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(RESEARCH ARTICLE)

The relationship between blood flow rate and changes in blood pressure of patients during hemodialysis in Central Java, Indonesia

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Abstract

Chronic Kidney Disease (CKD) is a disease that causes the kidneys to be unable to function or work again according to their function. One of the therapies that are often used by CKD patients is hemodialysis (HD) machines. Hemodialysis is a substitute for damaged kidney work. A HD machine has a Blood Flow Rate (BFR) arrangement to control the blood flow according to the patient's condition. This research aimed to determine the relationship between blood flow rate and changes in blood pressure (BP) of patients during hemodialysis. This study was conducted in the HD room of RSUP Dr Soeradji Tirtonegoro Klaten, Central Java, Indonesia. The type of research was quantitative non-correlational experiments with a cross-sectional approach. BFR was measured and monitored the speed on HD machines. Change of BP was measured before and intra-HD (2 hours of HD process started) with the digital sphygmomanometer. The study population was CKD patients in the HD process. The sample was 65 peoples. The sampling technique used Accidental Sampling and data analysis used the Spearman Rank. The majority of the BFR was 191-220 mL/minute, and the majority of respondents experienced decreased BP. Bivariate test results obtained P-value = 0.884 (p>0.05). There was no relation between the blood flow rate of HD machine and change of patient BP in hemodialysis process.

Keywords: Blood Flow Rate; Blood Pressure; Chronic Kidney Disease; Hemodialysis

1. Introduction

A kidney is an organ of the body that has a vital function to maintain the balance system in the body. This function is known as homeostasis. A kidney has a function to excrete remnants of the end product of protein metabolism, namely urea, creatinine, ammonia, toxic/toxic substances, and maintain fluid balance, acid-base levels from body fluids, and the balance of salt and other substances in the body. Because of the importance of kidney function, impaired kidney function can affect the disruption of kidney function as a blood purifier. Kidney disorders can include kidney stones, perirenal abscesses, pyonephrosis, renal tuberculosis, and kidney cancer [1].

The incidence of chronic kidney disease (CKD) from the results of a review of 5,842 articles meta-analysis in the world was 13.4%. The incidence of chronic stage 3-5 kidney failure in Europe is 11.86%. The second most ranked countries were Japan, South Korea and Oceania at 11.73%. In China, Taiwan and Mongolia, the prevalence is 10.06%, while in Iran it is 11.68%. India and Bangladesh are countries with the lowest prevalence of 6.76% [2]. The prevalence of CKD in Indonesia, according to the 2018 Basic Health Research was 3.8%. This incidence rate has increased from 2013, which amounted to 0.2%. The highest prevalence in North Kalimantan was 6.4%, followed by North Maluku and areas with the lowest prevalence of West Sulawesi, which was 1.8% [3]

Management of CKD is essential to increase patient life expectancy. They are specific disease-based therapy, prevention and therapy of comorbid conditions, cardiovascular disease and its complications slowing the deterioration of kidney

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function, and renal replacement therapy in the form of dialysis or kidney transplantation [4]. Dialysis is a process used to remove fluids and waste products from the body when the kidneys are unable to carry out of the process, and dialysis is divided into two, namely peritoneal dialysis and HD. Patients usually do hemodialysis because diet or drug therapy is no longer able to treat or reduce the patient's kidney condition and has led to chronic kidney failure [5].

The UK Kidney Alliance reported the year 2011 there were 230 peoples per one million populations (0.03%) suffering from chronic stages of kidney failure on dialysis therapy and as many as 60.4% of these patients choosing Hemodialysis (HD) therapy [6]. In Indonesia, the number of terminal kidney failure patients requiring dialysis or dialysis reaches 150.000 people. Patients who have received dialysis therapy are around 100.000 people. Indonesian nephrologists (kidney and hypertension experts) reported that every year there are 200.000 new cases of end-stage renal failure, but not all patients are served their dialysis needs because of the limited unit of dialysis machines. The number of dialysis machines throughout Indonesia is only 2.400 machines, each of which serves 6 patients per day. The number of active HD patients in Indonesia in 2016 was 52.835 and there were 25.446 new patients. Yogyakarta Special Region has several hemodialysis actions based on duration in 2015 (3-4 hours of HD duration) reaching 14.141 actions [7].

