Original Article

Association Between Intradialysis Hypotension and Interdialytic Weight Gain in Deceased Hemodialysis Patients at Banyumas Regional General Hospital

Gigih Rahmandanu Poernomo[1,3], Dwi Lestari Partiningrum[2], Lestariningsih[2], Ayudyah Nurani[2], Arwedi Arwanto[2], Shofa Chasani[2], Haidar Alatas[3]

[1] Trainee in Nephrology and Hypertension. Division of Nephrology and Hypertension, Department of Internal Medicine. Faculty of Medicine. Universitas Diponegoro/Kariadi Hospital, Semarang, Indonesia
[2] Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine, Universitas Diponegoro/Kariadi Hospital, Semarang, Indonesia
[3] Department of Internal Medicine, Banyumas Regional General Hospital, Banyumas, Indonesia

ARTICLE INFO

Article history:
Received: January 23, 2025
Accepted: April 8, 2025
Published Online: April 24, 2025

Corresponding Author:
Gigih Rahmandanu Poernomo,
Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia,
dr.gigih@gmail.com

ABSTRACT

Background: Intradialytic hypotension (IDH) occurs in 5-40 percent of chronic kidney disease (CKD) with hemodialysis patients, it is associated with increased cardiovascular events and mortality. High Interdialytic Weight Gain (IDWG) requires higher ultrafiltration, increases the incidence of IDH, associated with a worse prognosis, patients with a history of diabetes are at higher risk.
Objective: This study aimed to assess the association between IDWG and the occurrence of IDH in deceased patients undergoing hemodialysis, with a particular focus on the differences between diabetic and non-diabetic patients
Methods: A retrospective study was conducted for one year at Banyumas Regional General Hospital, involving deceased hemodialysis patients. IDWG was calculated as the average of the last three hemodialysis sessions. Patients were further categorized based on their history of diabetes.
Results: Among 37 deceased hemodialysis patients, 56.8% experienced IDH, including 50% of those with diabetes mellitus. IDWG was normally distributed ($p = 0.283$) and showed a weak but statistically significant correlation with IDH ($r = 0.333$, $p = 0.044$). Logistic regression indicated that each 1% increase in IDWG was associated with an 8% increase in the predicted probability of IDH. Diabetic status did not significantly modify this association ($p = 0.772$).
Conclusion: Higher IDWG was associated with increased incidence of IDH in deceased hemodialysis patients, independent of diabetic status.
Keywords: Chronic Kidney Disease, Hemodialysis, Interdialytic Weight Gain, Intradialytic Hypotension, Diabetes Mellitus.

Introduction

The prevalence of IDH, a frequent hemodialysis complication, ranges from 5 to 40%, with more recent research indicating a prevalence of roughly 11%. IDH is linked to a number of important clinical outcomes. Recurrent IDH-induced end-organ perfusion impairment can result in a number of detrimental clinical effects that impact the heart, kidney, digestive system, and central nervous system.[1–3]

IDH has a known correlation with an increase in cardiovascular events and mortality. The leading cause of death for those with CKD is cardiovascular disease, including in Indonesia. In a retrospective analysis, IDH was linked to myocardial infarction, heart failure,

Cite this as:
Poernomo GP, Partiningrum DL, Lestariningsih L, et al. Association Between Intradialysis Hypotension and Interdialytic Weight Gain in Deceased Hemodialysis Patients at Banyumas Regional General Hospital. InaKidney. 2025;2(1):12-18. doi: 10.32867/inakidney.v2i1.178

hospitalizations from fluid overload, cardiovascular issues, and overall mortality in a retrospective analysis of 39,497 hemodialysis patients. In addition, IDH accelerated the decline of residual kidney function.[4–6]

In addition to the negative long-term effects, IDH is the most common source of discomfort for patients during hemodialysis sessions since it can result in headaches, nausea, vomiting, weakness, and lightheadedness. The quality of life in hemodialysis patients is significantly influenced by their symptoms, even if definitions of IDH that just consider the amount of systolic blood pressure (SBP) reduction are insufficient to capture these symptoms. Furthermore, these symptoms could lead to an early termination of the hemodialysis session, resulting in insufficient removal of toxins and fluids.[7,8]

