis effectiveness was evaluated using the KT/V ratio, which reflects urea clearance in relation to its distribution volume, with thresholds set at less than 1.8 and 1.8 or higher. ED severity as the primary outcome was evaluated using the International Index of Erectile Function (IIEF-5) and categorized into five levels: normal (26-30), mild (22-25), mild to moderate (17-21), moderate (11-16), and severe (0-10). The covariates used were selected based on their clinical significance as well as their possible impact on ED, thus providing a comprehensive approach to analyzing the factors influencing sexual dysfunction in this patient group.

Statistical analysis

Data analysis in this study was conducted using SPSS version 22.0 software to systematically process and interpret the data. Descriptive statistics were applied to summarize the characteristics of the study population, including age, hemoglobin (Hb) level, KT/V ratio, and severity of erectile dysfunction (ED). In this analysis, continuous variables were presented as means and standard deviations, while categorical variables were presented as frequency distributions and percentages. To evaluate the relationship between the categorical variables, the Chi-Square test was used, which allowed identification of significant associations between age, Hb level, KT/V ratio, and ED severity. The results of the analysis were considered statistically significant when the p-value was less than 0.05, indicating that the observed association was not the result of chance alone. As such, this test plays an important role in determining whether variations in ED severity are significantly associated with physiological factors such as age, hemoglobin level, or KT/V ratio. This analysis aims to identify the main factors contributing to ED in patients undergoing hemodialysis and assess their clinical relevance in improving patients' quality of life.

Results

Patient selection

This study involved 24 male patients undergoing hemodialysis at Dr. Reksodiwiryo Hospital, selected through consecutive sampling between January and July 2024. Erectile dysfunction severity was evaluated using the International Index of Erectile Function (IIEF-5) questionnaire. Patient characteristics were analyzed concerning key factors such as age, Hb levels, and KT/V ratios, which assess dialysis adequacy. Ethical approval was secured to ensure adherence to research standards.[8]

The findings showed that 58.3% of patients were under 60 years old, while 41.7% were 60 years or older (Table 1).

Table 1. Characteristics of patients in our study

Respondent Characteristic	Frequency	Percentage
Age		
a. <60	14	58.3%
b. >=60	10	41.7%
HB		
a. <10	14	58.3%
b. >=10	10	41.7%
KT/V		
a. <1,8	19	79.2%
b. >= 1,8	5	20.8%
ED Stages		
a. Mild erectile dysfunction	3	12.5%
b. Mild to moderate erectile dysfunction	4	16.7%
c. Moderate erectile dysfunction	3	12.5%
d. No erectile dysfunction	1	4.2%
e. Severe erectile dysfunction	13	54.2%

In terms of hemoglobin levels, 58.3% had values below 10 mg/dl, whereas 41.7% had levels of 10 mg/dl or higher (Table 2).

Table 2. Distribution of Age and Erectile Dysfunction Grades

		ED Grades					
		Mild erectile dysfunction	Mild to moderate erectile dysfunction	Moderate erectile dysfunction	No erectile dysfunction	Severe erectile dysfunction	total
Age	<60	3 21.4%	4 28.6%	0 .0%	1 7.1%	6 42.9%	14 100.0%
	>= 60	0 .0%	0 .0%	3 30.0%	0 .0%	7 70.0%	10 100.0%
Total		3 12.5%	4 16.7%	3 12.5%	1 4.2%	13 54.2%	24 100.0%

The KT/V ratio analysis indicated that 79.2% of patients had values below 1.8, suggesting inadequate hemodialysis, while only 20.8% had ratios of 1.8 or higher (Table 3).

Table 3. Distribution of Hemoglobin and Erectile Dysfunction grades

		ED Grades					
		Mild erectile dysfunction	Mild to moderate erectile dysfunction	Moderate erectile dysfunction	No erectile dysfunction	Severe erectile dysfunction	Total
HB	<10	1 7.1%	1 7.1%	3 21.4%	0 .0%	9 64.3%	14 100.0%
	>= 10	2 20.0%	3 30.0%	0 10.0%	1 10.0%	4 40.0%	10 100.0%
Total		3 12.5%	4 16.7%	3 12.5%	1 4.2%	13 54.2%	24 100.0%

The severity of ED among participants was notable: 54.2% suffered from severe ED, 4.2% had no ED, and the remaining individuals experienced varying degrees of mild to moderate ED (Table 4).

Table 4. Distribution of KT/V and Erectile Dysfunction grades

		ED Grades					
		Mild erectile dysfunction	Mild to moderate erectile dysfunction	Moderate erectile dysfunction	No erectile dysfunction	Severe erectile dysfunction	Total
KT/V	<1.8	3 15.8%	3 15.8%	1 5.3%	0 .0%	12 63.2%	19 100.0%
	>= 1.8	0 .0%	1 20.0%	2 40.0%	1 20.0%	1 20.0%	5 100.0%
Total		3 12.5%	4 16.7%	3 12.5%	1 4.2%	13 54.2%	24 100.0%

Additional analysis revealed a significant correlation between KT/V ratios and ED severity, with a Chi-Square test p-value of 0.044 (Table 5).

Table 5. Association between KT/V and Erectile Dysfunction with Chi-Square

	Asymp. Sig (2-sided)
Pearson Chi- Square	0.044

Patients with lower KT/V ratios (<1.8) were more prone to severe ED. However, no statistically significant link was found between hemoglobin levels and ED severity, as indicated by a p-value of 0.148 (Table 6). Age also appeared to influence ED severity, with patients aged 60 years or older experiencing higher rates of severe ED than younger individuals. These results highlight the impact of dialysis adequacy and age on ED development in hemodialysis patients, while hemoglobin levels had a less pronounced effect.

Table 6. Association between Hemoglobin and Erectile Dysfunction with Chi-Square

	Asymp. Sig (2-sided)
Pearson Chi- Square	0.148

Discussion

This study offers valuable insights into the prevalence and contributing factors of ED in male patients undergoing hemodialysis. The results indicated a high occurrence of ED, with severe cases being the most common. Age and dialysis adequacy, assessed through KT/V ratios, were identified as key factors affecting ED severity, whereas hemoglobin levels showed no significant statistical association.

The strong correlation between KT/V ratios and ED severity underscores the vital role of dialysis adequacy in preserving sexual health among CKD patients. Those with KT/V values below 1.8 were more prone to severe ED, highlighting the necessity of optimizing dialysis to improve overall quality of life. This finding supports previous research indicating that insufficient dialysis not only impacts general health but also worsens sexual dysfunction. Effective dialysis plays a crucial role in eliminating uremic toxins, which, if retained, can interfere with vascular and hormonal pathways essential for normal erectile function.[9]

Age was also strongly associated with ED severity, with patients aged 60 and older being more likely to experience severe ED than younger individuals. This finding aligns with previous research suggesting that age is a major risk factor for ED, largely due to age-related vascular and hormonal changes. The increased prevalence of severe ED among older patients highlights the importance of targeted interventions and counseling to effectively address sexual health concerns in this population.[2]

On the other hand, hemoglobin levels, despite being an indicator of anemia frequently linked to CKD, did not exhibit a significant association with ED severity. Although anemia can affect oxygen transport and vascular function, its direct influence on ED may be less substantial compared to factors like hormonal imbalances and dialysis adequacy. This finding is consistent with some studies suggesting that while anemia is common in CKD, it does not always directly correlate with sexual dysfunction. Further research with larger sample sizes and more in-depth evaluations of anemia's effects on vascular and hormonal function could provide greater clarity on this relationship.[8,10]

The significant occurrence of severe ED in this study highlights the importance of comprehensive management strategies for CKD patients on hemodialysis. Efforts should prioritize optimizing dialysis adequacy, mitigating age-related risk factors, and implementing routine ED screening for early detection and treatment. Moreover, hormonal imbalances commonly seen in CKD, such as reduced testosterone levels and increased prolactin, should be further explored as potential therapeutic targets to enhance sexual function.[11]

This study highlights the complexity of erectile dysfunction (ED) in hemodialysis patients, which is caused by the dynamic interaction between various physiological, vascular, and hormonal factors. This condition not only affects aspects of sexual health but also has a significant impact on patients' overall quality of life. Therefore, a comprehensive management approach, encompassing medical interventions, hormonal therapy, as well as treatment strategies focusing on cardiovascular health, is crucial to improve patient well-being.

Conclusion

The study revealed that ED remains highly prevalent among CKD patients undergoing regular hemodialysis. Several factors, including low Hb levels and shorter dialysis duration, contribute to the severity of ED by leading to inadequate dialysis. These findings offer valuable insights for physicians and healthcare professionals on the importance of these factors in determining ED severity in CKD patients receiving hemodialysis. However, further research using a prospective approach and minimizing bias is necessary to strengthen these conclusions.

Limitations of the Study

Future research should be directed towards prospective studies with larger sample sizes to strengthen the scientific evidence regarding the relationship between these factors and the effectiveness of various treatment methods.

Declarations

Ethics approval and consent to participate

This study adhered to the guidelines for the Declaration of Helsinki and received approval from the Ethics Committee of the Dr. Reksodiwiryo Hospital, Padang, Indonesia, under reference number B/250/VII/2024.

Competing interests

There are no conflicts of interest in writing this article.

Funding source

This research was conducted using funds from sponsorship.

Acknowledgments

None.

Author's Contribution

Idea/concept: AV, MP, EV, HH. Design: AV, MP, EV, HH. Control/supervision: AV, MP, EV, HH. Data collection/ processing: AV, MP, EV, HH. Analysis/interpretation: AV, MP, EV, HH. Literature review: AV, MP, EV, HH. Writing the article: AV, MP, EV, HH. Critical review: AV, MP, EV, HH. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Vecchio M, Palmer SC, Tonelli M, Johnson DW, Strippoli GFM. Depression and sexual dysfunction in chronic kidney disease: a narrative review of the evidence in areas of significant unmet need. Nephrol Dial Transpl. 2012 Sep;27(9):3420–8. doi:10.1093/ndt/gfs135

2. Al-Qudimat A, Al-Zoubi R, Mahdi M, Talib R, Yassin A. Long-term testosterone therapy improves renal function in men with hypogonadism: A real-life prospective controlled registry. J Clin Nephrol Res. 2020;7(1):1095. doi:10.47739/2379-0652/1095

3. Navaneethan SD, Vecchio M, Johnson DW, Saglimbene V, Graziano G, Pellegrini F. Prevalence and correlates of self-reported sexual dysfunction in CKD: A meta-analysis of observational studies. Am J Kidney Dis. 2010;56(4):670–85. doi:10.1053/j.ajkd.2010.06.016

4. Mesquita JFP, Ramos TF, Mesquita FP, Netto JMB, Bastos MG, Figueiredo AA. Prevalence of erectile dysfunction in chronic renal disease patients on conservative treatment. Clinics. 2012;67(2):181–3. doi:10.6061/clinics/2012(02)15

5. Nassir A. Erectile dysfunction risk factors for patients entering dialysis programme. Andrologia. 2010;42(1):41–7. doi:10.1111/j.1439-0272.2009.00954.x

6. Chen TK, Knicely DH, Grams ME. Chronic kidney disease diagnosis and management: A review. JAMA. 2019;322(13):1294–1304. doi:10.1001/jama.2019.14745

7. Asai M, Kumakura S, Kikuchi M. Review of the efficacy of AST-120 (KREMEZIN®) on renal function in chronic kidney disease patients. Ren Fail. 2019;41(1):47–56. doi:10.1080/0886022x.2018.1561376

8. Malekmakan L, Shakeri S, Haghpanah S, Pakfetrat M, Sarvestani AS, Malekmakan A. Epidemiology of erectile dysfunction in hemodialysis patients using IIEF questionnaire. Saudi J Kidney Dis Transpl. 2011;22(2):232–6.

9. Hauk M, Kuhlmann MK, Riegel W, Köhler H. In vivo effects of dialysate flow rate on Kt/V in maintenance hemodialysis patients. Am J Kidney Dis. 2000;35(1):105–11. doi:10.1016/s0272-6386(00)70308-8

10. Naya Y, Soh J, Ochiai A, Mizutani Y, Ushijima S, Kamoi K. Significant decrease of the International Index of Erectile Function in male renal failure patients treated with hemodialysis. Int J Impot Res. 2002;14(3):172–7. doi:10.1038/sj.ijir.3900854

11. Arslan D, Aslan G, Sifil A, Çavdar C, Çelebi I, Gamsari T. Sexual dysfunction in male patients on hemodialysis: Assessment with the International Index of Erectile Function (IIEF). Int J Impot Res. 2002;14(6):539–42. doi:10.1038/sj.ijir.3900937

Available online at http://inakidneyhypertension.co.id Official Journal of the Indonesian Society of Nephrology

ndonesian Journal of Kidney & Hypertension InaKidney

Original Article

Understanding Readmission Risks in End-Stage Kidney Disease: A Study from Wangaya Hospital

Ni Nyoman Gita Kharisma Dewi[1], Made Sindy Astri Pratiwi[1], Made Priska Arya Agustini[1], Putu Itta Sandi Lesmana Dewi[1], Cindy Fahira[1], I Wayan Sunaka[2]

[1]Intern Doctor, Department of Internal Medicine, Wangaya Regional General Hospital, Denpasar, Indonesia
[2]Internal Internist, Department of Internal Medicine, Wangaya Regional General Hospital, Denpasar, Indonesia

ARTICLE INFO

Article history:
Received: September 16, 2025
Accepted: December 19, 2025
Published Online: December 24, 2025

Corresponding Author:
Ni Nyoman Gita Kharisma Dewi,
Intern Doctor, Department of Internal Medicine, Wangaya Regional General Hospital, Denpasar, 80231, Bali, Indonesia,
gitakharismadewi67@gmail.com

ABSTRACT

Background: End-stage kidney disease (ESKD) is a growing health burden. Poor patient knowledge and treatment adherence contribute to increased morbidity, as reflected in readmission rates.
Objective: This study aimed to identify factors associated with readmission among ESKD patients in Bali.
Methods: A retrospective cohort study was conducted at Wangaya Hospital. Adult patients (≥18 years) diagnosed with ESKD, with or without dialysis, between 2022 and 2024 were included. Patients with incomplete records or a solitary kidney were excluded. Bivariate analysis (chi-square test) and multivariate analysis (binary logistic regression) were used to assess associations, with significance set at $p < 0.05$.
Results: A total of 199 patients met the inclusion criteria; 61.8% were male, with a median age of 57 years (range: 22–88 years). Readmission rates within and beyond one month were 18.6% and 15.1%, respectively. Reduced eGFR was significantly associated with 30-day readmission ($p = 0.041$). For readmission beyond 30 days, significant predictors included diabetes mellitus ($p = 0.014$), neurologic disorders ($p < 0.001$), and adherence ($p = 0.019$).
Conclusion: eGFR predicts early readmission, while diabetes mellitus, neurological disorders, and treatment adherence influence later readmissions. Identifying these factors is vital for improving patient education and reducing healthcare burdens.
Keywords: End-stage kidney disease, readmission, predictive factors.

