SOUTH EAST ASIA NURSING RESEARCH
Available on : https://jurnal.unimus.ac.id/index.php/SEANR

Original Research

Factors Contributing to Intradialytic Hypertension in Hemodialysis Patients

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Article Info

Article History:
Submitted: May 26th 2021
Accepted: June 21st 2021
Published: June 23rd 2021

Keywords:
IDWG; fluid adherence; ultrafiltration; intradialytic hypertension; hemodialysis

Abstract

Intradialytic hypertension (IDH) is the most common complication of hemodialysis patients in Indonesia. It must be controlled, to maintain the patient's quality of life and prevent worsening conditions. Some factors affecting IDH include predialysis fluid overload characterized by excessive interdialytic weight gain (IDWG), low adherence to fluid restriction and increased ultrafiltration during haemodialysis. The study aims to identify contributing factors of IDH. A case-control design was used in this study. A purposive sampling technique was used to recruit 92 samples at two centres of dialysis in Semarang, which was divided into case group (n=46) and control group (n=46). Data were analyzed using the Chi-square test by calculating Odds Ratios (OR). The finding showed that excessive IDWG (p=0,000, OR=16.95, 95% CI:5,56-51,65), low fluid adherence (p=0,001, OR=4,41, 95% CI:1,82-10,68) and excessive ultrafiltration (p=0,000, OR = 29,52, 95% CI:9,23-94,46) showed significant result. However, the incidence of IDH was not correlated with sex, age and length of haemodialysis. A greater increase in interdialytic weight requires lower fluid and higher ultrafiltration factors must be controlled precisely because those are considered as the risk factors for the high incidence of IDH. Excessive ultrafiltration is the most dominant risk factor in the high incidence of IDH.

INTRODUCTION

The prevalence number of Chronic Kidney Disease (CKD) in Indonesia around 90% to 3.8 cases in 1000 population increased significantly past decades, and 19.3% of them require hemodialysis treatment.[1] CKD patients at the end stage of the kidney disease stage require renal replacement therapy to maintain body functions.[2] Hemodialysis is the main choice of the kidney replacement therapy which is performed routinely to replace part of kidney function in patients with end-stage kidney disease. Data from the Indonesian Renal Registry (IRR) shows an increasing new patients undergoing haemodialysis in Indonesia from 2017 to 2018 as much as 53.7%.[3]

Haemodialysis is effective in removing fluids, electrolytes and metabolic waste,

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South East Asia Nursing Research, Vol 3 No 2, June 2021
ISSN:2685-032X
DOI: https://doi.org/10.26714/seanr.3.2.2021.73-80

symptom relief and improving the quality of life for end stage kidney disease patients.[4] Moreover, haemodialysis is also effective and safe enough as routine therapy for CKD patients to reduce morbidity and improve quality of life. However, various intradialytic complications can occur during the hemodialysis procedure. One of the important complications is the increased of intradialytic blood pressure or the occurrence of intradialytic hypertension (IDH). IDH is a phenomenon where blood pressure increases during the hemodialysis procedure.[5] The blood pressure average decreases in the first hour, and increases more in the next third and fourth hours during hemodialysis procedures.[6]

The prevalence incidence of IDH is quite varied across the globe. It can be determined by many factors, including differences in the definition of the IDH terminology.[7] A retrospective cohort study of 22,955 hemodialysis treatments showed that the prevalence of IDH was 21.3 per 100 procedures.[8] Study in Korea showed that 19.2% of patients on routine hemodialysis had IDH.[9] A study in India concluded that IDH was experienced by 81.8% of hemodialysis patients.[10] Several studies in Indonesia showed that IDH is often experienced by hemodialysis patients. The 2018 annual report of the Indonesian Nephrology Association stated that the prevalence of IDH in Indonesia was 38%.[3] Research at one dialysis center in Semarang showed the prevalence of IDH was 25.9%.[11] Another study in Bali showed that IDH was the most common complication experienced by hemodialysis patients with 52.4%.[12] The increasing blood pressure can be severe even to the point of a hypertensive crisis that endangers the patients.