The ultrafiltration rate (UFR), vascular resistance, cardiac output, and the ability to restore volume from the extravascular space are interconnected in the pathophysiology of IDH. Factors related to patients that cannot be changed, including age and comorbidities such as heart disease and diabetes mellitus, elevate the risk.[9] IDWG greater than 5.7% is associated with a higher mortality risk. Higher IDWG requires higher UFR, thereby increasing the risk of IDH. During hemodialysis, increased IDWG is associated with higher ultrafiltration. Hemodialysis patients with higher IDWG have faster ultrafiltration rates and shorter periods of dialysis therapy, which are associated with poorer outcomes.[10–16]

In Indonesia, diabetes mellitus is the second leading cause of ESKD. Patients with diabetes are more likely to develop IDH. Autonomic dysfunction reduces the sympathetic activity in response to intravascular volume loss during hemodialysis and is common in DM, paraproteinemias, and other comorbidities linked to CKD and ESKD. This raises the risk of IDH and impairs compensatory arteriolar vasoconstriction.[3,17,18]

This study analyzed deceased patients undergoing maintenance hemodialysis to assess whether IDWG and IDH contributed to mortality. Findings from this population may inform strategies to mitigate risk and improve outcomes in hemodialysis patients.

Methods

Design and participants

This retrospective study aimed to evaluate the association between the incidence of IDH and IDWG in deceased hemodialysis patients at Banyumas Regional General Hospital. The study included deceased hemodialysis patients treated at the hospital from July 1, 2023, to July 1, 2024. Inclusion criteria required patients to have been on routine hemodialysis for at least three months, while patients without documented dry weight data were excluded.

Study covariates

1. Patient Demographics and Clinical History
   a. Age: Documented in years.
   b. Sex: Male or female.
   c. History of diabetes mellitus: categorized based on a documented history of diabetes. The diabetes variable was also included in the subgroup analysis to evaluate differences in the incidence of IDH and IDWG between patients with and without diabetes.
2. Dialysis-Related Parameters
   a. Dry Weight: Defined as the weight at which the patient achieves an edema-free state and experiences no orthostatic hypotension post-hemodialysis.
   b. Intradialytic Weight Gain: Determined by subtracting the post-dialysis weight from the pre-dialysis weight before hemodialysis treatment, divided by dry weight, and expressed as a percentage. IDWG was estimated using the mean pre- and post-hemodialysis weight data from three sequential hemodialysis sessions, excluding sessions during hospitalization.
   c. Ultrafiltration Rate: Total volume of fluid removed during dialysis divided by

the patient's weight and session duration, expressed as mL/kg/hour.

d. Incidence of IDH: According to the 2005 criteria set by Kidney Disease: Improving Global Outcomes (KDIGO), a definition includes a reduction in systolic blood pressure (SBP) of at least 20 mmHg or a drop in mean arterial pressure (MAP) of at least 10 mmHg, along with clinical manifestations of hypotension.[19]

Statistical analysis

All data were analyzed using SPSS software version 26. The Shapiro-Wilk test was used to assess the normality of continuous variables. The association between interdialytic weight gain (IDWG) and intradialytic hypotension (IDH) was initially explored using point-biserial (Pearson) correlation.

To further investigate the relationship between IDWG (%) and the occurrence of IDH, a binary logistic regression analysis was performed. Predicted probabilities of IDH were derived from the logistic regression model.

A multivariate logistic regression analysis was also conducted to examine potential effect modification by diabetic status. This included an interaction term between IDWG and diabetes mellitus (DM) status. Statistical significance was defined as a p-value of less than 0.05.

Results

Patient selection

The study included a total of 37 patients. The demographics and patient characteristics are summarized in the table 1. IDH was observed in 56.8% of the total patients (table 2). Incidence in Diabetic Patients: Among the 16 patients with DM, the overall incidence of IDH was 50%.