Introduction

Chronic kidney disease (CKD) is a progressive condition characterized by structural or functional kidney abnormalities or a sustained reduction in estimated glomerular filtration rate (eGFR) below 60 mL/min/1.73 m² for at least three months. These abnormalities may include pathological findings on imaging or biopsy, persistent albuminuria, or abnormal urinary sediment.[1] Over time, CKD can advance to end-stage kidney disease (ESKD), the most severe stage of CKD, where kidney function declines to an eGFR below 15 mL/min/1.73 m². At this point, the kidneys can no longer support the body's metabolic and fluid balance, necessitating renal replacement therapy, such as dialysis or kidney transplantation, to sustain life.

The global burden of CKD is substantial and increasing. Approximately 13.4% of the world's population is affected, with most cases falling into stages 3–5 of the disease. However,

Cite this as:
Dewi NNGK, Pratiwi MSA, Agustini MPA, et al. Understanding Readmission Risks in End-Stage Kidney Disease: A Study from Wangaya Hospital. InaKidney. 2025;2(3):114-125. doi:10.32867/inakidney.v2i3.206

the early stages of CKD (stages 1–2) are likely underdiagnosed due to their asymptomatic nature.[2–4] CKD has been linked to approximately 5–10 million deaths annually, according to the World Health Organization.[4,5] This growing prevalence is closely associated with the rising incidence of chronic conditions such as type 2 diabetes mellitus, hypertension, obesity, and cardiovascular disease, each of which serves as a major risk factor for the development and progression of CKD.[4,6–8]

Despite advancements in treatment, CKD and ESKD patients continue to face high morbidity and mortality, with frequent hospital readmissions contributing significantly to poor outcomes. A major contributor to this is the lack of disease awareness among patients and caregivers, which often results in poor disease management and treatment adherence.[4,9,10] High readmission rates among ESKD patients are often driven by disease complications, comorbid conditions, and suboptimal discharge planning or outpatient follow-up. These repeated hospitalizations not only strain healthcare resources but also reflect inadequacies in the continuity of care provided to these patients.

Recent studies have identified several modifiable and non-modifiable risk factors for hospital readmission among CKD and ESKD patients. For instance, Wijayanti (2019) found that poor hemodialysis adherence ($p = 0.002$), anemia ($p = 0.048$), and limited social support ($p = 0.034$) significantly increased the risk of readmission.[11] Similarly, Wagle (2022) reported that comorbidities such as hypertension, diabetes mellitus, and tuberculosis were associated with higher readmission risks, as were low hemoglobin and serum albumin levels, markers of poor nutritional and clinical status. These findings suggest that addressing these factors may help reduce the burden of readmissions and improve clinical outcomes.[12]

Given the clinical and economic implications of readmissions among ESKD patients, it is crucial to identify the contributing risk factors within local healthcare contexts. Therefore, this study aims to evaluate the factors associated with increased readmission rates among ESKD patients at Wangaya Hospital. The results of this study may support targeted interventions to improve patient outcomes and reduce preventable hospital readmissions.

Methods

Design and participants

This study utilized a single-center, retrospective cohort design conducted at Wangaya Regional General Hospital, Bali, Indonesia. The inclusion criteria encompassed all adult patients aged ≥18 years who were diagnosed with end-stage kidney disease (ESKD), with or without dialysis, between 2022 and 2024 at the aforementioned hospital. Patients with incomplete medical records and those with a solitary kidney were excluded from the study. Following the selection process, a total of 199 patients met the eligibility criteria.

Clinical data, including the history of readmission within one month or beyond one month from the initial diagnosis of ESKD and their first hospitalization, were retrieved from medical records. Laboratory parameters were obtained from the initial test results at the time of kidney failure diagnosis.

Study Covariate

This study examined several variables hypothesized to contribute to the occurrence of readmission in patients with ESKD. These variables included age, gender, comorbid conditions (diabetes mellitus, cardiovascular disease, malignancy, psychiatric disorders, infections, orthopedic disorders, pulmonary disease, neurological disorders, liver and gastrointestinal disorders), anemia, treatment adherence, dialysis status, hemoglobin levels, blood urea nitrogen (BUN), serum creatinine (SC), estimated glomerular filtration rate (eGFR), and potassium levels. Treatment adherence in this study was assessed based on whether patients attended regular follow-up visits at the nephrology–hypertension outpatient clinic according to the scheduled appointments provided.

Gender was classified as male or female, while comorbid conditions were categorized as present or absent. Adherence to treatment was defined as either compliant or non-compliant, and dialysis status was recorded as either "yes" or "no." Laboratory parameters, including hemoglobin, BUN, SC, and potassium levels, were extracted from medical records, while eGFR was calculated using the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) equation via a medical calculator. The cut-off values for numerical parameters were determined based on receiver operating characteristic (ROC) analysis. The dependent variable in this study was patient readmission. Readmission in patients with chronic kidney disease in this study was defined as a subsequent hospitalization following a previous inpatient admission. Readmissions were classified into two groups: those occurring within 30 days and those occurring more than 30 days after discharge.

Statistical analysis

Demographic, clinical, and laboratory data of the patients were analyzed using descriptive statistics and presented in a study characteristics table. Categorical data were reported as frequencies and percentages. Numerical data underwent normality testing and were expressed as either mean ± SD or median (range), depending on the normality test results.

Bivariate and multivariate analyses were conducted to assess factors suspected to determine readmission within one month and beyond one month in ESKD patients, regardless of dialysis status. Bivariate analysis was performed using the Chi-square test, with all data converted into categorical variables. Numerical variables (age, BUN, SC, hemoglobin, and potassium) were analyzed using ROC curve analysis to determine appropriate cut-off values, subsequently transforming them into categorical variables. Variables with a p-value ≤ 0.25 in the bivariate analysis were included in the multivariate analysis using binary logistic regression. The results of the binary logistic regression analysis were considered statistically significant if the p-value was < 0.05.

Results

Study Characteristics

A total of 199 participants were included in this study. The sample was predominantly male (61.8%) compared to female (38.2%). The median age was 57 years, with a range of 22–88 years. The most common comorbid condition was cardiovascular disease (80.4%), followed by diabetes mellitus (47.7%) and pulmonary disease (25.1%). The majority of participants adhered to their scheduled follow-up visits and were willing to undergo dialysis as part of their treatment. The 1-month readmission rate was 18.6%, while the readmission rate beyond one month was 15.1%. Detailed data are presented in Table 1.

Table 1. Study characteristics

Variable	**N = 199**
Gender, n (%)	
Male	123 (61.8)
Female	76 (38.2)
Age, median (range)	57 (22-88)
Comorbid factors, n (%)	
Diabetes mellitus	95 (47.7)
Cardiovascular disease	160 (80.4)
Tumor or malignancy	8 (4.0)
Psychiatric disease	2 (1.0)
Orthopedic disease	2 (1.0)
Pulmonary disease	50 (25.1)
Neurologic disorders	9 (4.5)
Liver and Gastrointestinal disorders	13 (6.5)

Other infectious diseases	5 (2.5)
Anemia, n (%)	60 (30.2)
Adherence, n (%)	
Yes	141 (70.9)
No	58 (29.1)
Dialysis, n (%)	
Yes	161 (80.9)
No	38 (19.1)
Hemoglobin, mean ± SD	8.05 ± 1.89
Blood urea nitrogen, median (range)	162 (30-448)
Serum creatinine, median (range)	9.1 (2.59-35)
Glomerular filtration rate, median (range)	6.0 (1.0-28)
Kalium, median (range)	4.7 (2.1-8.0)
Readmission status, n (%)	
1 month	37 (18.6)
> 1 month	30 (15.1)
No readmission	1326.3)

Bivariate Analysis of Independent Variables and One-Month Readmission

Based on the bivariate analysis, only the estimated glomerular filtration rate was found to be significantly associated with readmission within one month. However, eight out of nineteen variables had a p-value of <0.25, meeting the criteria for inclusion in the multivariate analysis. These variables include diabetes mellitus (p = 0.122), neurologic disorders (p = 0.169), dialysis (p = 0.057), anemia (p = 0.099), hemoglobin ≥ 8.05 g/dL (p = 0.066), BUN ≥ 169 mg/dL (p = 0.079), serum creatinine ≥ 9.45 mg/dL (p = 0.154), and eGFR ≤ 5.5 mL/min/1.73 m² (p = 0.024). Detailed results of the bivariate analysis are presented in Table 2.

Table 2. Bivariate Analysis of Independent Variables and Readmission in One Month

Variable	Readmission in 1 Month		P value
	Yes	No	
Gender, n (%)			
Male	21 (19.8)	85 (80.2)	0.396
Female	16 (25.4)	47 (74.6)	
Age, n (%)			
≥ 57.5	20 (23.8)	64 (76.2)	0.549
< 57.5	17 (20)	68 (80)	
Diabetes mellitus			
Yes	21 (27.3)	56 (72.7)	**0.122**
No	16 (17.4)	76 (82.6)	
Cardiovascular disease			
Yes	31 (22.8)	105 (77.2)	0.565
No	6 (18.2)	27 (81.8)	
Tumor or malignancy			
Yes	1 (20)	4 (80)	0.917

No	36 (22)	128 (78)	
Psychiatric disorder			
Yes	1 (50)	1 (50)	0.334
No	36 (21.6)	131 (78.4)	
Other infection			
Yes	2 (40)	3 (60)	0.320
No	35 (21.3)	129 (78.7)	
Orthopedic disorders			
Yes	0 (0)	2 (100)	0.451
No	37 (22.2)	130 (77.8)	
Pulmonary disease			
Yes	9 (22)	32 (78)	0.992
No	28 (21.9)	100 (78.1)	
Neurologic disorders			
Yes	2 (50)	2 (50)	**0.169**
No	35 (21.2)	130 (78.8)	
Liver and gastrointestinal disorders			
Yes	1 (11.1)	8 (88.9)	0.421
No	36 (22.5)	124 (77.5)	
Adherence			
No	28 (24.3)	87 (75.7)	0.260
Yes	9 (16.7)	45 (83.3)	
Dialysis			
No	34 (24.8	103 (75.2)	**0.057**
Yes	3 (9.4)	29 (90.6)	
Anemia			
Yes	15 (30)	35 (70)	**0.099**
No	22 (18.5)	97 (81.5)	
Hemoglobin			
≥ 8.05	22 (28.2)	56 (71.8)	**0.066**
< 8.05	15 (16.5)	76 (83.5)	
BUN			
≥ 169	22 (27.8)	57 (72.2)	**0.079**
< 169	15 (16.7)	75 (83.3)	
SC			
≥ 9.45	21 (26.9)	57 (73.1)	**0.154**
<9.45	16 (17.8)	74 (82.2)	
eGFR			
≤ 5.5	24 (29.3)	58 (70.7)	**0.024**
> 5.5	13 (14.9)	74 (85.1)	
Potassium level			
≥ 4.75	19 (25.7)	55 (74.3)	0.777
< 4.75	18 (23.7)	58 (76.3)	

BUN: blood urea nitrogen, SC: serum creatinine, eGFR: estimated glomerular filtration rate. Data analyzed by the chi-square test.

The bivariate analysis of variables associated with readmission beyond one month found that only two variables were statistically significant, namely neurologic disorders ($p < 0.001$) and adherence ($p = 0.025$), with p-values <0.05. Additionally, seven out of nineteen variables had p-values <0.25, qualifying them for inclusion in the multivariate analysis. These variables included age ≥ 54.5 years ($p = 0.071$), diabetes mellitus ($p = 0.081$), tumor or malignancy ($p = 0.090$), neurologic disorders ($p < 0.001$), liver and gastrointestinal disorders ($p = 0.170$), adherence ($p = 0.025$), and potassium level ≥ 4.65 mmol/L ($p = 0.216$). A detailed summary of the bivariate analysis results is presented in Table 3.

Table 3. Bivariate Analysis of Independent Variables and Readmission Beyond One Month

Variable	**Readmission in 1 Month**		**P value**
	Yes	**No**	
Gender, n (%)			
Male	17 (16.7)	85 (83.3)	0.429
Female	13 (21.7)	47 (78.3)	
Age, n (%)			
≥ 54.5	13 (13.8)	81 (86.2)	**0.071**
< 54.5	17 (25)	51 (75)	
Diabetes mellitus			
Yes	18 (24.3)	56 (75.7)	**0.081**
No	12 (13.6)	76 (86.4)	
Cardiovascular disease			
Yes	24 (18.6)	105 (81.4)	
No	6 (18.2)	27 (81.8)	0.956
Tumor or malignancy			
Yes	3 (42.9)	4 (57.1)	
No	27 (17.4)	128 (82.6)	**0.090**
Psychiatric disorder			
Yes	0 (0)	1 (100)	
No	30 (18.6)	131 (81.4)	0.633
Other infection			
Yes	0 (0)	3 (100)	0.405
No	30 (18.9)	129 (81.1)	
Orthopedic disorders			
Yes	0 (0)	2 (100)	0.498
No	30 (18.8)	130 (81.3)	
Pulmonary disease			
Yes	9 (22)	32 (78)	0.513
No	21 (17.4)	100 (82.6)	
Neurologic disorders			
Yes	5 (71.4)	2 (28.6)	**<0.001**

No	25 (16.1)	130 (83.9)	
Liver and gastrointestinal disorders			
Yes	4 (33.3)	8 (66.7)	**0.170**
No	26 (17.3)	124 (82.7)	
Adherence			
No	4 (8.2)	45 (91.8)	**0.025**
Yes	26 (23)	87 (77)	
Dialysis			
No	6 (17.1)	29 (82.9)	0.813
Yes	24 (18.9)	103 (81.1)	
Anemia			
Yes	10 (22.2)	35 (77.8)	0.452
No	20 (17.1)	97 (82.9)	
Hemoglobin			
≥ 8.35	12 (15.4)	66 (84.6)	0.400
< 8.35	17 (20.5)	66 (79.5)	
BUN			
≥ 151.5	13 (15.5)	71 (84.5)	0.382
< 151.5	16 (20.8)	61 (79.2)	
SC			
≥ 8.8	14 (17.5)	66 (82.5)	0.837
< 8.8	15 (18.8)	65 (81.3)	
eGFR			
≤ 5.5	15 (16.5)	76 (83.5)	0.565
> 5.5	14 (20.0)	56 (80.0)	
Potassium level			
≥ 4.65	11 (15.3)	61 (84.7)	**0.216**
< 4.65	16 (23.5)	52 76.5)	

BUN: blood urea nitrogen, SC: serum creatinine, eGFR: estimated glomerular filtration rate. Data analyzed by the chi-square test.