IDH will affect hemodialysis adequacy, increasing the risk of heart failure and patient's mortality. IDH in routine hemodialysis patients is associated with increased morbidity and mortality.[13] Previous study in 151 routine hemodialysis patients showed that high interdialytic blood pressure was associated with an increased risk of stroke and death. Previous study showed a total of 13.91% of patients with high interdialytic blood pressure had a stroke and 16.56% of patients were died.[14] IDH on maintenance hemodialysis patients is associated with the increased mortality. Previous study showed that the increasing >10 mmHg blood pressure during hemodialysis increased the 3.68 times risk of patient's mortality (14). A prior study of 73 hemodialysis patients also found that IDH was associated with high mortality in hemodialysis patients. The IDH group showed a mortality rate of 2,846 times higher than the group without IDH.[15] Anticipation and control of IDH can be prepared by controlling the risk factors.

Various factors contribute to IDH including predialysis fluid overload. Predialysis fluid overload can be identified by an Interdialytic Weight Gain (IDWG) assessment. The increase in fluid volume between two dialysis times, manifested by interdialytic weight gain, is the most common cause of changes in blood pressure.[16] IDH can occur because of the activation of the renin angiotensin aldosterone system (RAAS) due to hypovolemia when fluid withdrawal is carried out through ultrafiltration.[17] A Study showed that blood pressure increases during IDH due to increased cardiac output, mediated by volume overload.[18] A decrease in relative blood volume and total blood volume due to a large ultrafiltration goal decreases blood flow to the kidneys, stimulates the release of renin and causes hypertension.[2]

Fluid regulation plays an important role in the incidence of fluid overload in hemodialysis patients. Excess fluid occurs due to poor fluid intake regulation during the interdialytic period, which is characterized by a high IDWG value.[18] The increase in fluid volume between two dialysis times, manifested by increasing of interdialytic weight gain.[19] If fluid intake is

excessive, during the period between dialysis there will be a large weight gain.[20] A cross sectional study on hemodialysis patients in Yogyakarta showed a relationship between fluid intake and IDWG.[21] Another study on hemodialysis patients in Jakarta concluded that there was a relationship between fluid restriction self-efficacy and IDWG.[22]

Other factors related to patient characteristics can also influence the occurrence of intradialytic hypertension. These factors include age, gender, duration of hemodialysis. This study was purposed to analyze the various factors that contribute to the incidence of IDH such us sex, age, length of undergoing hemodialysis, IDWG, compliance with fluid regulations and ultrafiltation during hemodialysis. This research is useful to anticipate and prevent IDH by controlling these factors.

METHODS

This was a descriptive quantitative study with a case control study design. The study starting by identifying subjects who had IDH and did not experience IDH. Then the risk factors were investigated retrospectively. The study was conducted in January 2019 at two hemodialysis units in Semarang Indonesia. A total of 92 participants from 188 patients population were recruited in this study by using purposive sampling method and it was divided into both case (n=46) and control (n=46) groups. The inclusion criteria of this study were: patients with regular hemodialysis for more than three months, scheduled hemodialysis with a frequency of 2 times a week with a duration of hemodialysis 4-5 hours, awareness of compos mentis, can communicate verbally, aged ranged from 18 to 60 years and they were not using erythropoetin. The case group patient characteristic was the patients experienced increase in mean arterial blood pressure > 15 mmHg on dialysis sessions.