Table 1. Demographics and patient characteristics

Characteristic	Value
Male sex (%)	51.4
Age (years), mean ± SD	52.11 ± 11.28
Diabetes Mellitus (%)	43.2
Hypertension (%)	97.3
Average IDWG (%), mean ± SD	4.15 ± 1.97
Average IDWG (%) in patients with DM	3.72 ± 1.78
Average dry body weight (kg), mean ± SD	53.35 ± 11.32
Average duration of HD (months), mean ± SD	30.08 ± 22.10
Average duration of HD in DM (months)	24.44 ± 15.57
Average weight gain (kg), mean ± SD	2.62 ± 0.91

Note. IDWG = interdialytic weight gain; HD = hemodialysis; DM = diabetes mellitus

Table 2. Study result

Group	Sample Size (n)	Incidence of IDH (%)
All patients	37	56.8
Patients with DM	16	50.0

The Shapiro-Wilk test confirmed that IDWG (%) data were normally distributed ($p = 0.283$), allowing for parametric analysis. A point-biserial correlation showed a weak but statistically significant positive correlation between IDWG (%) and the incidence of intradialytic hypotension (IDH) ($r = 0.333$, $p = 0.044$).

Bivariate logistic regression suggested a trend toward increased odds of IDH with higher IDWG values (OR = 1.495; 95% CI: 0.991–2.255; $p = 0.055$). A predictive model showed that each 1% increase in IDWG was associated with an 8% increase in the probability of IDH (IDH probability = $0.22 + 0.08 \times$ IDWG%).

Multivariate logistic regression, including diabetic status and its interaction with IDWG, showed no significant effect modification (interaction p = 0.772), and diabetic status alone was not significantly associated with IDH (p = 0.929). These results indicate that the relationship between IDWG and IDH is consistent across diabetic and non-diabetic patients.

Discussion

The study explored the relationship between IDWG and IDH in a population of deceased hemodialysis patients. The findings underscore the impact of IDWG as a predictor of IDH, but they also reveal some unexpected results, particularly in patients with a history of DM. This is notable because DM is typically considered a risk factor for IDH.[6]

Our results demonstrate a significant association between IDWG and the incidence of IDH. This supports existing literature suggesting that higher IDWG is linked to an increased risk of IDH. The mechanism is likely attributable to the increased ultrafiltration required to manage higher IDWG, which can exacerbate fluid removal during dialysis and lead to hypotension. Given that IDH is linked with adverse outcomes such as cardiovascular events and increased mortality, these findings emphasize the importance of managing IDWG effectively in hemodialysis patients.

The observed correlation, though statistically significant (r = 0.333, p = 0.044), was considered weak, indicating that while IDWG contributes to IDH risk, it is likely not the sole factor. The logistic regression analysis also showed a trend towards significance (OR = 1.495; p = 0.055), reinforcing this relationship and underscoring the clinical relevance of fluid management in hemodialysis. The predicted probability model showed that each 1% increase in IDWG was associated with an 8% increase in the likelihood of IDH. These findings emphasize the need for stringent control of fluid intake and ultrafiltration during dialysis to minimize the risk of hypotensive events.

During dialysis, the removal of volume activates cardiopulmonary receptors located in the atria as well as baroreceptors in the aortic arch and carotid sinuses. Depletion of volume leads to the activation of the sympathetic nervous system (SNS) and the stimulation of the renin-angiotensin-aldosterone system. Activation of the SNS boosts cardiac venous return by decreasing venous capacitance in the splanchnic and cutaneous blood flows to support the central circulation. Extending the weekly treatment duration will, by definition, lower the necessary UFR (unchanged weight loss, extended time), which will reduce the incidence of IDH. The extended weekend interdialytic period correlates with a greater increase. Weekly treatment duration will reduce the necessary UFR (same weight loss, extended time), which in turn will lower the incidence of IDH. The longer interdialytic period during the weekend is associated with a higher IDWG.[9,14]

Multivariate logistic regression analysis revealed that diabetic status did not significantly modify the association between IDWG (%) and IDH (interaction p = 0.772). The main effect of diabetes was also not statistically significant (p = 0.929). These findings indicate that the relationship between IDWG and IDH is consistent across both diabetic and non-diabetic patients. This is further supported by stratified scatter plots, which demonstrate comparable trends in both subgroups, with only minimal variation in the regression slopes. Another study found that adjusted mortality risk was linked to IDWG among individuals with diabetes but not in those without diabetes.[10] For diabetic patients, each 1% rise in IDWG relative to dry weight per day resulted in a 67.5% increase in the adjusted relative risk (RR) of mortality. This risk was notably higher in patients new to dialysis compared to those already undergoing treatment.