Hemodialysis is one method of dialysis therapy used to remove fluid and waste products from the body when the kidneys are acutely or progressively unable to carry out the process. This therapy is carried out using a machine equipped with a semipermeable membrane filter (artificial kidney) [1]. The working principle of fluid transfer in HD is diffusion, osmosis and ultrafiltration. The process of transferring the patient's blood fluid to the dialyser is determined by the speed of blood flow/blood flow rate (BFR). BFR is the amount of blood that can be flowed in units of time (mL/minute). The more blood that can be flowed into the dialyser in the minute, the more toxic substances and excess fluid can be removed from the patient's body [8].

Complications that often occur in HD therapy is the change in blood pressure (BP). Before treated by HD patients have experience hypertension due to accumulation of liquid and toxic substances that cannot be excreted by the kidneys, while in HD process fluid and these substances will be released through the osmosis process, diffusion/ultrafiltration on HD machines, and patients often experience complications such as hypotension or hypertension [9].

From the results of the previous study, the blood pump/BFR settings data given to patients were adjusted according to the patient is a condition/patient comfort level and catheter/needle lumen size used, the average of blood pump/BFR that given ranged from 170-300 mL/minute. Usually, the initial speed given is <200 (150-180) mL/minute and then increased from 180 to 250 mL/minute until it is obtained according to the patient's condition. As long as the HD process takes place room nurses to make arrangements for BFR if the patient experiences complications that require BFR regulation, the nurse adjusts the BFR until the patient feels comfortable. The researchers also measured BP before HD and measured BFR and BP in HD for 10 of 16 patients who were undergoing HD in RSUP Dr Soeradji Tirtonegoro Klaten, the results obtained from the comparison before and when HD was done, patients experienced changes in BP (hypotension and hypertension) during the HD process carried out with different BFR values.

2. Methods

2.1. Study design

The type of research was quantitative non-experimental (observational) correlational research. The approach was a cross-sectional approach.

2.2. Participants in the study

The samples in this study were all those with respondents to CKD who have HD process at Dr Soeradji Tirtonegoro Klaten Hospital appropriate with the inclusion and exclusion criteria. The inclusion criteria for respondents aged 25-65 years, did not take heart medicine, did not take antihypertensive drugs. Exclusion criteria of respondents were a history of previous hypertension, respondents with a history of heart disease, respondents who were admitted to the ICU. The total sample of 65 respondents was obtained by accidental sampling. The sample calculated using Slovin formula with a margin error of 5%.

2.3. Instruments

Blood pressure measurements using a *digital sphygmomanometer* Omron brand and recapitulated on the observation sheet. Blood pressure is measured by standard operational procedures. Blow flow rate was recapitulated on the observation sheet.

2.4. Data collection

Blood flow rate (BFR) was determined by adjusting the HD machine button that is set when and the dialysis process and the speed shown on the HD machine monitor, with a speed of ml/minute. Blood pressure changes was a comparison of BP in respondents before HD (pre HD) with BP when HD is performed (intra-HD). Pre-HD BP was measured 10-15 minutes before HD and intra-HD BP was measured two hours after HD started.

2.5. Data analysis

Bivariate analysis was performed Spearman Rank**.**

2.6. Ethical consideration

The study permission was obtained from the Director of The Central Public Hospital (Rumah Sakit Umum Pusat/RSUP) Dr Soeradji Tirtonegoro Klaten. Informed consent was signed to all respondents before the data collection.