Multivariate Analysis of Independent Variables and One-Month Readmission

The multivariate analysis in this study found that only an estimated glomerular filtration rate (eGFR) ≤ 5.5 was significantly associated with readmission within one month for ESKD patients. This finding suggests that the lower the eGFR at the time of diagnosis, the higher the likelihood of readmission within one month, which in turn increases the risk of morbidity and mortality. Detailed data on the multivariate analysis results are presented in Table 4.

Table 4. Multivariate Analysis of Independent Variables and One-Month Readmission

Variable	P value	OR (95% CI)
Step 1		
Diabetes mellitus	0.142	1.81 (0.82 – 4.01)
Neurologic disorder	0.346	2.90 (0.32 – 26.63)
Dialysis	0.122	0.36 (0.10 – 1.31)
HB	0.304	1.57 (0.66 - 3.72)
BUN	0.554	1.33 (0.52 - 3.38)
SC	0.342	0.50 (0.12 - 2.08)
eGFR	0.141	2.95 (0.70 – 12.41)
Anemia	0.495	1.34 (0.58 - 3.13)
Step 7		
Dialysis	0.102	0.35 (0.10 – 1.23)
eGFR	**0.041**	**2.22 (1.03 – 4.79)**

BUN: blood urea nitrogen, SC: serum creatinine, eGFR: estimated glomerular filtration rate. Data analyzed by a binary logistic regression test.

The multivariate analysis in this study found that diabetes mellitus ($p = 0.014$), neurologic disorders ($p < 0.001$), and adherence ($p = 0.019$) were significantly associated with readmission beyond one month in ESKD patients. These findings suggest that comorbid factors such as diabetes mellitus and neurologic disorders play a role in increasing the likelihood of readmission in ESKD patients. Additionally, patient adherence to scheduled follow-up visits also contributes to the likelihood of readmission. These three variables should be considered in clinical practice to help reduce morbidity and mortality rates. Detailed results of the multivariate analysis are presented in Table 5.

Table 5. Multivariate Analysis of Independent Variables and Readmission Beyond One Month

Variable	P value	OR (95% CI)
Step 1		
Age	0.107	0.44 (0.16 – 1.19)
Potassium level	0.074	0.38 (0.13 – 1.10)
Diabetes mellitus	0.015	3.66 (1.29 – 10.36)
Neurologic disorders	0.002	235.66 (8.06 – 6887.88)
Liver and gastrointestinal disorders	0.800	1.29 (0.18 – 8.99)
Adherence	0.019	0.08 (0.01 – 0.67)
Tumor or malignancy	0.927	1.13 (0.08-16.58)
Step 3		
Age	0.102	0.44 (0.16 – 1.18)
Potassium level	0.073	0.38 (0.14 – 1.09)
Diabetes mellitus	**0.014**	**3.69 (1.31 – 10.42)**
Neurologic disorders	**< 0.001**	**249.73 (10.75 – 5803.81)**
Adherence	**0.019**	**0.08 (0.01 – 0.66)**

Data analyzed by a binary logistic regression test.

Discussion

In this study, the sample was predominantly male (61.8%), with a median age of 57 years (range 22-88). The most common comorbidity was cardiovascular disease (80.4%), followed by diabetes mellitus (47.7%) and pulmonary disease (25.1%). The adherence rate among the sample was relatively high (70.9%). However, a notable portion of the sample (19.1%) was found not to have undergone dialysis at ESKD. A total of 67 individuals were readmitted, with 37 of them being readmitted within one month, and the rest after more than one month.

The results of this study are consistent with the study by Vaidya and Aeddula (2024), which states that male gender is a risk factor for the development of CKD.[1] One of the comorbidities identified as a risk factor for end-stage renal disease is cardiovascular disease, particularly hypertension. The findings of this study also correspond with the study by Surasura (2024). According to this study, patients with ESKD are older on average, at 68.1 years, compared to those with CKD stage 3 (55.6 years) and stage 4 (62.4 years) ($p < 0.001$).[13] The study further indicates that male patients have a higher prevalence in the earlier stages, such as stage 3 and stage 4, while female patients show a higher prevalence at ESKD ($p = 0.023$). However, the results of this study do not align with these findings.

In this study, a bivariate analysis was performed to examine factors associated with readmission events within 1 month and after 1 month. For readmissions within 1 month, eight out of the nineteen variables had a p-value < 0.25, which allowed them to proceed to the multivariate analysis stage. These variables included diabetes mellitus ($p = 0.122$), neurologic disorders ($p = 0.169$), dialysis ($p = 0.057$), anemia ($p = 0.099$), hemoglobin ≥ 8.05 ($p = 0.066$), BUN ≥ 169 ($p = 0.079$), serum creatinine ≥ 9.45 ($p = 0.154$), and GFR ≤ 5.5 ($p = 0.024$). Following the multivariate analysis, only one of these variables was found to be statistically significant: GFR ≤ 5.5 ($p = 0.041$, 95% CI 1.033 – 4.788).

Studies show that a significant decline in eGFR can increase readmission rates in patients with ESKD. Lower eGFR reflects poorer kidney function, leading to the accumulation of toxins and metabolic waste products that cause uremia. In addition, fluid and electrolyte imbalances further worsen the patient's condition on a recurrent basis. Such conditions often cannot be managed in outpatient settings, thereby increasing the need for inpatient hospital care.[14,15]

Different results were observed in the bivariate and multivariate tests for the group with readmissions occurring after one month. In the bivariate analysis, seven out of nineteen variables had a p-value < 0.25, which allowed them to proceed to the multivariate analysis. These seven variables included age ≥ 54.5 ($p = 0.071$), diabetes mellitus ($p = 0.081$), tumor or malignancy ($p = 0.090$), neurologic disorders ($p < 0.001$), liver and gastrointestinal disorders ($p = 0.170$), adherence ($p = 0.025$), and potassium ≥ 4.65 ($p = 0.216$). The multivariate analysis revealed that only three of the seven variables were statistically significant in relation to readmissions after one month: diabetes mellitus ($p = 0.014$, 95% CI 1.308–10.415), neurologic disorders ($p < 0.001$, 95% CI 10.746–5803.811), and adherence ($p = 0.019$, 95% CI 0.010–0.661).

Diabetes mellitus is a major comorbidity that significantly correlates with increased readmission events among patients with ESKD. Persistent hyperglycemia in diabetes activates metabolic and hemodynamic pathways, including advanced glycation end products, oxidative stress, and renin–angiotensin–aldosterone system dysregulation, which accelerate nephron loss and promote diabetic kidney disease progression. In patients with end-stage renal disease, diabetes further contributes to cardiovascular instability, infection susceptibility, volume overload, and poor glycemic control during renal replacement therapy, all of which are common causes of hospital readmission. Moreover, diabetic patients with advanced CKD often have higher comorbidity burdens and impaired physiological reserve, making them more vulnerable to acute decompensations requiring rehospitalization. These pathophysiological mechanisms explain why diabetes mellitus remains a strong predictor of frequent readmission among ESKD.[16,17]

Neurological disorders such as stroke are associated with high readmission rates due to complex multisystem pathophysiological processes. Brain injury following stroke leads to motor, sensory, cognitive, and autonomic dysfunction, predisposing patients to complications such as immobility, dysphagia, aspiration pneumonia, and urinary tract infections.[18,19] In addition, stroke induces systemic inflammation and autonomic dysregulation, which can worsen cardiovascular instability, including arrhythmias and blood pressure fluctuations.[18] Persistent neurological deficits combined with common comorbidities such as hypertension and diabetes mellitus further increase the risk of clinical deterioration and hospital readmission.[20]

The findings of this study are consistent with previous research. Surasura's study (2024) discovered that age (per 10 years) ($p = 0.003$), comorbidities ($p < 0.001$), and a history of prior hospitalizations ($p < 0.001$) were significantly linked to readmission events in CKD patients.[13] Similarly, Wijayanti's study (2019) identified several factors associated with readmission in CKD patients undergoing hemodialysis. This research found that adherence to hemodialysis ($p = 0.002$), anemia ($p = 0.048$), and social support ($p = 0.034$) were statistically significant factors in readmissions among ESKD patients on hemodialysis.[11] Wagle's study (2022) also identified factors related to 30-day readmissions in CKD patients. This study revealed that higher readmission rates were found in individuals over 75 years old and those aged 25-50 years. Patients with comorbidities such as hypertension, diabetes mellitus, and tuberculosis had higher readmission rates, with odds ratios of (1.51, CI 0.60-3.77), (1.48, CI 0.79-2.76), and (1.569, CI 0.441-4.468), respectively. Additionally, hemoglobin levels below 9 g/dL and serum albumin levels under 35 g/L were linked to increased readmission rates, with odds ratios of 1.109 (95% CI 0.605-2.033) and 1.877 (95% CI 0.869-4.054), respectively.[12]

This study has successfully identified several factors related to readmission events in ESKD patients within 1 month and after 1 month.

Conclusion

The estimated glomerular filtration rate serves as a significant prognostic factor for readmission within one month, indicating its role in predicting short-term hospital readmissions in ESKD patients. On the other hand, factors such as diabetes mellitus, neurological disorders, and patient adherence are important prognostic indicators for readmission beyond one month. These factors help in understanding long-term outcomes and potential complications that could lead to extended hospital stays. Identifying and understanding these predictive factors is crucial for improving the overall management of ESKD patients. By recognizing these key elements, healthcare providers can tailor treatment plans and patient education more effectively, addressing the specific needs of patients and improving adherence to care protocols. Ultimately, this proactive approach can lead to better patient outcomes, reduce the rates of readmission, and help decrease the associated morbidity, mortality, and strain on healthcare resources.

Limitations of the Study

However, a limitation of this study is the small sample size, as the data were only collected from a single center. As a result, the findings should be validated through future research that includes a larger sample size and data from multiple centers to provide a more comprehensive representation of the general population.

Declarations

Ethics approval and consent to participate

This research has been approved by the ethics committee of Wangaya Regional General Hospital with number 000.9.2/531/RSUDW.

Competing interests

The author has declared that they have no conflicts of interest.

Funding source

Not applicable.

Acknowledgments

The author would like to express gratitude to the team for their support in preparing this study.

Author's Contribution

Idea/concept: NNGKD. Design: NNGKD, MSAP. Control/supervision: IWS. Data collection/ processing: NNGKD, MSAP, MPAA, PISL, CF. Analysis/interpretation: NNGKD. Writing the article: NNGKD, MSAP, MPAA, PISL, CF. Critical review: IWS. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Vaidya SR, Aeddula NR. Chronic Kidney Disease. StatPearls Publishing; 2025.

2. Organisation KI. KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Kidney Int Suppl. 2013;3(1):1.

3. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS. Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis. PLoS One. 2016;11(7):e0158765. doi:10.1371/journal.pone.0158765

4. Evans M, Lewis RD, Morgan AR, Whyte MB, Hanif W, Bain SC. A Narrative Review of Chronic Kidney Disease in Clinical Practice: Current Challenges and Future Perspectives. Adv Ther. 2022;39(1):33–43. doi:10.1007/s12325-021-01927-z

5. Luyckx VA, Tonelli M, Stanifer JW. The global burden of kidney disease and the sustainable development goals. Bull World Heal Organ. 2018;96(6):414–422D. doi:10.2471/blt.17.206441

6. Thomas R, Kanso A, Sedor JR. Chronic Kidney Disease and Its Complications. Prim Care. 2008;35(2):329–44. doi:10.1016/j.pop.2008.01.008

7. Jha V, Garcia-Garcia G, Iseki K, Li Z, Naicker S, Plattner B. Chronic kidney disease: global dimension and perspectives. Lancet. 2013;382(9888):260–72. doi:10.1016/s0140-6736(13)60687-x

8. Go AS, Chertow GM, Fan D, McCulloch CE, Yuan HC. Chronic Kidney Disease and the Risks of Death, Cardiovascular Events, and Hospitalization. N Engl J Med. 2004;351(13):1296–305. doi:10.1056/nejmoa041031

9. Plantinga LC, Tuot DS, Powe NR. Awareness of Chronic Kidney Disease Among Patients and Providers. Adv Chronic Kidney Dis. 2010;17(3):225–36. doi:10.1053/j.ackd.2010.03.002

10. Tuot DS, Wong KK, Velasquez A, Crews DC, Zonderman AB, Evans MK. CKD Awareness in the General Population: Performance of CKD-Specific Questions. Kidney Med. 2019;1(2):43–50. doi:10.1016/j.xkme.2019.01.005

11. Wijayanti S, Pujiarto P, Dewi AR. Hubungan Kepatuhan Hemodialisis dengan Interdialytic Weight Gain (IDWG) Pada Pasien Hemodialisis. MAHESA Malahayati Heal Student J. 2024;4(2):475–84. doi:10.33024/mahesa.v4i2.13148

12. Wagle A, Sigdel MR. Factors Affecting Readmission in Hospitalized Patients with Chronic Kidney Disease: a Single Center Study. J Inst Med Nepal. 2022;44(2):14–21. doi:10.59779/jiomnepal.1217

13. Surasura A, Siva Krishna Pavan Kumar BG, Chinamanagonda S, Durga D, Gubbala S. Understanding Hospital Readmissions: Insights, Patterns, and Interventions for Improvement in Chronic Kidney Disease. Cureus. 2024;16(5):e59524. doi:10.7759/cureus.59524

14. Xie Y, Bowe B, Xian H, Balasubramanian S, Al-Aly Z. Rate of Kidney Function Decline and Risk of Hospitalizations in Stage 3A CKD. Clin J Am Soc Nephrol. 2015;10(11):1946–55. doi:10.2215/cjn.04480415

15. Dhondup T, Qian Q. Electrolyte and acid-base disorders in chronic kidney disease and end-stage kidney failure.

Blood Purif. 2017;43(1–3):179–188. doi:10.1159/000452725

16. Alicic RZ, Rooney MT, Tuttle KR. Diabetic Kidney Disease: Challenges, Progress, and Possibilities. Clin J Am Soc Nephrol. 2017;12(12):2032–45. doi:10.2215/cjn.11491116

17. Hickson LJ, Thorsteinsdottir B, Ramar P, Reinalda MS, Crowson CS, Williams AW, et al. Hospital Readmission among New Dialysis Patients Associated with Young Age and Poor Functional Status. Nephron. 2018;139(1):1–12. doi:10.1159/000485985

18. Feigin VL, Roth GA, Naghavi M, Parmar P, Krishnamurthi R, Chugh S. Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet Neurol. 2016;15(9):913–924. doi:10.1016/s1474-4422(16)30073-4

19. Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. Lancet. 2011;377(9778):1693–1702. doi:10.1016/s0140-6736(11)60325-5

20. Kumar V, Abbas AK, Aster JC. Robbins and Cotran Pathologic Basis of Disease. 10th ed. Elsevier; 2020.

Available online at http://inakidneyhypertension.co.id Official Journal of the Indonesian Society of Nephrology

Indonesian Journal of Kidney & Hypertension InaKidney

Original Article

The Correlation of Volume Overload Measured by Bio Impedance Analysis and Intradialytic Hypertension in End Stage Kidney Disease Patients at Bandung Hasan Sadikin Hospital

Mohammad Iqbal[1], Ria Bandiara[1], Rudi Supriyadi[1], Lazuardhi Dwipa[2]

[1]Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine Universitas Padjadjaran-Hasan Sadikin Hospital, Bandung, Indonesia
[2]Division of Geriatric, Department of Internal Medicine, Faculty of Medicine Universitas Padjadjaran-Hasan Sadikin Hospital, Bandung, Indonesia

ARTICLE INFO

Article history:
Received: June 6, 2025
Accepted: December 19, 2025
Published Online: December 24, 2025

Corresponding Author:
Mohammad Iqbal, Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine Universitas Padjadjaran-Hasan Sadikin Hospital, Bandung, Indonesia,
iqbalmdrsai@gmail.com

ABSTRACT

Background: Assessing dry weight is essential for calculating the ultrafiltration volume during dialysis. Volume overload affects hemodynamic stability including intradialytic hypertension (IDH). Using Bio Impedance Analysis (BIA) to guide fluid assessment enhances the accuracy of fluid overload evaluation.