A standard calibrated digital spygmomanometer as used to measure the patients' blood pressure (BP). BP measurements were taken before, every hour during hemodialysis and after hemodialysis. Measurements were applied on the patients' arm that was not attached to the vascular access. The predialysis blood pressure was measured 5 minutes before the dialysis needle was inserted and the post-analysis blood pressure was measured 5 minutes after the dialysis needle was removed. Predialysis fluid overload measured based on the IDWG value which is the increase in body weight between two dialysis times, representing the addition of body fluids. Fluid adherence was categorized as good adherence if IDWG score was <4.8% and non-compliant (bad adherence) with IDWG score > 4.8%. Ultrafiltration volume or ultrafiltration goal (UFG) is the amount of fluid drawn by the hemodialysis machine during a hemodialysis session in liters. Excess UFG is the amount of fluid drawn by the hemodialysis machine during one hemodialysis session in excess of 4.8% dry body weight.

This study had obtained approval from the research ethics committee with the approval number: 231/KEPK-FKM/Unimus. The principles of research ethics include confidentiality, benefits, the principles of respecting human dignity and the principles of justice. Univariate analysis was used to describe the characteristic of respondents' characteristics such as sex, age, length of undergoing hemodialysis, IDWG, compliance with fluid regulations and UFG. Bivariate analysis was performed by using statistical data processing software on the computer. Bivariate analysis to examine the relationship between sex, age, length of hemodialysis, IDWG, fluid restriction compliance and UFG. The bivariate test in this study used the Chi-Square test.

RESULTS

Table 1 described that most of participants' age in this study ranged from 35 to 65 years old with the same average number of gender category. The mean length of hemodialysis showed 18,3 months. Most respondents (61%) have normal of IDWG, most respondents had excessive UFG values and good fluid regulatory compliance.

Table 2 showed various contributing factors of IDH. The case group was patients with IDH (n=46), while the control group was patients without IDH during hemodialysis (n=46). The finding described that IDH incidence were not correlated with sex, age and length of hemodialysis. This study showed, there was a trend towards excessive IDWG in the IDH group with 31 (86,1%) samples when compared with non IDH with 5 (13,9%) samples. Most of the IDH group (70%) had poor fluid adherence, while most of the non IDH group (65,4%) had good fluid adherence. Most of the IDH group (87,8%) had excessive UFG, while most of the non IDH group (80,4%) had normal UFG. Table 2 also showed that contributing factors of IDH were excessive of IDWG (p=0,000, OR=16.95, 95% CI:5,56-51,65), bad fluid adherence (p=0,001, OR=4,41, 95% CI:1,82-10,68) and over ultrafiltration volume (p=0,000, OR = 29,52, 95% CI:9,23-94,46).

Table 1
Characteristic of responden (n=92)

Indicators	f	%	Mean ± SD (min-max)
Age (year)			49,13 ± 8,663 (35-65)
Length of hemodialysis (months)			18,3 ± 15,614 (2-66)
Gender			
Male	46	50	
Female	46	50	
IDWG			
<4,8 % (normal)	56	61	
>4,8% (excessive)	36	39	
Fluid adherence			
Good	52	56	
Bad	44	44	
Ultrafiltration Goal			
Normal	51	45	
Over (excessive)	41	55	

Table 2
Contributing factors of Intradialytic Hypertension

Indicators	Case		Control		*p-value**	*OR (95%CI)*
	f	%	f	%		
Sex						
Male	26	56,5	20	43,5	0,149	0,592 (0,259-1,349)
Female	20	43,5	26	56,5		
Age						
< 45 years	24	58,5	17	41,5	0,104	0,537 (0,234-1,235)
> 45 years	22	43,1	29	56,9		
Length of hemodialysis						
< 12 months	25	52,1	23	47,9	0,417	0,840 (0,370-1,905)
> 12 months	21	47,7	23	52,3		
IDWG						
< 4,8 % (normal)	15	26,8	41	73,2	0,00	16.95 (5,56-51,65)
> 4,8% (excessive)	31	86,1	5	13,9		
Fluid adherence						
Good	18	34,6	34	65,4	0,00	4,41 (1,82-10,68)
Bad	28	70,0	12	30,0		
Ultrafiltration Volume (UFG)						
Normal	10	19,6	41	80,4	0,00	29,52 (9,23-94,46)
Over (excessive)	36	87,8	5	12,2		