3. Results

3.1. Characteristics of respondents

Table 1 Characteristics of patients during hemodialysis

Characteristic	Frequency (f)	Percentage (%)
Age		
25-40	19	29.2
41-55	30	46.2
56-65	16	24.6
Total	65	100
Gender		
Male	43	66.2
Female	22	33.8
Total	65	100

Table 1 presents the profile characteristics of the respondents. Findings indicated that the majority of respondents were male, 43 respondents (66.2%). Based on the highest age of 41-55 years was 30 peoples (46.2%).

3.2. Blow flow rate patients

Table 2 Blood flow rate (BFR) of patients during hemodialysis

BFR (ml/minute)	Frequency (f)	Percentage (%)
150 – 170	17	26.2
171 – 190	23	35.4
191 – 220	25	38.5
Total	**65**	**100**

Table 2 shows that the majority of CKD patients who are having HD process in the HD room was given a BFR with a value of 191-220 ml/min, which was 25 respondents (38.5%).

3.3. Changes of blood pressure patients

Table 3 Changes of Blood Pressure of patients during

Blood Pressure	Frequency (f)	Percentage (%)
Increase	18	27.7
Stable	29	44.6
Decrease	18	27.7
Total	**65**	**100**

Based on table 3 know that the majority of CKD patients who were HD process in the hemodialysis room experienced a decrease in BP were 29 peoples (44.6%).

3.4. The relationship between blow flow rate and changes of blood pressure

Table 4 Relation between blood flow rate and changes in blood pressure of patients during hemodialysis

BFR (ml/minute)	Change of Blood Pressure								P-*Value*
	Increase		Decrease		Stable		Total		
	f	%	f	%	f	%	F	%	
150-170	7	10.8	6	9.2	4	6.2	17	26.2	0.884
171-190	4	6.2	12	18.5	7	10.8	23	35.4	
191-220	7	10.8	11	16.9	7	10.8	25	38.5	
Total	18	27.7	29	44.6	18	27.7	65	100.0	

Based on table 4 known from 17 patients (26.2%) who received a BFR 150-170, the majority experienced increased BP were 7 respondents (10.8%). From 23 patients (35.4%) who received BFR 171-190, the majority experienced a decrease in BP were 12 respondents (18.5%). From 25 patients (38.5%) who received 191-220 BFR, the majority experienced a decrease in BP were 11 respondents (16.9%). The results of the statistical analysis showed that p-value=0.884 (p-value> 0.05) means that there were no relations between the blood flow rate of HD machine and change of BP in patients have HD process.

4. Discussion

Based on the results of the study found that out of 65 respondents who experienced CKD who have HD process in the hemodialysis room was given the most BFR, which ranged between 191-220 ml/min as many as 25 respondents (38.5%). So, that it can be explained that the BFR at Dr Soeradji Tirtonegoro Klaten is most often given at speeds of 191-220 ml/min in patients undergoing HD. The blood flow rate is the flow of blood from the patient's arterial needle through the body line to the dialyser, then returns to the patient's body through the venous needle. The type of blood pump that is often used is a roller pump. The speed of the roller determines the speed of blood flow, which is regulated by dialysis staples. The speed of blood flow can vary from 0-600 mL/minute. Hemodialysis requires high blood flow between 200-450 ml/min. Such a large flow cannot be achieved with peripheral veins, so dialysis requires central venous access to provide for the need for blood flow [10].

BFR is given based on the patient's comfort level and the size of the catheter or needle lumen. If the patient feels more comfortable with a BFR of 180 or 200 ml/min, the value will be left until the HD process is complete and always pay attention to possible complications (such as hypothermia, cramps, nausea, vomiting). This is in line with the provision of Quick of blood or BFR can be given based on the size of the catheter's lumen or needle. The given BFR can change if the condition of the patient in the middle of undergoing hemodialysis feels uncomfortable; the nurse will reduce or increase the BFR until the patient feels more comfortable [11]. This is in line with the research that no relationship that

is too significant from 38 respondents surveyed the statistical results show that there is no overly significant relationship (p0.225) [12].