This result might be attributed to the potential masking effect of diabetic autonomic neuropathy. Autonomic neuropathy can alter the usual symptoms of hypotension, making it harder to detect and possibly leading to an underestimation of IDH incidence in diabetic patients. We used KDIGO criteria for IDH that

included symptoms for several reasons; blood pressure readings alone might not capture the full picture of a patient's hemodynamic status. Different patients may experience symptoms of hypotension at different thresholds of blood pressure. Some might show symptoms even at higher blood pressures, while others may not show symptoms until blood pressure is very low. Including symptoms in the criteria helps account for individual variability in how hypotension is experienced and reported. Proper adjustment of dialysis parameters can reduce the likelihood of IDH, such as dialysate flow rate, ultrafiltration rate, and session duration.

Definitions of IDH vary based on the blood pressure parameter used (decrease in SBP, nadir SBP, decrease in mean arterial pressure), the cut-off value for the blood pressure parameter, and whether associated symptoms and/or intervention are required for diagnosis. There are other IDH criteria, such as UK Renal Association Guidelines 2011, European Best Practice Guidelines 2007, and Japanese Society of Dialysis Therapy Guidelines. Additionally, the relative risk of 0.81 (95% CI: 0.45 – 1.46) suggests that while diabetic patients might still have an elevated risk, the effect was not statistically significant in our study.

The findings highlight the need for careful monitoring and education of IDWG in all hemodialysis patients to mitigate the risk of IDH. For diabetic patients, clinicians should be aware of the potential for atypical presentations of IDH due to autonomic neuropathy. This may necessitate a tailored approach to managing fluid balance and monitoring for hypotension in this population.

Conclusion

This study found that higher IDWG was associated with an increased incidence of IDH in deceased hemodialysis patients. However, this association was not statistically significant among patients with a history of diabetes.

Limitations of the Study

The retrospective design of this study, along with the relatively small sample size, limits the generalizability of the findings. Future research could benefit from larger, prospective studies to validate these results and explore the complex interactions between diabetes, IDWG, and IDH. Additionally, investigating other factors that may contribute to IDH in diabetic patients, such as glycemic control, cardiovascular status, and medication effects, could provide a more comprehensive understanding of this issue.

Declarations

Ethics approval and consent to participate

This study adhered to the guidelines for conducting clinical research and received approval from the Ethics Committee of the under Banyumas Regional General Hospital reference number 269A/KEPK-RSUDBMS/IX/2024.

Competing interests

There are no conflicts of interest in writing this article.

Funding source

Not applicable.

Acknowledgments

None.

