

Interdialytic weight gain levels and blood pressure changes during fluid withdrawal in hemodialysis patients

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Abstract

Introduction. Interdialytic weight gains (IDWG) are a secondary impact of excessive fluid and/or food intake. In addition, IDWG is common in hemodialysis patients due to renal excretion dysfunction, which impacts fluid buildup. Interdialytic Weight Gain (IDWG) is a secondary impact of excessive fluid and/or food intake and is common in hemodialysis patients due to renal excretion dysfunction. If the patient has severe IDWG, it will have an impact that fluid withdrawal will be increased. This increases the risk of complications during fluid withdrawal on hemodialysis.

Objective. To identify the relationship of IDWG levels with

changes in blood pressure during fluid withdrawal in hemodialysis patients.

Materials and Methods. This was a descriptive-analytic study in which 90 patients undergoing HD were recruited using consecutive sampling. Respondents are free to get involved and withdraw from research and respondents who are involved in research are given rewards from researchers.

Result. The study found a relationship between IDWG and blood pressure changes during fluid withdrawal during the 1st hour (P value < α ; α = 0.05).

Discussion. Blood pressure changes during hemodialysis primarily increased blood pressure influenced by some factors. The factors are IDWG levels, UF volume, stimulation of the Renin-Angiotensin-Aldosterone System, antihypertensive therapy, and history of cardiovascular disease. The limitation of this study is that blood pressure measurements on some respondents were not carried out on time, because respondents sometimes fell asleep.

Conclusion. Based on this study, IDWG is related to changes in blood pressure at the 1st hour of fluid withdrawal.

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Key words: blood pressure; cardiovascular diseases; hemodialysis; renal dialysis; interdialytic weight gains (IDWG).

Acknowledgments: we would like to thank the Faculty of Nursing Universitas Indonesia for funding support.

Contributions: KY, TH, MPR, conceptualization; MA, MPR, methodology; MPR, TH, MA, formal analysis; MPR, TH, writing-original draft preparation, writing-review and editing; KY, supervision; MPR, MA, project administration. All the authors approved the final version to be published.

Conflict of interest: the authors declare no potential conflict of interest.

Funding: this research was funded by the Faculty of Nursing Universitas Indonesia.

Ethical approval and consent to participate: this research has received ethical approval from the Ethics Committee of the Faculty of Nursing, University of Indonesia.

Availability of data and material: data and materials are available by the authors.

Informed consent: the manuscript does not contain any individual person's data in any form.

Received for publication: 20 October 2022.

Accepted for publication: 8 February 2023.

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Journal of Public Health in Africa 2023; 14(s2):2566

doi:10.4081/jphia.2023.2566

Introduction

Hemodialysis is carried out to eliminate metabolic wastes such as urea and creatinine in the blood and overcome the problem of excessive fluid and electrolyte balance.¹ According to the Centers for Disease Control and Prevention (2019), in the United States, only 1 in 2 people with ESRD do not undergo hemodialysis therapy. In Singapore, 87.7% of all ESRD patients in Singapore choose hemodialysis as their renal replacement therapy.² Meanwhile, in Indonesia, there are 19.3% or 77892 ESRD patients are actively undergoing renal replacement therapy with hemodialysis.³ This shows that hemodialysis is a kidney replacement therapy that is widely chosen and is believed to have the most optimal therapeutic Effect for treating problems caused by kidney damage in ESRD patients.

Hemodialysis is usually performed 2-3 times a week for 3–4 hours.⁴ In Indonesia, hemodialysis is carried out in a hospital or hemodialysis unit/clinic. Hemodialysis is according to a predetermined schedule, which is only 2-3 times a week with a duration of 3–4 hours.³ Meanwhile, the standard recommended by the Indonesian Nephrology Association (PERNEFRI) is that the total duration of hemodialysis in one week is good for maintaining adequacy, which is 10 hours.⁵ It means that if the patient does hemodialysis twice a week, the duration of hemodialysis is 5 hours. The difference in the schedule can lead to less hemodialysis adequacy and cause fluid accumulation to be more at risk. This fluid accumulation can be evaluated by calculating the Interdialytic Weight Gains (IDWG).⁶

Interdialytic Weight gain (IDWG) is a secondary impact of excessive fluid and/or food intake.^{7,8} The Indonesian Nephrology Association (PERNEFRI) classifies IDWG into three, namely <2% is said to be mild IDWG, 2–4% is said to be mild IDWG, and >4% is said to be severe IDWG. In addition, the IDWG serves as

a guide for determining the amount of fluid that should be withdrawn and filtered during a hemodialysis session. When a patient has a high IDWG, the ultrafiltration fluid is also high.⁹ The high amount of ultrafiltrated fluid can pose several risks during fluid withdrawal on hemodialysis.^{10–12} One of the risks that can occur during fluid withdrawal is changes in blood pressure.³ Changes in blood pressure during hemodialysis can be categorized into two, decreased and increased blood pressure. Hemodialysis patients are said to experience a decrease in blood pressure, namely when there is a decrease in systolic blood pressure of > 20 mmHg during hemodialysis. Meanwhile, increased blood pressure when there is an increase in systolic blood pressure > 10 mmHg during hemodialysis.^{10,13–15} Based on this background, researchers are interested in knowing how the level of interdialytic weight gain (IDWG) is related to changes in blood pressure.