Objective: This study aimed to find the correlation between volume overload and IDH in patients undergoing chronic dialysis at Bandung Hasan Sadikin Hospital

Methods: This is a cross-sectional study to evaluate the correlation of volume overload and IDH in patients undergoing chronic dialysis at Bandung Hasan Sadikin Hospital. Exclusion criteria were patient below the age of 18 years old, unable to performed BIA measurement. Blood pressure before, during and after dialysis session was recorded to asses IDH. BIA was measured after dialysis session. Point biserial correlation used to analyze correlation between volume overload and intradialytic hypertension. The data were analysed with SPSS version 23.0. The statistical significance was set at P<0.05.

Results: Ninety-seven patients enrolled, the average age was 49,9 ± 12.3 years old, 55,7% was male. There were 23,7% of patients with IDH with increasing systolic blood pressure of 19.21 mmHg (10-66). A significant correlation was observed between the incidence of IDH and the percentage of volume overload after dialysis with R coefficient 0,238 (p 0,014).

Conclusion: The majority (59.87%) of patients undergoing chronic hemodialysis had a greater dry weight based on BIA examination, 23,7% had IDH and its occurrence has a significant correlation with the percentage of volume overload after dialysis.

Keywords: Volume overload, dry weight, BIA, IDH.

Introduction

Chronic kidney disease (CKD) is a global health problem with escalating prevalence and incidence, poor prognosis, and steep costs. Globally, the total of patients undergoing kidney replacement therapy is more than 2.5 million, and is estimated to rise to 5.4 million by 2030.[1,2] The population of patients undergoing hemodialysis in Indonesia increases annually.[3]

The most prevalent complication in end-stage kidney disease (ESKD) patients is volume overload, which is closely linked to several other issues such as resistant hypertension, cardiac hypertrophy, congestive heart failure, or arterial stiffness. Therefore, volume overload is currently recognized as a crucial risk factor for unfavorable outcomes, such as all-cause or cardiovascular death.[4]

Assessing dry weight is fundamental in calculating the ultrafiltration volume during dialysis sessions. As a result, hemodynamic stability may be influenced and may lead to

Cite this as:
Iqbal M, Bandiara R, Supriyadi R, et al. The Correlation of Volume Overload Measured by Bio Impedance Analysis and Intradialytic Hypertension in End Stage Kidney Disease Patients at Bandung Hasan Sadikin Hospital. InaKidney. 2025;2(3):126-133. doi:10.32867/inakidney.v2i3.194

symptoms including muscle cramps, general weakness, abdominal pain, edema, dyspnea, hypotension, or hypertension during and after dialysis. Blood pressure checks conducted prior to and following dialysis, the weight increase occurring from one dialysis session to the next, and the patient's subjective symptoms have been used to determine the patient's body fluid volume excess index. Earlier studies have demonstrated that Bio Impedance Analysis (BIA) guided fluid assessment can help better assess a patient's fluid volume excess status and thereby greatly reduce patient mortality.[5–7]

Intradialytic hypertension (IDH) is a condition associated with dynamic changes in cardiac output during dialysis. The reduction in end-diastolic volume that occurs through the ultrafiltration process allows blood pressure to increase along with cardiac output. Studies of hypervolume in ESKD patients undergoing hemodialysis collectively support the practice that the initial approach in patients with IDH should be a reassessment of dry weight.[8–12]

Methods

Design and participants

We conducted a cross-sectional study to evaluate the correlation of volume overload and IDH in patient undergoing chronic dialysis at Bandung Hasan Sadikin Hospital . This study was conducted with the approval of the Research Ethical Board, Bandung Hasan Sadikin Hospital (approval number DP.04.03/D.XIV.6.5/329/2024), and all participants provided written informed consent prior to study enrollment. A total of 184 patients on chronic dialysis were enrolled in this study. Patients under the age of 18 years old, liver cirrhosis with ascites, active cancer, pulmonary oedema, patients with a history of severe illness in the past 12 weeks, and class III or class IV congestive heart failure (using the New York Heart Association classification system), including patients who had lymphedema of the limbs or had an amputation were excluded.

Study Covariate

Data on the patients' medical background, including their medical history, cause of kidney failure with corresponding replacement therapy, antihypertensive treatment, and duration of hemodialysis were collected from medical records. Blood pressure measurements were taken prior to, during, and following the dialysis session to assess intradialytic hypertension. BIA was measured after dialysis session. Given the individual need to remain standing for roughly 2 minutes before measurements are recorded using the TANITA BIA machine, only participants who can grip the arm holders of the machine using both hands and remain standing unassisted are included in the assessment. Extracellular Water (ECW) and Total Body Water (TBW) were measured and dry weight of patient was estimated based on an ECW/TBW ratio of 0,38.[13,14] The approach for determining dry weight is as follows:

Dry weight = Body weight − overhydrated ECW

(ECW − overhydrated ECW) ÷ (TBW − overhydrated ECW) = 0.380

Dry weight = Body weight – [[ECW – (0.380 × TBW)] ÷ (1 − 0.380)]

Patient with predicted dry weight meet with calculated dry weight measured by BIA were excluded. Volume overload (VO) was defined as excess body weight after undergoing dialysis substract by the amount of ultrafiltration in dialysis session.

Statistical analysis

Data were analysed using SPSS 23.0 and expressed as mean ± standard deviation or as median value (interquartile range) for data displaying skewed distribution. Differences in mean values between two groups were analysed with an unpaired t-test , while data with skewed distributions were compared using the Mann-Whitney U test.

The associations between variables were defined by Spearman's coefficient, correlation between categorical and numerical were defined by point biserial correlation and chi-square tests were used to determine the relationships between categorical variables. A *p* values less than 0.05 were considered significant.

Results

Baseline characteristics including demographics and laboratory findings

Of 181 patients who had ongoing chronic dialysis at Bandung Hasan Sadikin Hospital, 22 patients were excluded because they could not undergo BIA examination, 62 patients had a dry weight that matched the BIA measurement, and 97 patients enrolled in this study. Table 1 presents a summary of the demographic data for the 97 patients. The average age calculated was 49,9 ± 12.3 years old; 55,7% were male participants and 44,3% were female participants. HD vintage was 3,8 year (2,2-7,5), most of them were hypertensive nephrosclerosis (26,8%) as the underlyng disease of ESKD, their dialysis adequacy (Kt/V) were near to appropriate 1.75 (1,59-1,95). Laboratory finding showed albumin at the level 3,88 ± 0.31 mg/dl, sodium 137,41 ± 2,77 mmol/L , kalium 4,63 ± 0,81mg/dl and serum creatinine 12.88 ± 3.35 mg/dl . Fourty two of the participant had high blood pressure before dialysis session and 23,7% had IDH. In pregeriatric and geriatric group high blood pressure before dialysis found in 21,6% and 4,1% respectively and IDH found in 11,3% and 4,1% respectively. The most widely used antihypertensive drug is Calcium Chanel Blocker (73.2%), followed by Angiotensin Receptor Blocker (50.52%), Beta Blocker and ACE Inhibitor.

Table 1. Baseline characteristics

Variable	N=97
Age (year), mean ± SD	49.9 ± 12.3
Pregeriatric (45-65 yo)	61 (62,9)
Geriatric (>65 yo)	11 (11,3)
Gender, n (%)	
Male	54 (55.7)
Female	43 (44.3)
HD vintage (year), median (IQR)	3.8 (2.2 – 7.5)
ESKD etiology, n (%)	
NA	29 (29.9)
Hypertensive Nephrosclerosis	26 (26.8)
Primary Glomerulopathy	18 (18.6)
Diabetic Nephropathy	14 (14.4)
Chronic pyelonephritis	2 (2.1)
Polycystic kidney	1 (1.0)
Nephritis Lupus	1 (1.0)
Obstructive Nephropathy	2 (2.0)
Others	4 (4.1)
Comorbidity, n (%)	
Hypertension	37 (38.1)
Diabetes melitus	12 (12.4)
Cardiovascular disease	9 (9.3)
SLE	1 (1.0)
Gastrointestinal disease	1 (1.0)
Laboratory, mean ± SD	
Albumin (g/dL)	3.88 ± 0.31
Kreatinin (μmol/L)	12.88 ± 3.35
Natrium (mmol/L)	137.41 ± 2.77

Variable	N=97
Kalium (mmol/L)	4.63 ± 0.81
Adequacy (Kt/V), median (IQR)	1.75 (1.59 – 1.95)
Pre HD hypertension, n (%)	42 (43.3)
Pregeriatric	21 (21,6)
Geriatric	4 (4,1)
IDH , n (%)	23 (23.7)
Pregeriatric	11 (11,3)
Geriatric	4 (4,1)
Antyhypertension agent, n (%)	
ACE (Ramipril)	2 (2,06)
ARB (Candesartan, Telmisartan, Valsartan)	49 (50,52)
CCB (Amlodipin, Nifedipin)	71 (73,2)
B Blocker (Bisoprolol, Cervedilol)	21 (21,65)
Others (Clonidin, Methyldopa)	3 (3,09)

Body weight distribution and volume overload

As Shown at Table 2, body weight before hemodialysis (pre-HD) had a median of 59.0 kg with an interquartile range (IQR) of 50.5 to 65.5 kg. After hemodialysis (post-HD), median body weight decreased to 55.5 kg (IQR 48.3 – 63.8 kg). Dry body weight, which is the ideal body weight calculated base.

Table 2. Body weight distribution and volume overload

Variable	N=97
Body weight	
Pre HD (kg), median (IQR)	59.0 (50.5 – 65.5)
Post HD (kg, median (IQR)	55.5 (48.3 – 63.8)
Dry weight based on BIA (kg), median (IQR)	52.6 (46.65 – 61.2)
Ultrafiltrasi (liter), median (IQR)	2.7 (2.3 – 3.3)
Volume Overload	
Pre HD (%), median (IQR)	8.9 (6.3 – 10.9)
Post HD (%), median (IQR)	4.1 (2.5 – 5.6)
Post HD (liter), mean ± SD	2.47 ± 1.30

Notes: SD=Standard Deviation, IQR=Inter Quartile Range

Ultrafiltration volume, which is the amount of fluid removed during hemodialysis, had a median of 2.7 liters, with an IQR of 2.3 to 3.3 liters. Before hemodialysis, fluid overload showed a median of 8.9% of body weight, with an IQR ranging from 6.3% to 10.9%. After hemodialysis, fluid overload was lowered to a median of 4.1% (IQR 2.5% – 5.6%). In absolute terms, the average excess fluid after hemodialysis is 2.47 liters with a standard deviation of 1.30 liters.

Blood pressure measurement

Blood pressure measurement before dialysis session had systolic blood pressure 142.10 ± 17.27 mmHg and during dialysis session tend to decrease from 144.44 ± 18.89 mmHg in 1st hour to 138.88 ± 21.33 mmHg after dialysis session. While diastolic blood pressure 82.11 ± 6.85 mmHg before dialysis and also tend to decrease to 79.12 ± 11.65 after dialysis session. As mention before, Fourty two of the participant had high blood pressure before dialysis session and 23,7% had IDH. The median of systolic blood pressure increasing in the IDH group was 19.21 mmHg (10-66) as shown in Table 3.

Table 3. Blood pressure variation before, during and after dialysis

BP measurement	n	Systolic		Diastolic	
		Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)
Before Dialysis	97	142.10 ± 17.27	140 (130 – 150)	82.11 ± 6.85	80 (80 – 90)
1st hour	97	144.44 ± 18.89	140 (140 – 158)	82.13 ± 7.63	80 (80 – 90)
2nd hour	97	143.22 ± 19.73	140 (130 – 160)	81.48 ± 7.87	80 (80 – 90)
3rd hour	97	142.79 ± 20.72	140 (130 – 160)	80.65 ± 10.66	80 (80 – 90)
4th hour	97	142.44 ± 20.43	140 (130 – 160)	79.20 ± 15.33	80 (80 – 90)
5th hour	97	139.68 ± 21.64	140 (120 – 160)	78.46 ± 13.19	80 (80 – 80)
After Dialysis	97	138.88 ± 21.33	140 (120 – 152.25)	79.12 ± 11.65	80 (80 – 90)
Average	97	141.34 ± 17.15	141 (130 – 153.5)	80.36 ± 6.23	80 (78 – 84)
Maximum	97	153.44 ± 19.75	150 (140 – 170)	86.11 ± 7.03	90 (80 – 90)

Notes: SD=Standard Deviation, IQR=Inter Quartile Range

Table 4 shows that the factor that has a significant relationship with the incidence of IDH is the percentage of volume overload after dialysis, which means that the greater the percentage of volume overload after dialysis, the greater the likelihood of IDH. Table 5 shows that when the study subjects were divided based on non-geriatric, pre-geriatric and geriatric age groups, it appears that in the non-geriatric and geriatric groups there was a significant relationship between the amount of ultrafiltration and the incidence of IDH, which means that the smaller the ultrafiltration volume, the more likely IDH is. While in the pregeriatric group, a significant relationship was found in the percentage of fluid excess after HD according to Table 4.