**Chi-Square Test*

DISCUSSION

The findings of this study indicate that IDWG has a great contribution to the incidence of IDH. This study found that hemodialysis patients with a high/over IDWG 4.8% had a 16.95 chance of experiencing IDH. IDWG is the increase in body weight between two dialysis times which represents the addition of fluid in the body. An increase in fluid volume as manifested by an increase in body weight can be seen with an increase in IDWG level.[23] One kilogram of weight gain is equivalent to one litter of water consumed by the patient.

This study confirms the findings of the previous studies. A study in China showed that post-dialysis volume expansion is an important factor for the development of IDH.[24] Previous study in Jakarta described there was a trend towards predialysis excess fluid in the IDH group. Subclinical fluid overload was higher in IDH group.[25] Previous research at Semarang also stated that IDWG is the one of the important factor influencing hemodialysis blood pressure in patients with chronic renal failure.[26] There is a significant relationship between interdialytic weight gain and changes in intradialytic blood pressure in CKD patients. The smaller the IDWG level, the lower intradialytic blood pressure.[12]

The increase in IDWG contributes to systolic blood pressure elevation, the BP will increase by about 3 mmHg for every 1 kg of extra body weight.[27] The findings of another American study also showed that every 1% increase in the percentage of IDWG is associated with an increase of 1.00 mm Hg (95% CI ± 0.24) in predialysis systolic blood pressure and 1.08 mm Hg (95% CI ± 0.22) in systolic blood pressure during hemodialysis.[28] This means that excess IDWG has a high chance of occurrence of IDH. A case control study used bioimpedance spectroscopy and impedance cardiography to compare pre-dialysis, post-dialysis, and intradialytic change in total body water and extracellular water, as well as cardiac index and total peripheral resistance index (TPRI) found recurrent intradialytic hypertension is associated with higher post-dialysis extracellular volume and TPRI. Intradialytic TPRI surges account for the vasoconstrictive state post-dialysis.[29] Result of this study also linear with other study in South Africa, there was a trend towards pre-dialysis overhydration in the IDH group when compared with controls 2,6 L (95% CI 1.7-3.4) versus 1.8 L (95% CI 1.4-2.1), respectively; p = 0.06 as measured by bioimpedance spectroscopy.[30] A study in China also showed that poor IDWG control, left ventricel diastolic dysfunction might be associated with increasing prevalence of IDH in maintenance hemodialisis patients.[31]

If the IDWG level increases more than 4.8% of dry weight, it can cause complications, including IDH, left heart failure and decreased quality.[32] An excessive IDWG describes a buildup of fluid in the body that is excess. Excess fluid (overload) causes an increase in cardiac output which is one of the important causes of increased blood pressure. Hypervolumia (fluid overload) is believed to play a role in the pathogenesis of intradialytic hypertension, so controlling the volume overload is important in preventing and managing the occurrence of IDH.[33] The findings of previous studies in Medan also concluded that high IDWG was associated with the incidence of intradialysis complications such as the occurrence of intradialysis hypertension.[34] The high IDWG also increases the occurrence of other intradialysis complications. A study in Purwokerto showed that there was correlation between IDWG and intradialytic complications in patients with a hemodialysis treatment. Several Intradialysis complications associated with high IDWG including intradialytic hypertension (85.7%), followed by muscle cramps (55.4%), nausea (51.8%), headache (46.4%) and chest pain.[35]

Patients with IDH have an increased mortality risk compared to patients with modest decreases in BP during dialysis. IDH is associated with extracellular volume overload in addition to acute increases in vascular resistance during dialysis. Management strategies should include re-evaluation of dry weight.[29] Control of IDWG and modification dry body weight is needed to prevent an increase in the incidence of IDH. A study in China showed that the decrease in dry weight was associated with significantly higher decreases in angiotensin-II. Reducing fluid overload in IDH patients with high predialytic BP can effectively improve their BP, but had no effect on BP in normal predialytic BP IDH cases.[36]