Materials and Methods

This study uses a descriptive-analytic design that describes the relationship between the level of interdialytic weight gain (IDWG) and changes in blood pressure. This study was conducted in July–September 2020 at the Hemodialysis Installation at a hospital in Malang, involving 90 hemodialysis patients determined by consecutive sampling technique. The inclusion criteria in this research are over 18 years of age, having undergone hemodialysis for more than three months, undergoing hemodialysis twice a week with a duration of 4 hours, having complete predialysis awareness, and communicating verbally well.

Data collection begins with determining the respondents according to the research criteria. Hemodialysis patients who met the criteria were then given an explanation (informed) and asked for their consent to be involved in the study. Data were collected by observation before, during, and after the patient undergoing hemodialysis. Before and after undergoing hemodialysis, respondents were weighed, and measured their blood pressure. During the respondent's hemodialysis, blood pressure was measured every hour. Data collection in this study was carried out using a questionnaire on respondent characteristics data and an observation sheet consisting of IDWG and risk observation sheets during fluid withdrawal.

Univariate analysis performed a frequency distribution test for gender, IDWG level, changes in blood pressure, history of cardiovascular disease, history of diabetes mellitus, anemia, and antihypertensive therapy and tested using mean values. The mean (mean) and variation (minimum-maximum) values for numerical data (age, amount of fluid withdrawn, and ultrafiltration rate). The bivariate analysis used the chi-square test to analyze the relationship between IDWG levels and changes in blood pressure every hour. This research has received ethical approval from the Ethics Committee of the Faculty of Nursing, University of Indonesia. The researcher explains the activities, procedures, objectives, benefits, risks of loss, rights, and obligations of the participants. Participation of participants is voluntary.

Results

Respondents' characteristics were age, gender, and level of interdialytic weight gain (IDWG). The distribution of sex, IDWG level, history of cardiovascular disease, antihypertensive therapy, history of diabetes mellitus, and anemia are shown in Table 1. Table 1 shows that most of the respondents were female (58.9%), had a moderate IDWG level (44.4%), had a history of cardiovas-

cular disease (54.4%), used antihypertensive therapy (64.4%), did not have a history of diabetes mellitus (83.3%), and anemia (76.7%). Meanwhile, the respondents' average age is 52.33 years, according to Table 2, with the youngest respondent being 19 and the oldest 82 years old. At the light IDWG level, 1.15 liters of liquid are typically extracted, 2.49 liters are typical at the medium IDWG level, and 3.13 liters are typical at the heavy IDWG level. The average ultrafiltration rate (UFR) is 1.25 liters/hour at the light IDWG level, 1.25 liters/hour at the moderate IDWG level, and 1.59 liters/hour at the heavy IDWG level (Table 2).

The analysis showed a significant relationship between IDWG levels and changes in blood pressure at the 1st hour of fluid withdrawal ($P = 0,05$). In the 1st hour, the increase in blood pressure occurred the most. There was no significant relationship between IDWG level and changes in blood pressure from the 2nd hour to the 4th hour of fluid withdrawal ($P \text{ value} > 0,05$) (Table 3). This result is because, at the 2nd and 3rd hour, the cardiovascular response has adapted to the withdrawal of the fluid being carried out. At the 4th hour, the nurse withdraws fluids to reduce the ultrafiltration rate after completing hemodialysis. It is because the patient's body can adapt more quickly to avoid post-hemodialysis complications such as hypotension, headaches, or decreased consciousness.

Table 1. Distribution of patients' hemodialysis by gender, interdialytic weight gains level, history of cardiovascular disease, antihypertensive therapy, history of diabetes mellitus, and anemia in a hospital in Malang, 2021.

Variable	f	%
Gender		
Male	37	41,1
Female	53	58,9
Interdialytic Weight Gains (IDWG)		
Mild	18	20,0
Moderate	40	44,4
Severe	32	35,6
History of Cardiovascular Disease		
No	41	45,6
Yes	49	54,4
Antihypertensive Therapy		
No	32	35,5
Yes	58	64,4
History of Diabetes Mellitus		
No	75	83,3
Yes	15	16,7
Anemia		
No	21	23,3
Yes	69	76,7

Table 2. Distribution of patient hemodialysis by age, amount of fluid withdrawn, and ultrafiltration rate in a hospital in Malang, 2021.