Table 4. Correlation of Body Weight, Ultrafiltration and Volume overload to the Incidence of IDH

Variable	IDH	
	R coefficient	P value
Body weight		
Before HD (kg)	-0.088	0.194
After HD (kg)	-0.109	0.144
Ultrafiltration volume (liter)	-0.141	0.084
Volume overload		
Before HD (%)	0.110	0.143
After HD (%)	**0.238**	**0.014***
After HD (liter)	-0.102	0.161

Analysis with point biserial correlation, *significancy $p<0.05$

Table 5. Correlation of Body Weight, Ultrafiltration and Volume overload to the Incidence of IDH in difference age groups

Variable	Non Geriatric (n=30)		Pre Geriatric (n=57)		Geriatric (n=10)	
	IDH		IDH		IDH	
	R coefficient	P value	R coefficient	P value	R coefficient	P value
Body weight						
Before HD (kg)	-0.233	0.108	-0.019	0.444	-0.237	0.255
After HD (kg)	-0.197	0.149	-0.07	0.302	-0.209	0.281
Ultrafiltration volume (liter)	**-0.429**	**0.009***	0.141	0.147	**-0.660**	**0.019***
Volume overload						
Before HD (%)	-0.161	0.197	0.218	0.052	-0.299	0.200
After HD (%)	0.116	0.299	**0.274**	**0.024***	0.087	0.405
After HD (liter)	-0.093	0.312	-0.140	0.149	-0.211	0.279

Analysis with point biserial correlation, *significancy p<0.05, non-geriatric: <45 yo, pre-geriatric 45-65 yo, geriatric > 65 yo

Correlation of Age, BMI, Albumin, Sodium, Potassium and MIS to volume overload

Several factors related to volume overload are seen in Table 6, it appears that age, BMI and potassium levels are related to volume overload. Age factors have an effect on the whole, meaning that the older the age the more frequent the occurrence of volume overload, while BMI factors have an effect especially on the IDH group, where the lower the BMI the more likely volume overload is to occur. Low potassium levels appear to be related to volume overload in all groups, meaning that the lower the potassium levels the more likely volume overload is to occur.

Table 6. Correlation of Age, BMI, Albumin, Sodium, Potassium and MIS to volume overload

Variable	All (n=85)		IDH (n=19)		Non IDH (n=66)	
	Volume overload after HD (%)		Volume overload after HD (%)		Volume overload after HD (%)	
	R coefficient	P value	R coefficient	P value	R coefficient	P value
Age (yo)	**0.221**	**0.021***	0.285	0.119	0.189	0.064
BMI	**-0.228**	**0.018***	**-0.630**	**0.002***	-0.093	0.229
Albumin (g/dL)	0.121	0.135	0.015	0.476	0.184	0.070
Sodium (mmol/L)	-0.083	0.225	-0.075	0.380	-0.114	**0.181**
Potassium (mmol/L)	**-0.337**	**0.001***	**-0.404**	**0.043***	**-0.316**	**0.005***
MIS	-0.002	0.492	-0.075	0.381	-0.015	**0.452**

Analysis using Rank Spearman correlation, *significancy p<0.05

Discussion

Of the 162 patients undergoing routine hemodialysis, 97 included in this study had a dry weight still above the dry weight predicted by BIA measurements. Of all the patients involved in this study, 23 patients (23.7%) experienced intra-dialytic hypertension, this figure is nearly identical to that reported in the study by Van Buren et al with a prevalence of 22.3%, and another study led by Inrig et al. al had a lower prevalence, namely 12.2% and 13.2%.[8,12]

In research conducted by Inrig et al, the characteristics of patients who experienced intradialytic hypertension were older, lower dry weight, lower creatinine, lower albumin and more use of anti-hypertensive drugs.[8,12] In this study, the factors that were directly correlated with intradialytic hypertension were the percentage of volume overload after dialysis and ultrafiltration volume during dialysis in the non-geriatric and geriatric groups, while age, BMI and potassium factors were indirectly correlated with the incidence of volume overload in the study subjects.

Research on the correlation between potassium levels and intradialytic hypertension is usually associated with the concentration of dialysate used, for instance, a study by Dolson et al revealed that low potassium dialysate levels were associated with the occurrence of intradialytic hypertension. It is not yet known whether low potassium levels are associated with vasoconstriction of blood vessels.[8]

Prospective observations are needed to see the effect of adjusting dry weight as measured by BIA on reducing the incidence of intradialytic hypertension in patients undergoing chronic dialysis.

Conclusion

This research shows that, the majority (59.87%) of patients undergoing chronic hemodialysis at Hasan Sadikin Hospital Bandung have a greater dry weight based on BIA examination, have a volume overload percentage of 8.9% before hemodialysis and 4.1% after hemodialysis. Of all the patients involved in this study, 23 patients (23.7%) experienced intra-dialytic hypertension, the factors that were directly correlated with intradialytic hypertension were the percentage of volume overload after dialysis and ultrafiltration volume during dialysis in the non-geriatric and geriatric groups, while age, BMI and potassium factors were indirectly correlated with the incidence of volume overload.

Limitations of the Study

However, several limitations to this study should be acknowledged. First, the cross-sectional design limits the capacity to establish causality between hemodialysis adequacy and inflammation. The data provides a snapshot of the relationship at a single point in time, so it is difficult to determine the changes in Kt/V over time that may differentially impact inflammatory markers. Moreover, the modest sample of the study is 45 patients, which may limit the relevance of the result to the general CKD5 patient population. There are other possible influencing factors, including comorbid conditions or variations in dialysis protocols, that were not fully completely considered in the analysis.

Declarations

Ethics approval and consent to participate

This study received approval from the Ethics Committee of the Hasan Sadikin Hospital Bandung under reference number DP.04.03/D.XIV.6.5/329/2024.

Competing interests

There are no conflicts of interest in writing this article.

Funding source

Not applicable.

Acknowledgments

None.

Author's Contribution

Idea/concept: MI. Design: MI. Control/supervision: RB, RS, LD. Data collection/ processing: MI. Analysis/interpretation: MI, RB, RS, LD. Literature review: - Writing the article: MI. Critical review: - All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Carrero JJ, Thomas F, Nagy K, Arogundade F, Avesani CM, Chan M. Global prevalence of protein-energy wasting in kidney disease: a meta-analysis of contemporary observational studies from the international society of Renal nutrition and metabolism. J Ren Nutr. 2018;28(6):380–92. doi:10.1053/j.jrn.2018.08.006

2. U.S.R.D.S. 2020 USRDS Annual Data Report: Epidemiology of kidney disease in the United States. Natl Institutes Heal Natl Inst Diabetes Dig Kidney Dis. 2020;

3. I.R.R. 11th Report of Indonesian Renal Registry. In: Indonesian Renal Registry (IRR). 2018.

4. Covic A, Siriopol L. Assessment and Management of Volume Overload Among Patients on Chronic Dialysis. Curr Vasc Pharmacol. 2021;19(1):34–40. doi:10.2174/1570161118666200225093827

5. Mermelstein A, JG. R, Wang Y, KotankoP D, J.T. Ultrafiltration Rate Levels in Hemodialysis Patients Associated with Weight-Specific Mortality Risks. Clin J Am Soc Nephrol. 2023;18(6):767–76. doi:10.2215/cjn.0000000000000144

6. Lee JE, Jo IY, Lee SM, Kim WJ, Choi HY, SK H. Comparison of hydration and nutritional status between young and elderly hemodialysis patients through bioimpedance analysis. Clin Interv Aging. 2015;10:1327–34. doi:10.2147/cia.s86229

7. Park JH, Jo YI, Lee JH. Clinical usefulness of bioimpedance analysis for assessing volume statu in patients receiving maintenance dialysis. Korean J Intern Med. 2018;33(4):660–669. doi:10.3904/kjim.2018.197

8. Georgianos PI, Sarafidis PA, Zoccali C. Intradialysis Hypertension in End-Stage Renal Disease Patients Clinical Epidemiology, Pathogenesis, and Treatment. Hypertension. 2015;66(3):456–463. doi:10.1161/hypertensionaha.115.05858

9. Bossola M, Mariani I, Sacco M, Antocicco M, Pepe G, Stasio ED. Interdialytic weight gain and low dialysate sodium concentration in patients on chronic hemodialysis: a systematic review and meta-analysis. Int Urol Nephrol. 2024;56(7):2313–2323. doi:10.1007/s11255-024-03972-3

10. Singh AT, Waikar SS, Causland FRM. Association of Different Definitions of Intradialytic Hypertension With Long-Term Mortality in Hemodialysis. Hypertension. 2022;79(4):855–62. doi:10.1161/hypertensionaha.121.18058

11. Kandarini Y, Widiana R, Suwitra K. Association between ultrafiltration volume and intradialytic hypertension in maintenance hemodialysis. Medicina (B Aires). 2017;48(2):152–156. doi:10.15562/medicina.v48i2.47

12. Diakité F, Baldé MS, Koné A, Traoré M, Chérif I, Bah AB, et al. Intradialytic Hypertension and Associated Factors in Chronic Hemodialysis at the National Hemodidiadiasis Center in Donka, Guinea. Open J Nephrol. 2020;10(1):34–42. doi:10.4236/ojneph.2020.101005

13. Sasaki N, Ueno K, Shiraishi T, Yoshimura A, Kuno M, Takeda SI. The optimal ratio of extracellular water to total body water (ECW/TBW) deter mined by bioelectrical impedance analysis (BIA) for setting dry weight in hemodialysis patients. J Japanese Soc Dial Ther. 2008;41(10):723–30. doi:10.4009/jsdt.41.723

14. Ohashi Y, Joki N, Yamazaki K, Kawamura T, Tai R, Oguchi H. Changes in the fluid volume balance between intra- and extracellular water in a sample of Japanese adults aged 15-88 yr old: a cross-sectional study. Am J Physiol Ren Physiol. 2018;314(4):F614–22. doi:10.1152/ajprenal.00477.2017

Indonesian Journal of Kidney & Hypertension InaKidney

Review Article

Finerenone in Diabetic-Kidney Disease, Renal and Cardiovascular Outcome: A Meta-Analysis of Independent Trial Registries

Felicita Gracia[1], Arya Marganda Simanjuntak[2], Samira Amanda[3], Linda Ida Mustika[1], Juwanto[2], Ligat Pribadi Sembiring[2], Jazil Karimi[2], Sari Harahap[2], Rosmaliana[4]

[1]Faculty of Medicine and Health Sciences, Universitas Bangka Belitung, Pangkal Pinang, Indonesia
[2]Department of Internal Medicine, Faculty of Medicine, Universitas Riau, Arifin Achmad General Hospital, Pekanbaru, Indonesia
[3]Faculty of Medicine, Universitas Riau, Pekanbaru, Indonesia
[4]Department of Cardiovascular, Faculty of Medicine, Universitas Riau, Arifin Achmad General Hospital, Pekanbaru, Indonesia

ARTICLE INFO

Article history:
Received: December 7, 2025
Accepted: December 19, 2025
Published Online: December 24, 2025

Corresponding Author:
Felicita Gracia, Faculty of Medicine and Health Sciences, Universitas Bangka Belitung, Pangkalpinang, Bangka Belitung, Indonesia, felicitagracia0905@gmail.com

ABSTRACT

Background: Diabetic kidney disease (DKD) remains a frequent complication of type 2 diabetes, which significantly increases cardiovascular risk. Despite existing treatments, a substantial risk of disease progression still remains, leading to further exploration in Finerenone, a selective nonsteroidal mineralocorticoid receptor antagonist.

Objective: This meta-analysis evaluates finerenone's effects on the improvement of cardiorenal outcomes in DKD.

Methods: A Systematic Review and Meta-Analysis (PROSPERO CRD420251122382) followed PRISMA guidelines. PubMed, ScienceDirect, and Epistemonikos utilized and used keywords "Finerenone AND Diabetes AND Chronic Kidney Disease AND Outcomes." RCTs comparing finerenone to placebo in DKD, reporting renal or cardiovascular outcomes, were included. Data extraction covered study characteristics and outcomes. RevMan 5.4 analyzed data using a random-effects model. Risk of bias (RoB2) and certainty of evidence (GRADE-PRO) were assessed.

Results: Three RCTs (19,027 participants) were included for renal outcomes, and two RCTs (13,026 participants) for cardiovascular outcomes. Finerenone significantly reduced the odds of sustained eGFR decline ≥40% (OR 0.83, p=0.0003) and≥57% (OR 0.86, p=0.0001), as well as the major composite kidney outcome (OR 0.76, p<0.0001). ESKD odds reduction (21%) was not statistically significant. For cardiovascular outcomes, finerenone significantly reduced hospitalization for heart failure (OR 0.78, p=0.0001). Trends towards reduced cardiovascular death (OR 0.88, p=0.09) were noted. Studies had low bias risk, and most outcomes showed moderate evidence certainty.

Conclusions: Finerenone is associated with significant renoprotection and significantly reduces heart failure hospitalizations in DKD. Finerenone as an effective nonsteroidal mineralocorticoid receptor antagonist for comprehensive management, improving cardiorenal outcomes in this high-risk group.

Keywords: Chronic kidney disease, cardiovascular, diabetes, finerenone, renal.

Cite this as:
Gracia F, Simanjuntak AM, Amanda S, et al. Finerenone in Diabetic-Kidney Disease, Renal and Cardiovascular Outcome: A Meta-Analysis of Independent Trial Registries. InaKidney. 2025;2(3):134-144. doi:10.32867/inakidney.v2i3.224

Introduction

Currently, global health data shows approximately 589 million adults affected by diabetes, representing 11.1% of the world's population. Projections suggest figures will climb up to 853 million by 2050, with Type 2 Diabetes Mellitus (T2DM) constituting 90% of the cases.[1–3] A critical yet frequent complication of T2DM is diabetic kidney disease (DKD), impacting 20-50% of T2DM patients, and DKD itself remains the primary driver of chronic kidney disease (CKD) and end-stage kidney disease (ESKD).[4] While International guidelines emphasize management of CKD in T2DM patients through control of hypertension and hyperglycemia using renin-angiotensin system (RAS) blockers and sodium-glucose cotransporter 2 (SGLT2) inhibitors, the risk of CKD progression remains significant, leading to a need for the development of newer therapies.[5–7]

Finerenone emerged as one of the potent nonsteroidal MRAs (mineralocorticoid receptor antagonists) with high selectivity for MR (mineralocorticoid receptor). Compared to steroidal MRAs, finerenone possesses a shorter half-life, no active metabolites, demonstrating higher selectivity to MR compared to spironolactone and enhanced receptor binding affinity to eplerenone.[8,9] Clinical studies have also assessed Finerenone in mitigating cardiorenal risks, such can be seen in FIDELIO-DKD and FIGARO DKD trials.[10,11] Previously, several meta-analyses have discussed the role of finerenone towards renal and cardiovascular outcomes of patients with DKD, however the inclusion of those studies includes overlapping data from the subgroup analysis derived from the same RCT registry. This methodology can result in overlapping patient populations, potentially affecting the independence of pooled data in the research. Consequently, there is a need for a meta-analysis that re-analyses the data according to the RCT registry to provide an analysis of independent primary trial results without any data duplication to provide a clear synthesis of independent data points.