Author's Contribution

Idea/concept: GRP. Design: GRP. Control/supervision: DLP, L. Data collection/ processing: GRP. Analysis/interpretation: GRP, DLP, L, HA. Literature review: GRP, DLP, L, AN, AA, SC. Writing the article: GRP, DLP, L, AN, AA, SC, HA. Critical review: GRP, DLP, L, AN, AA, SC. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Chou JA, Kalantar-Zadeh K, Mathew AT. A brief review of intradialytic hypotension with a focus on survival. Semin Dial. 2017 Nov;30(6):473–80. doi:10.1111/sdi.12627
2. Kuipers J, Verboom LM, Ipema KJR, Paans W, Krijnen WP, Gaillard CAJM, et al. The prevalence of intradialytic hypotension in patients on conventional hemodialysis: A systematic review with meta-analysis. Am J Nephrol. 2019 May;49(6):497–506. doi:10.1159/000500877
3. Nakagawa N. Seasonal variation and predictors of intradialytic hypotension. Hypertens Res. 2021 Nov;44:1551–3. doi:10.1038/s41440-021-00730-1
4. Afiatin. 13th Annual Report of Indonesian Renal Registry 2020 [Internet]. Bandung; 2023. Available from: http://www.indonesianrenalregistry.org
5. Stefánsson B V, Brunelli SM, Cabrera C, Rosenbaum D, Anum E, Ramakrishnan K, et al. Intradialytic hypotension and risk of cardiovascular disease. Clin J Am Soc Nephrol. 2014 Dec;9(12):2124–32. doi:10.2215/cjn.02680314
6. Shemin D, Bostom AG, Laliberty P, Dworkin LD. Residual renal function and mortality risk in hemodialysis patients. Am J Kidney Dis. 2001 Jul;38(1):85–90. doi:10.1053/ajkd.2001.25198
7. Caplin B, Kumar S, Davenport A. Patients' perspective of haemodialysis-associated symptoms. Nephrol Dial Transpl. 2011 Aug;26(8):2656–63. doi:10.1093/ndt/gfq763
8. Kuipers J, Oosterhuis JK, Paans W, Krijnen WP, Gaillard CAJM, Westerhuis R, et al. Association between quality of life and various aspects of intradialytic hypotension including patient-reported intradialytic symptom score. BMC Nephrol. 2019 Dec;20:164. doi:10.1186/s12882-019-1366-2
9. Hamrahian SM, Vilayet S, Herberth J, Fülöp T. Prevention of intradialytic hypotension in hemodialysis patients: Current challenges and future prospects. Int J Nephrol Renov Dis. 2023 Aug;16:173–81. doi:10.2147/ijnrd.s245621
10. Wong MMY, McCullough KP, Bieber BA, Bommer J, Hecking M, Levin NW, et al. Interdialytic weight gain: Trends, predictors, and associated outcomes in the international Dialysis Outcomes and Practice Patterns Study ({DOPPS}). Am J Kidney Dis. 2017 Mar;69(3):367–79. doi:10.1053/j.ajkd.2016.08.030
11. Singh AT, Mc Causland FR. Osmolality and blood pressure stability during hemodialysis. Semin Dial. 2017 Nov;30(6):509–17. doi:10.1111/sdi.12629
12. Flythe JE, Curhan GC, Brunelli SM. Disentangling the ultrafiltration rate-mortality association: the respective roles of session length and weight gain. Clin J Am Soc Nephrol. 2013 Jul;8(7):1151–61. doi:10.2215/cjn.09460912
13. Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. Kidney Int. 2011 Jan;79(2):250–7. doi:10.1038/ki.2010.383
14. Foley RN, Herzog CA, Collins AJ, United States Renal Data System. Blood pressure and long-term mortality in United States hemodialysis patients: {USRDS} Waves 3 and 4 Study. Kidney Int. 2002 Nov;62(5):1784–90. doi:10.1046/j.1523-1755.2002.00636.x
15. Kalantar-Zadeh K, Regidor DL, Kovesdy CP, Van Wyck D, Bunnapradist S, Horwich TB, et al. Fluid retention is associated with cardiovascular mortality in patients undergoing long-term hemodialysis. Circulation. 2009 Feb;119(5):671–9. doi:10.1161/circulationaha.108.807362
16. Assimon MM, Wenger JB, Wang L, Flythe JE. Ultrafiltration rate and mortality in maintenance hemodialysis patients. Am J Kidney Dis. 2016 Dec;68(6):911–22. doi:10.1053/j.ajkd.2016.06.020
17. Nette RW, van den Dorpel MA, Krepel HP, Ie EHY, van den Meiracker AH, Poldermans D, et al. Hypotension during hemodialysis results from an impairment

of arteriolar tone and left ventricular function. Clin Nephrol. 2005 Apr;63(4):276–83. doi:10.5414/cnp63276

18. Shafi T, Mullangi S, Jaar BG, Silber H. Autonomic dysfunction as a mechanism of intradialytic blood pressure instability. Semin Dial. 2017 Nov;30(6):537–44. doi:10.1111/sdi.12635

19. Foundation TNK. KDOQI clinical practice guidelines for cardiovascular disease in dialysis patients: Guideline 3. Identification of hemodialysis patients at high risk for intradialytic hypotension [Internet]. Available from: https://kidneyfoundation.cachefly.net/professionals/KDOQI/guidelines_cvd/intradialytic.htm