Variable	Mean ± SD	Min-Max
Age	52,33 ± 12,443	19 - 82
UF Volume		
Mild IDWG	1,15 ± 0,478	0,50 – 2,0
Moderate IDWG	2,49 ± 0,576	1,0 – 3,50
Severe IDWG	3,13 ± 0,799	1,12 – 4,50
Ultrafiltration rate		
Mild IDWG	1,25 ± 0,287	0,25 – 1,25
Moderate IDWG	1,25 ± 0,287	0,50 – 1,75
Severe IDWG	1,59 ± 0,356	1,0 – 2,25

Discussion

The result showed a significant relationship between IDWG levels and changes in blood pressure at the 1st hour of fluid withdrawal (P value=0,05), where at the 1st hour, the increase in blood pressure occurred the most. It is in line with previous studies which showed a relationship between IDWG and changes in blood pressure, wherein individuals with higher IDWG were at greater risk of experiencing an increase in blood pressure.¹⁶ The results of this study are also in line with the research by Inrig et al. (2007). It showed an association between IDWG and increased blood pressure during hemodialysis. Every 1% increase in IDWG was associated with an increase in systolic blood pressure during hemodialysis of 1.66 mmHg. The results of this study are also in line with research in Indonesia, which showed a relationship between moderate and severe IDWG levels and the incidence of intradialytic hypertension ($P=0.01$).¹⁷

The amount of fluid withdrawn during hemodialysis depends on the dry weight to be achieved. Dry weight in patients undergoing hemodialysis is closely related to the level of IDWG. In patients with high IDWG levels, the amount of fluid that must be withdrawn will increase to meet the dry weight of the patient. Kandarini *et al.* (2017) explain that patients with high IDWG have a high amount of fluid that must be withdrawn. The amount of fluid withdrawn is called the Ultrafiltration Volume (UF Volume). UF volume is one of the factors that can cause changes in blood pressure during fluid withdrawal in hemodialysis.¹⁸ The results showed a significant relationship between high UF volume and hypertension during hemodialysis ($P=0.0001$).¹⁹ Another study also showed a significant relationship between UF volume and changes in blood pressure in patients undergoing hemodialysis.^{20,21} Withdrawing some fluids during hemodialysis will cause the Renin-Angiotensin-Aldosterone System (RAAS). RAAS activation occurs because of the body's compensatory mechanism due to a decrease in intravascular volume when some fluids are drawn out of the body during hemodialysis. The activated RAAS causes an increase in the secretion of renin and angiotensin II. This condition can cause a sudden increase in systemic vascular resistance and blood pressure during the fluid withdrawal process in hemodialysis.^{19,22-24}

Another cause of increased blood pressure is an increase in systolic blood pressure >10 mmHg during hemodialysis in the first hour of fluid withdrawal. It is the withdrawal of antihypertensive drugs and the withdrawal of some fluids. Angiotensin Converting Enzyme Inhibitor (ACEI) and β -blockers are antihypertensive therapies that will be attracted during the fluid withdrawal process in hemodialysis.²⁵ The loss of antihypertensive drugs causes the loss of therapeutic effects that aim to lower blood pressure so that when blood pressure rises again. A previous study showed that 90% of hemodialysis patients taking ACEI antihypertensives and β -blockers had intradialytic hypertension.²⁶⁻²⁸ This study showed a relationship between antihypertensive drugs and hypertension during hemodialysis ($P<0.01$). The results of this study indicate that most respondents (54.4%) use ACEI antihypertensives and β -blockers. It can be assumed that one of the causes of hypertension in this study is because they are interested in the release of antihypertensive drugs consumed by respondents.²⁹

The high increase in blood pressure in this study can also be caused by the underlying condition of the patient, who has a history of cardiovascular disease. It is in line with the statement of Teng *et al.* (2015), which states that one of the factors that cause hypertension during hemodialysis is the patient's primary condition in the form of a history of cardiovascular disease. In this study, 54.4% of respondents had a history of cardiovascular disease. A history of cardiovascular disease can increase vascular resistance, which can be exacerbated by the withdrawal of fluids as an acute response to hemodialysis.³⁰⁻³² An increase in vascular resistance will increase blood flow, where every five m/s increase is associated with an increase in systolic blood pressure of 8 mmHg.³³ The cause of increased vascular resistance can also occur due to endothelial dysfunction, where patients with endothelial dysfunction will have a greater risk of experiencing changes in blood pressure during fluid withdrawal.^{30,34,35} The presence of comorbidities in the form of a history of cardiovascular disease. It causes high predialysis blood pressure, one of the risk factors for hypertension during hemodialysis. A study in Guinea showed that 40.5% of patients undergoing hypertension during hemodialysis. It is because have predialysis blood pressure >140 mmHg.³⁶

At the 2nd hour, 3rd hour, and 4th hour of fluid withdrawal, there was statistically no relationship between the level of Interdialytic Weight Gain (IDWG) and changes in blood pressure ($P>0.05$).