Methods

Protocol registration

Protocols employed in this study have been registered and accepted by PROSPERO, with the identification number [CRD420251122382]. This systematic review and meta-analysis were prepared in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[12]

Search strategy

Various search engines to search for articles including PubMed, ScienceDirect, and Epistemonikos. Each author independently screened each database, extracting references manually and using Zotero's Reference Manager for duplicate reduction. "Finerenone AND Diabetes AND Chronic Kidney Disease AND Outcomes" served as the basis for our keyword selection.

Eligibility criteria

The eligibility criteria for this study were based on the PICOS framework, with additional inclusion and exclusion criteria. PICOS framework comprises the following elements: [P]atients, Diabetic Kidney Disease patient; [I]ntervention, Finerenone; [C]omparator, Control OR Placebo; [O]utcome, Cardiovascular Outcome and Renal Outcome, and [S]tudy, Randomized Controlled Trial (RCT). Inclusion criteria are: (1) article in Indonesia or English, and (2) Full-Text available. Review articles, animal studies, editorials, commentaries, and non-accessible articles were excluded.

Data extraction and statistical analysis

Various data extracted from included studies such as: (1) First author name, (2) Year of Publication, (3) RCT registry, (4) RCT code name, (5) number of sample, (6) Age, (7) Gender, (8) intervention description, (9) duration of follow up, (10) Renal outcome, such as eGFR kidney composite, ESKD event and (11) Cardiovascular outcome, such as time to CV death, Non-Fatal Myocardial Infarction, Non-Fatal Stroke, Hospitalization of Heart Failure. RevMan 5.4 was utilized for statistical meta-analysis of a dichotomous outcome. Randomized

Effect Model (REM) was used to generalize the result so it is not limited to inclusion alone. Heterogeneity was analyzed by the I2 value.

Risk of bias and quality assessment

We analyzed the risk of bias for our RCTs using RoB2 by assessing study quality based on the five domains in RoB2. The assessment was done with the conclusion of Low Risk / Some Concern / High Risk. Conclusions were presented using a summary plot and a traffic plot. Quality assessment for the result will be assessed with GRADE-PRO Analysis.

Result

Study selection & characteristics

We identified 906 studies across databases, and 26 of them were excluded due to duplication. We summarize our literature searching and selection in Figure 1. In the end, we include 3 articles in this review. We compile characteristics of included studies in Table 1. We include 19.027 participants, 9522 of them with the Finerenone group and 9505 Placebo. The average age of participants was relatively high, but there were no differences between the two groups in each inclusion study. No gender imbalance was observed between studies. Patients were given Finerenone orally at a dose of 10 mg or 20 mg once daily. Each study had a different follow-up period, ranging from 2.6 years to 3.4 years of observation.

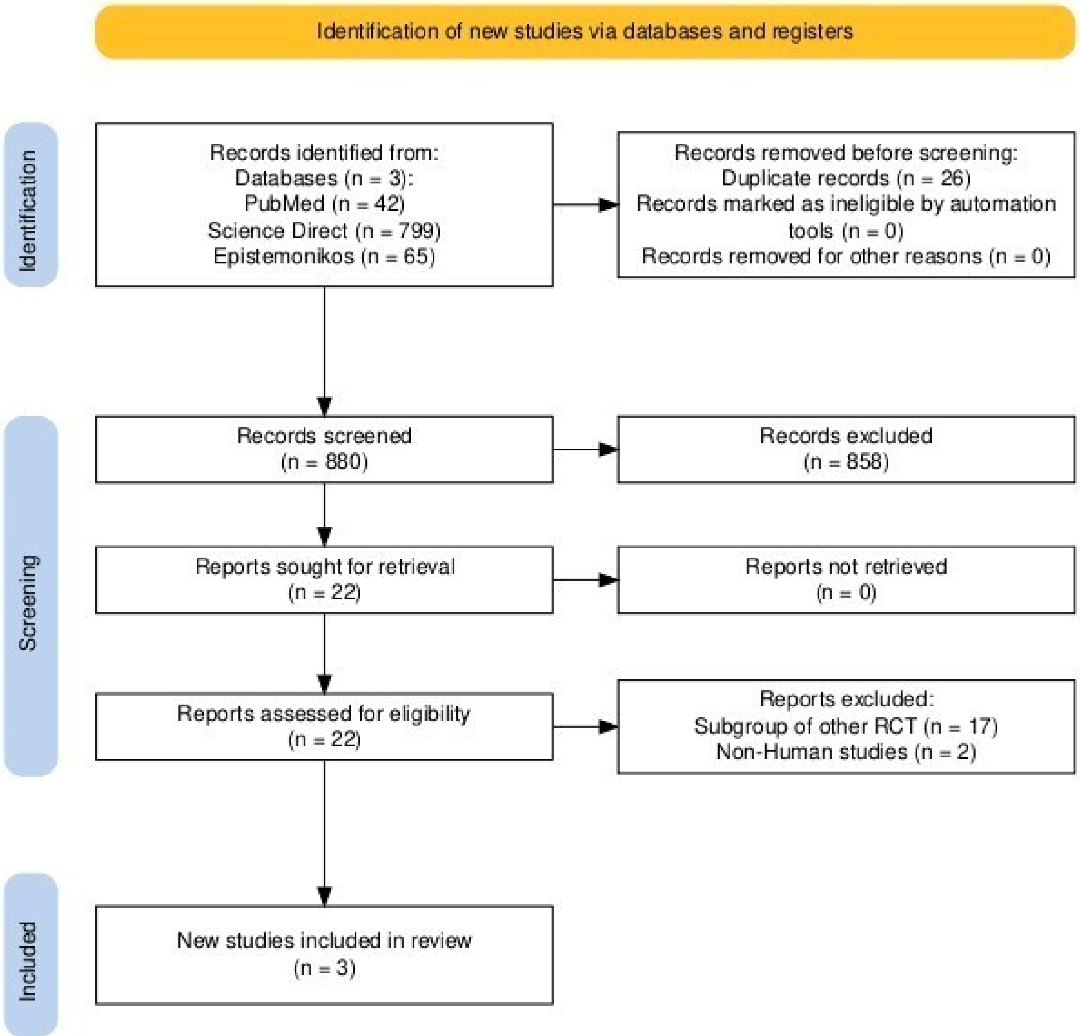


Figure 1. PRISMA FlowChart

Table 1. Characteristics of Included Studies

No	Author	Age (Finerenone)	Age (Control)	Gender (Finerenone)	Gender (Control)	Dose (Finerenone)	Follow-Up
1	Bakris et al.,[10] 2020	65.4 ± 8.9	65.7 ± 9.2	Male (1953)	Male (2030)	10 mg/ 20mg	2.6 years
2	Pitt et al.,[11] 2021	64.1 ± 9.7	64.1 ± 10	Male (2528)	Male (2577)	10 mg/ 20 mg	3.4 years
3	Finnian et al.,[13] 2025	71.94 ± 9.60	72.04 ± 9.69	Male (1648)	Male (1621)	10 mg, 20 mg or 40 mg	32 months

Renal outcome analysis

Finerenone treatment is linked to notable deceleration in the progression of kidney disease (Fig. 2 (upper portion)). The odds of a sustained decline in estimated glomerular filtration rate (eGFR) of ≥40% from baseline were 17% lower than that of the control group (pooled OR = 0.83; 95% CI, 0.75 to 0.92; p=0.0003). Consistent benefits were observed for a more severe decline in kidney function, defined as a sustained eGFR decrease of ≥57% from baseline (pooled OR = 0.86; 95% CI, 0.76 to 0.97; p=0.0001). The renoprotective effect was observed in the analysis of the major composite kidney outcome (including a sustained eGFR decrease of ≥57%, end-stage kidney disease, or renal death). Finerenone was associated with a highly significant 24% reduction in the odds of the composite kidney endpoint (pooled OR = 0.76; 95% CI, 0.68 to 0.85; p<0.0001). When evaluating the most severe renal outcomes, the effect of finerenone showed positive trends but did not reach statistical significance. There was no significant difference between groups for the outcome of an eGFR falling below 15 ml/min/1.73m2 (pooled OR = 0.89; 95% CI, 0.62 to 1.08; p=0.31). For the critical endpoint of end-stage kidney disease (ESKD), the analysis showed a clinically relevant 21% reduction in odds with finerenone. However, this result narrowly missed the threshold for statistical significance (pooled OR = 0.79; 95% CI, 0.62 to 1.01; p=0.06).

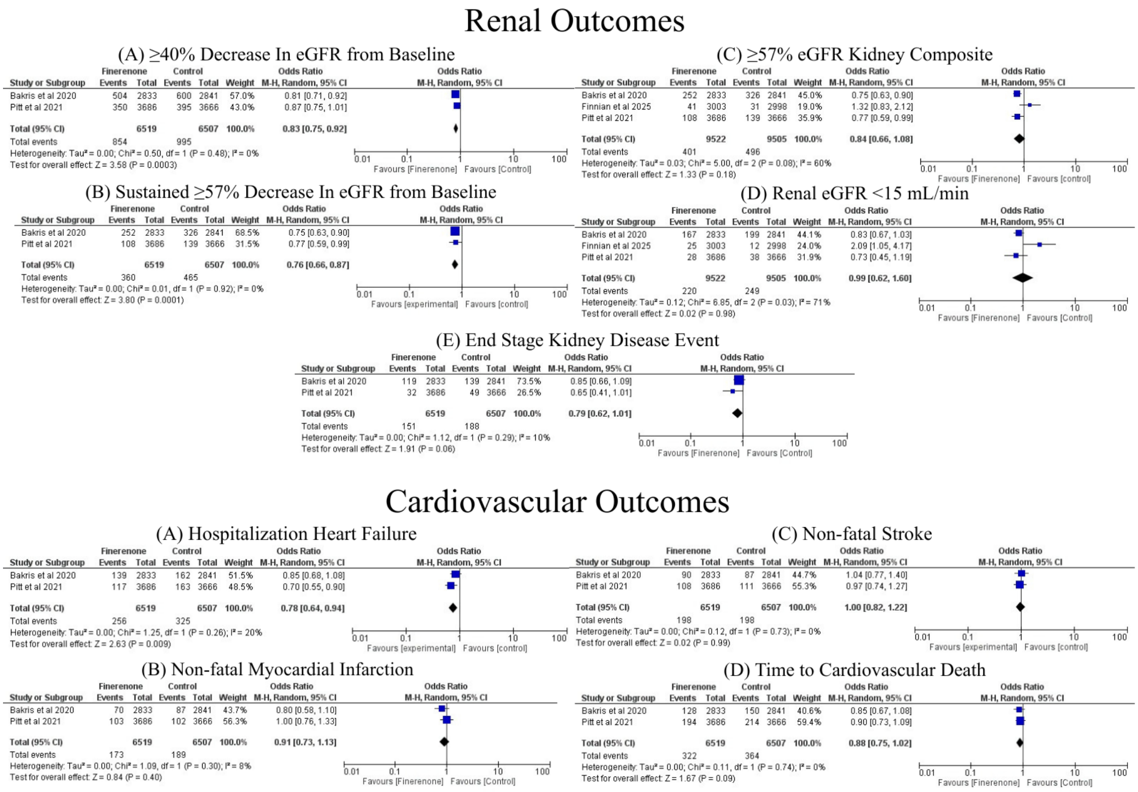


Figure 2. Forest Plot of Renal & Cardiovascular Outcome

Cardiovascular outcome analysis

We were only able to include two RCT data sets by Bakris et al and Pitt et al, which had the same cardiovascular outcome parameters and were arranged in a forest plot as shown in Fig. 2 (below renal outcome). Encompassing a total of 13,026 participants (6,519 in the finerenone arm and 6,507 in the control arm). The pooled effects of finerenone on four prespecified cardiovascular outcomes were assessed using a random-effects model. No significant statistical heterogeneity was detected across any of the analyzed outcomes (all I2=0%). Hospitalization for heart failure was lower in the finerenone group compared to placebo by 12% (OR 0.78, 95% CI: 0.64–0.94) and was statistically significant (Fig. 2A). For the endpoint of non-fatal myocardial infarction (Fig.2B), the meta-analysis found no significant difference between the intervention and control groups (pooled OR = 0.91; 95% CI, 0.73 to 1.13; p=0.40). Similarly, there was no statistically significant effect observed for the outcome of non-fatal stroke (Fig.2C). The pooled OR was 1.08 (95% CI, 0.88 to 1.32; p=0.39), indicating no discernible difference in stroke risk between the finerenone and control arms. In the analysis of cardiovascular death (Fig.2D), finerenone did not demonstrate a statistically significant reduction in odds compared to placebo (pooled OR = 0.88; 95% CI, 0.75 to 1.03). However, the result showed a strong trend towards a beneficial effect, narrowly missing statistical significance (p=0.09).

Risk of Bias

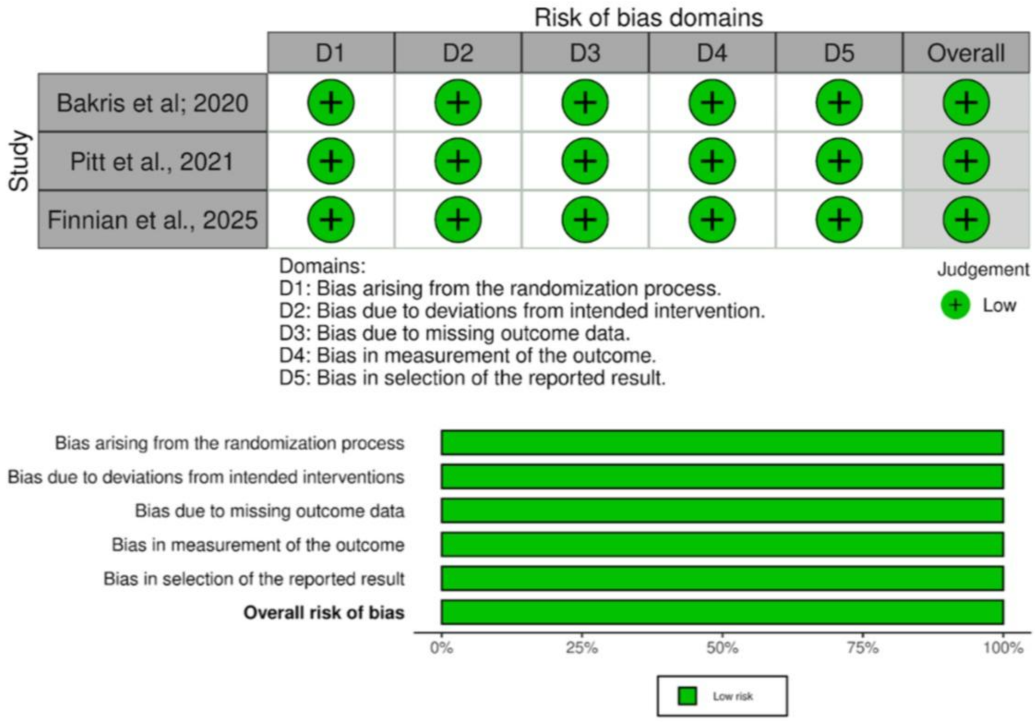


Figure 3. Traffic Light Plot & Summary Plot of Included Studies

Overall, studies have a low risk of bias and have well-conducted, large-scale randomized controlled trials with robust methodology across all domains. Studies do not indicate substantial imbalances that would suggest problems with the randomization process; there is the availability of nearly all participants' data and proper methods in measuring outcomes.