Fluid excess (overload) can also be associated with adherence to fluid intake restriction. The findings of this study indicate that poor fluid adherence correlated with incident of IDH. This study showed that hemodialysis patients who did not comply with fluid intake restrictions have a risk of having IDH 4.41 times. This study showed 70% of patients who were not adherent to restriction of fluid intake had IDH. Patients who are were not adherent to fluid diet will experience an increase in IDWG. The research findings and justification are supported by the findings of previous research, that there is a relationship between self-efficacy's fluid restriction and IDWG.[22] An increase in IDWG contributes to fluid overload and the incidence of intradialytic hypertension. A study on 41 hemodialysis patients in Semarang also showed that 86.67% of patients who were non-adherent to fluid diet had IDWG > 4.8%.[37] Patients are said to be compliant if the intake of fluids is not more than the recommended intake. If the patient is not adherent, the risk of IDH is higher, the risk of intradialytic hypertension should be lower.

The findings of this study suggest that increased ultrafiltration during hemodialysis increases the risk of IDH. Excessive / over UFG (ultrafiltration volume) is the most dominant risk factor in the high incidence of IDH on this study, patients with excessive ultrafiltration have a 29.52 times risk of developing IDH. The findings of this study reinforce the results of previous research, that the amount of ultrafiltration during hemodialysis has a positive correlation with the incidence of increased intradialytic blood pressure with p = 0.003 and r = 0.42.[38] Another study conducted on 112 hemodialysis patients in Semarang showed that the greater the UFG and UFR the higher the intradialialysis blood pressure (r 0,211-0,320). The magnitude of UFG an asccociated with increase in intradialytic systolic (p=0,024; r=0,213), intradialytic diastolic (p=0,007; r=0,252) and mean arterial pressure (p=0,016; r=0,227). High UFR is associated with with increase in intradialytic systolic (p=0,037; r=0,211), intradialytic diastolic (p=0,001; r=0,320) and mean arterial pressure with p=0,034.[39]

Excessive ultrafiltration during hemodialysis due to high IDWG will lead to activation of the sympathetic nervous system, RAAS, and increased cardiac output. The process with intradialytic ultrafiltration risks reduce the Relative Blood Volume (RBV) and Total Blood Volume (TBV). The decrease in RBV and TBV will decrease blood flow to the kidneys and stimulate renin release. Renin stimulates angiotensin I to angiotensin II causing vasoconstriction and aldosterone secretion.[2]

Determination of the amount of utrafiltration must be optimal to achieve normotensive conditions in hemodialysis patients. When hemodialysis UFG determination is determined to attract excess, the magnitude of the UFG may depend on the addition of the IDWG and the target dry weight of the patient.[23] High UFG can lead intradialytic vascular resistance. Intradialytic vascular resistance surges remain implicated as the driving force for blood pressure increases.[5]

Management of hemodialysis patients must include of controlling IDWG, fluid adherence and ultrafiltration. A greater increase in interdialytic weight, requires lower fluid and higher ultrafiltration must be controlled precisely because it is a risk factor for the high incidence of IDH

CONCLUSION

The results of this study can be concluded that that contributing factors of IDH are excessive IDWG, low / bad fluid adherence and excessive ultrafiltration. Excessive ultrafiltration volume is the most dominant risk factor in the high incidence of IDH. IDH incidence not correlated with sex, age and length of hemodialysis.

ACKNOWLEDGMENT

Special thanks to patients, nurses and doctors at two Hemodialysis Units in Semarang.

CONFLICTS OF INTEREST

Neither of the authors has any conflicts of interest that would bias the findings presented here.

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