Table 3 Distribution of patients' hemodialysis based on interdialytic weight gains level and blood pressure in a hospital in Malang, 2021.

Time	IDWG	Change in Blood Pressure						Total		P
		Decreased		Stabil		Increased		n	%	
		n	%	n	%	n	%	n	%	
1 st	Mild	3	16,7	3	16,7	12	66,7	18	100	0,043*
	Moderate	15	37,5	7	17,5	18	45,0	40	100	
	Severe	8	25,0	6	18,8	18	56,3	32	100	
	Total	26	28,9	16	17,8	48	53,3	90	100	
2 nd	Mild	1	5,6	8	44,4	9	50,0	18	100	0,649
	Moderate	8	20,0	17	42,5	15	37,5	40	100	
	Severe	5	15,6	14	43,8	13	40,6	32	100	
	Total	14	15,6	39	43,3	37	41,1	90	100	
3 rd	Mild	2	11,1	7	38,9	9	50,0	18	100	0,401
	Moderate	12	30,0	16	40,0	12	30,0	40	100	
	Severe	9	28,1	14	43,8	9	28,1	32	100	
	Total	23	25,6	37	41,1	30	33,3	90	100	
4 th	Mild	0	0,0	10	55,6	8	44,4	18	100	0,438
	Moderate	14	35,0	13	32,5	13	32,5	40	100	
	Severe	8	25,0	16	50,0	8	25,0	32	100	
	Total	22	24,4	39	43,3	29	32,2	90	100	

IDWG, interdialytic weight gains.

These results are not in line with previous studies, which showed a significant relationship between IDWG and complications during hemodialysis, and changes in blood pressure (P value=0.001).³⁷ This result is not in line with other studies, which showed a significant relationship between IDWG and complications during hemodialysis in the form of changes in blood pressure (P=0.020).²⁷ The results of other studies also showed a relationship between IDWG and changes in blood pressure (P=0.031).³⁸ The difference in the results of this study is due to differences in measurement and analysis methods. In the study used as a comparison, the respondents experienced changes in blood pressure based on the average blood pressure while undergoing hemodialysis. In addition, the research analysis process used as a comparison is to analyze the relationship between IDWG and the average results of changes in blood pressure during the respondent undergoing hemodialysis. Meanwhile, in this study, the determination of changes in blood pressure and analysis of the relationship between IDWG levels and changes in blood pressure were carried out every hour, so there were differences in the study's results.

In this study, most of the respondents did not experience changes in blood pressure, and there was no relationship between IDWG levels and changes in blood pressure at the 2nd hour, 3rd hour, and 4th hour. It does not make changes in blood pressure from the 2nd hour to the 4th hour of fluid withdrawal negligible. It is because some respondents at the 2nd to 4th hour of fluid withdrawal experienced changes in blood pressure. At the 3rd hour of fluid withdrawal, a decrease in blood pressure is experienced. Then, at the 4th hour of fluid withdrawal, the incidence of changes in blood pressure decreases. It is because the nurse decreases the ultrafiltration rate (UFR) near the end of the hemodialysis session. This decrease in UFR was carried out because near the end of the hemodialysis session, the amount of fluid withdrawn was close to the maximum to prevent risks during fluid withdrawal. In addition, the goal of reducing UFR is to allow the body to adapt to changes before the hemodialysis session ends.³⁹ It is in line with Bowman & Rosner (2019); Saebra & Jaber (2010), which stated that the interaction of several factors, such as high UFR, could cause hypotension during fluid withdrawal on hemodialysis. Another study showed that a manual increase in UFR gradually every 5 minutes can affect the hemodynamic status, namely a decrease in blood pressure.^{2,40,41} Based on this, the nurse has taken the right action in reducing UFR near the end of the hemodialysis session. Blood pressure monitoring should be done from the 1st to the 4th hour of fluid withdrawal.

Conclusions

Interdialytic weight gain (IDWG) levels were associated with changes in blood pressure in the first hour of fluid withdrawal. Blood pressure changes during hemodialysis primarily increased blood pressure influenced by some factors. The factors are IDWG levels, UF volume, stimulation of the Renin-Angiotensin-Aldosterone System (RAAS), antihypertensive therapy, and history of cardiovascular disease. In future research, it can be continued in the broader area in various hemodialysis units and hospitals. It can be carried out by developing other factors related to risk during fluid withdrawal. It includes age, amount of fluid withdrawn, ultrafiltration rate, history of cardiovascular disease, diabetes mellitus, and antihypertensive.

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