Quality assessment

Quality assessment was analyzed with GRADE-Pro for all outcomes. GRADE-PRO was compiled in Figure 4. Most of the outcomes were Moderate Certainty, except that≥57% eGFR kidney composite and Renal eGFR <15 mL/min were considered Low Certainty of evidence. It is highly likely that confidence in the results is still low despite the large sample size, as the number of studies is still relatively small, meaning there is potential for publication bias that reduces current confidence.

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Finerenone	Placebo	Relative (95% CI)	Absolute (95% CI)		
Renal Outcome ≥40% Decrease in eGFR from Baseline (follow-up: range 2.4 years to 3.6 years)												
2	randomised trials	not serious	not serious	not serious	not serious	publication bias strongly suspected[a]	854/6519 (13.1%)	995/6507 (15.3%)	**OR 0.83** (0.75 to 0.92)	**23 fewer per 1,000** (from 34 fewer to 10 fewer)	⨁⨁⨁◯ Moderate[a]	
Sustained ≥57% decrease in eGFR												
2	randomised trials	not serious	not serious	not serious	not serious	publication bias strongly suspected[a]	360/6519 (5.5%)	465/6507 (7.1%)	**OR 0.76** (0.66 to 0.87)	**16 fewer per 1,000** (from 23 fewer to 9 fewer)	⨁⨁⨁◯ Moderate[a]	
≥57% eGFR kidney composite												
3	randomised trials	serious[b]	not serious	not serious	not serious	publication bias strongly suspected[a]	401/9522 (4.2%)	496/9505 (5.2%)	**OR 0.84** (0.66 to 1.08)	**8 fewer per 1,000** (from 17 fewer to 4 more)	⨁⨁◯◯ Low[a,b]	
Renal eGFR below 15 mL/min												
3	randomised trials	serious[b]	not serious	not serious	not serious	publication bias strongly suspected[a]	220/9522 (2.3%)	249/9505 (2.6%)	**OR 0.99** (0.62 to 1.60)	**0 fewer per 1,000** (from 10 fewer to 15 more)	⨁⨁◯◯ Low[a,b]	
ESKD Event												
2	randomised trials	not serious	not serious	not serious	not serious	publication bias strongly suspected[a]	151/6519 (2.3%)	188/6507 (2.9%)	**OR 0.79** (0.62 to 1.01)	**6 fewer per 1,000** (from 11 fewer to 0 fewer)	⨁⨁⨁◯ Moderate[a]	
Hospitalization Heart Failure												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Finerenone	Placebo	Relative (95% CI)	Absolute (95% CI)		
2	randomised trials	not serious	not serious	not serious	not serious	publication bias strongly suspected[a]	256/6519 (3.9%)	325/6507 (5.0%)	**OR 0.78** (0.64 to 0.94)	**11 fewer per 1,000** (from 17 fewer to 3 fewer)	⊕⊕⊕◯ Moderate[a]	
Non-fatal Myocardial Infarction												
2	randomised trials	not serious	not serious	not serious	not serious	publication bias strongly suspected[a]	173/6519 (2.7%)	189/6507 (2.9%)	**OR 0.91** (0.73 to 1.13)	**3 fewer per 1,000** (from 8 fewer to 4 more)	⊕⊕⊕◯ Moderate[a]	
Non-Fatal Stroke												
2	randomised trials	not serious	not serious	not serious	not serious	publication bias strongly suspected[a]	198/6519 (3.0%)	198/6507 (3.0%)	**OR 1.00** (0.82 to 1.22)	**0 fewer per 1,000** (from 5 fewer to 6 more)	⊕⊕⊕◯ Moderate[a]	
Cardiovascular Death												
2	randomised trials	not serious	not serious	not serious	not serious	publication bias strongly suspected[a]	322/6519 (4.9%)	364/6507 (5.6%)	**OR 0.88** (0.75 to 1.02)	**6 fewer per 1,000** (from 13 fewer to 1 more)	⊕⊕⊕◯ Moderate[a]	

CI: confidence interval; **OR:** odds ratio

Explanations

a. Only 2 RCT included

b. I2 more than 50%

Figure 4. Grade Analysis of Included Studies

Discussion

Clinical implication

This meta-analysis analyzes the clinical utility of finerenone as a therapeutic option for patients with DKD, and findings were also supported by GRADE analysis (table attached in the supplementary file). The significant reductions in key renal endpoints, particularly the major composite kidney outcome and the progression of eGFR decline, suggest that finerenone can potentially and substantially slow the rate of kidney damage in this vulnerable population. Furthermore, the significant reduction in hospitalization for heart failure highlights finerenone's additional benefit in mitigating cardiovascular complications, which are highly prevalent in DKD patients.

While the evidence for reducing ESKD or cardiovascular death did not reach conventional statistical significance, the observed positive trends are clinically meaningful and warrant consideration, especially given the established benefits for other severe renal and cardiovascular events. The findings suggest that finerenone should be considered as part of a comprehensive management strategy for patients with DKD in improving cardiorenal outcomes, thereby potentially reducing morbidity and improving quality of life. Its nonsteroidal mechanism of action and favorable safety profile (as implied by no significant heterogeneity in cardiovascular outcomes) further support its integration into clinical practice.

Limitation and strength

This study is limited by the very limited number of RCTs available, making it difficult to assess existing publication bias. This study also has not further analyzed the side effects of the treatment and the potential interactions with other medications. This is important because patients with DKD will inevitably use medications other than Finerenone, such as antidiabetic agents, antihypertensive agents, and others. There are also several parameters that have not yet reached statistical significance, which need to be further investigated to determine if there are other factors influencing these outcomes.

The strength of this study lies in the fact that, although only a few RCTs were included, the included studies were confirmed not to be duplicates of patients between RCTs. Previous meta-analyses have included studies from the same RCT registry but analyzed them further using subgroups. The issue with this data collection method in this case is the potential for data from one patient to be duplicated, appearing as if they were different patients. Thus, the strength of this study lies in prioritizing the use of non-overlapping trial registries which ensures data independence and avoids the potential for data redundancy.

Future research direction

Further RCTs are needed not only to increase the sample size, but also to compare with commonly used drug combinations in DKD patients, such as antidiabetic and antihypertensive drugs, to assess drug interactions and other potential side effects. Renal and cardiovascular parameters whose efficacy is still debated need further investigation to determine whether other factors influence the results or if the data is already accurate for general implementation. Subgroup analysis in RCTs is indeed important to identify demographic factors that may influence outcomes, however in the context of meta-analyses, it should be taken into consideration to avoid including both primary trials and their corresponding subgroup analysis simultaneously to prevent double-counting participants.

Conclusion

This meta-analysis demonstrates finerenone's renoprotective effects in diabetic kidney disease, markedly reducing kidney disease progression and major composite kidney outcomes. Additionally, it also confirms a substantial decrease in heart failure hospitalizations. While trends for ESKD and cardiovascular death were observed, the novel aspect lies in integrating comprehensive renal and cardiovascular benefits from a limited, yet highly methodologically sound, set of trials. This supports finerenone as a crucial nonsteroidal mineralocorticoid receptor antagonist for holistic management of DKD.

Declarations

Competing interests

The authors declare no conflict of interest.

Funding source

Not applicable.

Acknowledgments

None.

Author's Contribution

Idea/concept: FG, AMS. Design: FG, AMS, SA, LIM, J, LPS, JK, SH, R. Control/supervision: FG, AMS. Data collection/ processing: FG, AMS, SA, LIM, J, LPS, JK, SH, R. Analysis/interpretation: FG, AMS. Literature review: FG, AMS, SA, LIM, J, LPS, JK, SH, R. Writing the article: FG, AMS, SA, LIM, J, LPS, JK, SH, R. Critical review: FG, AMS, J, LPS, JK, SH, R. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Magliano DJ, Boyko EJ, Genitsaridi I, Piemonte L, Riley P, Atlas SPIDFD. IDF Diabetes Atlas 11th Edition - 2025. 11th ed. International Diabetes Federation. 2025. 130 p.
2. Bragg F, Li L, Yang L, Guo Y, Chen Y, Bian Z. Risks and Population Burden of Cardiovascular Diseases Associated with Diabetes in China: A Prospective Study of 0.5 Million Adults. PLoS Med. 2016;13(7):e1002026. doi:10.1371/journal.pmed.1002026
3. Shah AD, Langenberg C, Rapsomaniki E, Denaxas S, Pujades-Rodriguez M, Gale CP. Type 2 diabetes and incidence of cardiovascular diseases: a cohort study in 1·9 million people. Lancet Diabetes Endocrinol. 2015;3(2):105–13. doi:10.1016/s2213-8587(14)70219-0
4. Hoogeveen EK. The Epidemiology of Diabetic Kidney Disease. Kidney Dial. 2022;2(3):433–42. doi:10.3390/kidneydial2030038
5. Association AD. Standards of Medical Care in Diabetes—2020 Abridged for Primary Care Providers. Clin Diabetes. 2020;38(1):10–38. doi:10.2337/cd20-as01
6. Buse JB, Wexler DJ, Tsapas A, Rossing P, Mingrone G, Mathieu C. 2019 Update to: Management of Hyperglycemia in Type 2 Diabetes, 2018. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care. 2020;43(2):487–93. doi:10.2337/dci19-0066
7. Perkovic V, Jardine MJ, Neal B, Bompoint S, Heerspink HJL, Charytan DM. Canagliflozin and Renal Outcomes in Type 2 Diabetes and Nephropathy. N Engl J Med. 2019;380(24):2295–306. doi:10.1056/nejmoa1811744
8. Agarwal R, Kolkhof P, Bakris G, Bauersachs J, Haller H, Wada T. Steroidal and non-steroidal mineralocorticoid receptor antagonists in cardiorenal medicine. Eur Hear J. 2021;42(2):152–61. doi:10.1093/eurheartj/ehaa736
9. Lullo L Di, Lavalle C, Scatena A, Mariani MV, Ronco C, Bellasi A. Finerenone: Questions and Answers—The Four Fundamental Arguments on the New-Born Promising Non-Steroidal Mineralocorticoid Receptor Antagonist. J Clin Med. 2023;12(12):3992. doi:10.3390/jcm12123992
10. Bakris GL, Agarwal R, Anker SD, Pitt B, Ruilope LM, Rossing P. Effect of Finerenone on Chronic Kidney Disease Outcomes in Type 2 Diabetes. N Engl J Med. 2020;383(23):2219–29. doi:10.1056/nejmoa2025845
11. Pitt B, Filippatos G, Agarwal R, Anker SD, Bakris GL, Rossing P. Cardiovascular Events with Finerenone

in Kidney Disease and Type 2 Diabetes. N Engl J Med. 2021;385(24):2252–63. doi:10.1056/nejmoa2110956

12. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. doi:10.1136/bmj.n71

13. Causland FRM, Vaduganathan M, Claggett BL, Kulac IJ, Desai AS, Jhund PS, et al. Finerenone and Kidney Outcomes in Patients With Heart Failure. J Am Coll Cardiol. 2025;85(2):159–68. doi:10.1016/j.jacc.2024.10.091

Case Report

Mechanical and Technical Complication in Patient with Continuous Ambulatory Peritoneal Dialysis (CAPD) with Encapsulated Peritoneal Sclerosis

Theodore Dharma Tedjamartono[1], Yenny Kandarini[2], Gede Wira Mahadita[2]

[1]Department of Internal Medicine, Faculty of Medicine, Universitas Udayana/Prof. Ngoerah Hospital, Denpasar, Indonesia
[2]Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine, Universitas Udayana/Prof. Ngoerah Hospital, Denpasar, Indonesia

ARTICLE INFO

Article history:
Received: June 30, 2025
Accepted: December 19, 2025
Published Online: December 24, 2025

Corresponding Author:
Theodore Dharma Tedjamartono, Department of Internal Medicine, Faculty of Medicine, Universitas Udayana/Prof. Ngoerah Hospital, Denpasar, Indonesia,
theodoredharma@yahoo.com

ABSTRACT

Continuous Ambulatory Peritoneal Dialysis (CAPD) relies on an intraperitoneal catheter for the inflow and outflow of dialysate fluid; therefore, mechanical complications are often encountered. Encapsulated peritoneal sclerosis (EPS) is one of the rare complications in CAPD patients, but it has high mortality and morbidity rates. A case of a patient with EPS was reported in a 53-year-old man in the form of a problem with the dwelling of the CAPD. Patients complain of a longer duration of dwelling with a positive fluid balance. There are no complaints of fever or abdominal pain. Abdominal inspection shows symmetrical, no mass, no wound or pus from the CAPD tip. The patient had a history of recurrent peritonitis. CAPD Cuff was released due to laparoscopy findings with grade IV adhesions in the omentum and peritoneum; it also showed omental cakes and peritoneal fluid with debris. Diagnosis of EPS was established based on the presence of clinical symptoms due to intestinal obstruction and structural disorders due to peritoneal fibrosis, like thickening and adhesions of the intra-abdomen, accompanied by findings of fibrous cocoon or omental cakes in the intestine, with laparotomy and/or laparoscopy. CAPD is related to various complications of infections and non-infections. Although complications related to infections are more often found, non-infection complications such as EPS can also occur in CAPD Patients; therefore, clinicians need to be aware of this complication, especially in patients with a history of recurrent peritonitis.
Keywords: CAPD, Hemodialysis, Mechanical Complication, Encapsulated Peritoneal Sclerosis.

Introduction

Indonesia's geographical conditions in the form of islands, with limitations in transportation facilities resulting in patients' difficulty in reaching the hemodialysis (HD) unit routinely, thus, Continuous Ambulatory Peritoneal Dialysis (CAPD) can be considered as a first choice of renal replacement therapy in patients with End-Stage Renal Disease (ESRD).[1,2] The advantages of using CAPD include maintaining Residual Kidney Function (RKF), increasing patient independence, and reducing costs compared to HD. However, the inability to maintain patients on CAPD for the long term is one of the challenges of a Nephrologist.[2,3] CAPD is associated with various infectious and non-infectious complications. Infection is a common complication in CAPD patients.[1] Peritonitis is the main cause of technical complication of Peritoneal Dialysis and is one of

Cite this as:
Tedjamartono TD, Kandarini Y, Mahadita GW et al. Successful Management of Thyroid Storm with Continuous Renal Replacement Therapy without Plasma Exchange. InaKidney. 2025;2(2);145-150. doi: 10.32867/inakidney.v2i2.195

the most serious complications of CAPD. Although the mortality rate from peritonitis is less than 5%, severe and prolonged peritonitis will cause damage to the structure and function of the peritoneal membrane, which will lead to membrane failure.[2] While non-infectious complications include catheter-related complications, dialysis processes, and metabolic complications. Complications can also be related to increased intra-abdominal pressure and problems related to membrane dysfunction.[4]

Peritoneal dialysis relies on an intraperitoneal catheter for the inflow and outflow of dialysate fluid, so mechanical complications are common. Several studies have shown that around 40% of patients experience mechanical complications that cause a conversion rate to HD of up to 20%.[5] Encapsulated peritoneal sclerosis (EPS) is a rare complication in CAPD patients, but it has high mortality and morbidity rates.[6] The reported mortality is around 50% within one year of diagnosis. Estimates of the prevalence of EPS vary from 0.4% to 8.9%.[4] The duration of CAPD is one of the factors that increases the incidence of EPS. The prevalence of EPS increases from 2-3% in the first 5 years of DP to 6-20% after patients have undergone DP for 10 years.[1,2]

The pathogenesis of EPS is still unknown; it is suspected that fibrin deposition in the peritoneum causes the formation of a dense capsule that can wrap the small intestine, causing obstruction. The main risk factor for EPS is the duration of PD, with a higher incidence after more than five years, especially in patients with recurrent severe peritonitis.[6] The diagnosis of EPS is characterized by clinical symptoms that resemble intestinal obstruction such as weight loss or malnutrition (with or without systemic inflammation) and can be confirmed by radiological imaging (CT scan) or the presence of fibrous tissue thickening during laparotomy.[4]

This report will explain one of the non-infectious complications in patients with CAPD, namely Encapsulated Peritoneal Dialysis, with the aim of increasing clinician awareness of this condition.

Case Illustration

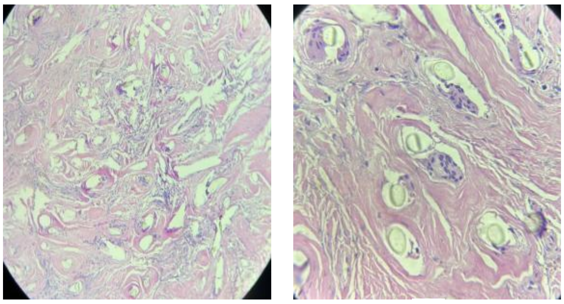
A 53-year-old male patient came with a chief complaint of dwelling abnormalities. The complaint was first felt about 4 days before entering the hospital. Initially, the patient said the dwelling duration was longer than usual. The patient dwelt 4 times a day; each dwelling session was said to generally last 4 hours, but over the last 4 days, it was said to last more than 6 hours. The patient said that in the last 4 days, the dwelling duration was longer with a fluid balance that was still negative, but since the day before, the patient's fluid balance was said to be positive. The last patient had a dwell time of 1700 ml of fluid in and 1400 ml of fluid out. CAPD fluid was said to be initially still clear. Other complaints, such as abdominal pain, were denied; there were no complaints of fever, nausea, or vomiting. The patient had a history of hypertension since 2019, but did not receive regular treatment. In 2020, the patient underwent HD for the first time with AV Shunt access. In early 2021, the patient agreed to do Peritoneal Dialysis as there was no HD machine in the area where the patient lived. Since undergoing dialysis with CAPD access, the patient has a history of treatment at the Hospital 3 times with a diagnosis of peritonitis. Patient said that several dwellings were carried out in rooms that were not clean, and the patient also admitted that he rarely washed his hands before and after dwelling.

Physical examination was done with stable vital signs, on examination, the abdomen appeared symmetrical, no masses, no visible wounds or pus from the CAPD tip, auscultation examination heard bowel sounds 8 times per minute, palpation did not feel enlarged liver or spleen, Laboratory examination was performed with the results of Leukocytes $3.44 \times 10^3/\mu L$, Hemoglobin 7.3 g/dL, MCV 71.1 fL, MCH 23.9 pg, PLT $105 \times 10^3/\mu L$, BUN 155.8 mg / dL, Creatinine 24.4 mg/dL, e-LFG 1.8, Sodium 137, Potassium 4.57. Abdominal X-ray examination did not show any ileus or pneumoperitoneum. During laparoscopy, grade IV adhesions were found in the omentum and peritoneum, and an omental cake was seen, so it was decided to release the CAPD cuff. Peritoneal fluid with debris was also seen (Figure 1).

A B

Figure 1. (A) Clinical photo of the patient after laparoscopy and CAPD removal. (B) CAPD fluid before CAPD removal

Biopsy results from the tissue at the catheter tip showed that the tissue consisted of connective tissue. In the connective tissue stroma, there was a wide distribution of fat vacuoles of varying sizes with histiocyte inflammatory cells surrounding the fat vacuoles of varying sizes, giving the impression of forming a granuloma structure. In some foci, multinucleated giant cells were also seen. A dense distribution of lymphoplasmacytic inflammatory cells and macrophages could be observed. There were no signs of dysplasia or malignancy. Histomorphology suggested a chronic inflammatory response with multinucleated giant cells of foreign bodies. Meanwhile, the biopsy results on the peritoneal fluid showed the distribution and clusters of polymorphonuclear leukocytes, neutrophils, and lymphocytes, inflammatory cells. Cytomorphology showed chronic suppurative inflammation. Peritoneal fluid culture was performed with isolated results of coagulase-negative Staphylococcus bacteria, which are normal flora on the skin. There were no complications after laparoscopy. After CAPD release, the patient returned to HD with AV Shunt access (Figure 2).



A B

Figure 2. (A) Histopathology of Catheter Tip (B) Histopathology of Catheter Peritoneum

Discussion

Although very rare, one possible complication in long-term PD patients is Encapsulated Peritoneal Sclerosis (EPS). The prevalence of EPS has been observed to vary between 0.4% and 8.9%, with an incidence of 0.7 to 13.6 per 1,000 patients per year, and the risk of occurrence after 5 years of PD is between 0.6% and 6.6%. The occurrence of EPS may be related to genetic factors, the volume of PD prescribed daily, exposure to dialysate glucose, use of biocompatible fluids, or a history of recurrent peritonitis.[7] EPS is associated with high morbidity and mortality. The reported mortality rate reaches 50%, usually within 12 months of diagnosis. However, the mortality rate depends on the severity of the disease, and not all deaths are directly caused by EPS.[8]

CAPD is indicated for all ESRD patients who require renal replacement therapy. Peritoneal dialysis requires patient independence, so patient selection is not only limited to medical and non-medical indications and contraindications, but also needs to consider several requirements. For the success of CAPD, prospective CAPD patients must meet several requirements, namely independent patients or those who help, living in a clean and healthy environment, and willing to undergo intensive training and comply with CAPD procedures.[2] In this case, the patient admitted that he did not maintain personal hygiene, especially when dwelling. Since CAPD was performed, the patient has had a history of hospitalization 3 times with a diagnosis of peritonitis. This is in accordance with the study that the main risk factor for EPS is the duration of CAPD, with a higher incidence after more than five years, especially in patients with recurrent peritonitis.[4,6]

In this case, suspicion of EPS is based on mechanical disturbances in the form of irregular CAPD dwelling, history of recurrent peritonitis, and during laparoscopy, grade IV adhesions were found in the omentum and peritoneum, omental cake was seen, and peritoneal fluid was also seen with debris. Biopsy results from the tissue at the catheter tip showed that the tissue consisted of connective tissue, and histomorphology suggested a chronic inflammatory response with multinucleated giant cells of foreign bodies. Meanwhile, biopsy results on peritoneal fluid showed the distribution and clusters of inflammatory cells, polymorphonuclear leukocytes, neutrophils, and lymphocytes. The diagnosis of EPS is based on the presence of clinical symptoms due to intestinal obstruction that depend on the severity of the obstruction, structural disorders due to peritoneal fibrosis, namely thickening and intra-abdominal adhesions, accompanied by a picture of fibrous cocoon or omental cakes in the intestine, with laparotomy and/or laparoscopy.[6,8] The initial symptoms in EPS patients are nausea, vomiting, and weight loss. Sometimes, inflammatory symptoms, including fever, fatigue, and weight loss, can also occur. In the advanced phase, the symptoms that appear can be complaints of intestinal obstruction, constipation, and abdominal pain. CT Scan has been proposed as a screening tool, but EPS can occur in a short time or with normal CT results in asymptomatic or advanced-stage patients. Radiological examination in the form of a CT Scan will show a picture of peritoneal calcification, accompanied by intestinal thickening or dilation.[8] Laboratory results in EPS are generally non-specific; one of the examinations that may be used is peritoneal dialysis fluid analysis, which shows an increase in the number of white blood cells.[6]

Pathophysiology of EPS is still unclear. Initially, it was assumed that EPS occurs due to changes in the structure of the peritoneum, such as loss of mesothelium and progressive thickening of the submesothelial layer due to long-term PD use.[9] Peritoneum is normally lined by mesothelium and submesothelium. In patients with CAPD, dialysate fluid can cause some mesothelial cells to be released. The area between the mesothelium and submesothelium becomes thick and contains fibrotic cells. Furthermore, mesothelial cells will be lost and cause hyalinous degeneration of collagen fibers (hyalinized peritoneal fibrosis) after being continuously exposed to dialysate fluid for a long period of time. In addition, the walls of micro blood vessels, especially in postcapillary venules, show hyaline thickening with narrowing or obstruction of the lumen (hyalinized vasculopathy). This condition will then cause hyalinized peritoneal sclerosis (HPS), and increased peritoneal permeability will induce fibrin exudation and form neo-membranes on the peritoneal surface. Neo-membranes will cause adhesion and encapsulation of the intestine and eventually develop into EPS as described in Figure 3.[7]

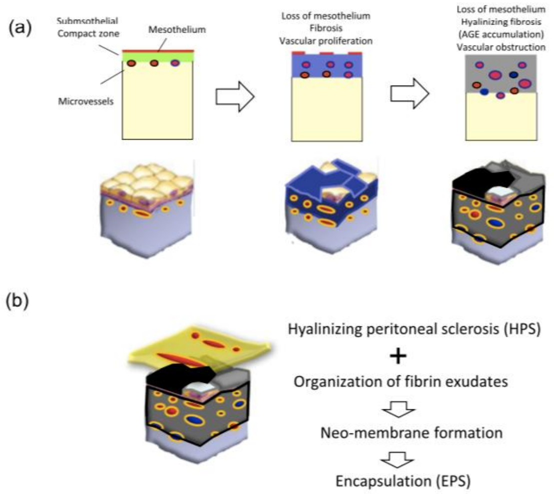


Figure 3. Pathophysiology of Encapsulated Peritoneal Sclerosis

The management of EPS can be in the form of medication, namely tamoxifen and prednisone. These drugs are given for at least three to four months, followed by tapering down prednisone for six to eight weeks. While non-medication management of EPS is carried out in patients with intestinal obstruction.[6] The recommended management of EPS with severe symptoms is not to use CAPD for 4 to 12 weeks. In some patients, CAPD is finally stopped permanently and replaced with HD.[6,9] As in this case, when laparoscopy was performed, grade IV adhesions were found in the omentum and peritoneum, omental cake was seen, so it was decided to release the CAPD cuff and replace it with HD. A similar case was reported by the study of Fawzi et al in patients with intestinal adhesions, with surgical intervention and releasing the CAPD cuff.[6]

Conclusion

Encapsulated Peritoneal Sclerosis (EPS) is a complex condition that causes high morbidity and mortality rates in patients with Continuous Ambulatory Peritoneal Dialysis (CAPD). Diagnosis of EPS in these cases was based on mechanical disorders in the form of problems with dwelling, a history of recurrent peritonitis, and findings of grade IV adhesions in the omentum and peritoneum, omental cake, and peritoneal fluid with debris in laparoscopy. Biopsy results from the tissue at the catheter tip showed that the tissue consisted of connective tissue, and histomorphology suggested a chronic inflammatory response with multinucleated giant cells of foreign bodies. Although complications related to infections are more often found, non-infection complications such as EPS can also occur in CAPD Patients; therefore, clinicians need to be aware of this complication, especially in patients with a history of recurrent peritonitis.

Declarations

Ethics approval and consent to participate

This study received approval from the Ethics Committee of the Ngoerah Hospital.

Competing interests

The authors declare no conflict of interest

Acknowledgments

None.

Author's Contribution

Idea/concept: TDT. Design: GWM. Control/supervision: YK. Data collection/processing: TDT. Analysis/interpretation: GWM. Literature review: GWM. Writing the article: TDT. Critical review: GWM. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Müller JVC, Ponce D. Infectious and mechanical complications in planned-start vs. urgent-start peritoneal dialysis: a cohort study. Brazilian J Nephrol. 2023;45(1):27–35. doi:10.1590/2175-8239-jbn-2021-0287en

2. Kandarini Y. CAPD Continuous Ambulatory Peritoneal Dialysis. Udayana University Press; 2021.

3. Ahbap E, Mazi EE, Basturk T, Sakaci T, Aykent MB, Unsal A. Peritoneal dialysis related non infectious complications: A single-center experience over 20 years. Clin Nephrol. 2023;100(1):19–26. doi:10.5414/cn111092

4. Khan SF. Updates on Infectious and Other Complications in Peritoneal Dialysis: Core Curriculum 2023. Am J Kidney Dis. 2023;82(4):481–90. doi:10.1053/j.ajkd.2023.03.011

5. Haggerty S. Surgical aspects of peritoneal dialysis. In: Surg Asp Perit Dial. 2017. p. 1–170.

6. Mudarres MF, Khan S. A Case Report and Clinical Insights on Encapsulating Peritoneal Sclerosis: A Rare yet Critical Complication of Peritoneal Dialysis. Cureus. 2024;16(8):e68344. doi:10.7759/cureus.68344

7. Nakayama M, Miyazaki M, Hamada C, Ito Y, Honda K. Pathophysiology of encapsulating peritoneal sclerosis: lessons from findings of the past three decades in Japan. Clin Exp Nephrol. 2023;27(9):717–27. doi:10.1007/s10157-023-02360-y

8. Brown EA, Bargman J, Biesen W, Chang

MY, Finkelstein FO, Hurst H. Length of time on peritoneal dialysis and encapsulating peritoneal sclerosis — Position paper for ISPD: 2017 update. Perit Dial Int. 2017;37(4):362–74. doi:10.3747/pdi.2017.00018

9. Goffin E, Krediet RT. CAPD Continuous Ambulatory Peritoneal Dialysis. Springer Nat Switz AG; 2021. 1–12 p.