The result showed that CKD patients who were HD process in the hemodialysis room experienced a decreased in blood pressure by 29 peoples (44.6%), increased 18 peoples (27.7%), and stable 18 peoples (27%). It can be explained that most of the 65 respondents who have HD process experienced a decrease in BP. Blood pressure is the pressure generated on the artery wall. Peak pressure occurs when the ventricle contracts and is called systolic pressure. Diastolic pressure is the lowest pressure that occurs when the heart is resting. Blood pressure is usually described as the ratio of systolic pressure to diastolic pressure [5].

This study measured the change in BP. BP in respondents before HD (pre HD) with BP when HD is performed (intra-HD). Pre-HD BP was measured 10-15 minutes before HD and intra-HD BP was measured two hours after HD started. The level of changes BP consists of three; increase (pre-HD < intra-HD), decrease (pre-HD > intra-HD) and stable (pre-HD = intra-HD).

In this study, before the patients had the HD process, the majority experienced high BP was 41 peoples. People with chronic kidney disease often experience hypertension. The function of the kidneys is to excrete metabolic remnants, maintain fluid and electrolyte balance/body salt through urine. Besides, the kidneys also produce hormones that affect the function of other organs such as hormones that stimulate the production of red blood cells and hormones that help balance blood pressure and control calcium metabolism. If blood flow to the kidneys, kidney tissue is disrupted or damaged, kidney function will be disrupted and can even stop completely, especially the cortex/outer layer will produce the hormone renin which will stimulate the occurrence of hypertension that can be sedentary. Besides that, when the kidneys are damaged, the excretion of water and salt will be disrupted, this results in the contents of the vascular cavity increasing to causing hypertension [13].

From 65 respondents who studied, 29 peoples (44.6%) experienced a decrease in BP while the HD process. This can be explained from several references and studies that the decrease in blood pressure when HD can be caused by a short HD session, a low dialysate temperature and in terms of physiological views due to an aggressive reduction in blood circulation volume so that the cardiovascular system is unable to respond to decreased blood volume adequately. In the study, explained that one of the causes of intradialytic hypotension because factors from dialysis itself can contribute to hemodynamic instability: short hemodialysis sessions, low dialysate temperature and reduced aggressive blood circulation volume [14].

The results of the analysis were obtained from the Spearman Rank test to connect the HD machine blood flow rate with a change of BP in patients having hemodialysis process obtained results there was no relation between the blood flow rate of HD machine and change of blood pressure in patients having hemodialysis process. Based on this, it can be concluded that the blood flow rate given does not affect changes in blood pressure.

From the research found that the BFR with 150-170 majority experienced an increase in BP, while the BFR with 171-190 and 191-220 the majority experienced a decrease in BP. It can be explained that the higher the BFR is given, the faster the BP declines. The, from several studies, revealed that low blood pressure that occurs when the process of hemodialysis is taking place due to diabetes mellitus, poor nutritional status, low albumin, low Na dialysate content, the target of fluid withdrawal or too high ultrafiltration target. The average BFR or velocity of blood flow is 4 times the body weight, the hemodialysis process with 4 hours of BFR needed is in the range of 200 ml/minute up to 400 ml/minute. BFRs greater than 450 ml/minute can be used when using a dialyser with high COA. CoA is the coefficient of transfer surface area, namely the ability of urea purification in ml/minute at the speed of blood flow and the speed of certain dialysate flow [15]. BFRs that meet the requirements to achieve the ideal HD dose is between 200 ml/minute up to 300 ml/minute [7].

5. Conclusion

The results of the study showed that there was no correlation between the blood flow rate of the HD machine and change of blood pressure in patients having hemodialysis process. It is expected that nurses will continue to pay attention to the amount of BFR given to patients because, in the study, there was a decrease and increase in blood pressure before and after hemodialysis.

Compliance with ethical standards

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Disclosure of conflict of interest

There was no conflict of interest in this study.

Statement of informed consent

Informed consent was signed to all respondents before the data collection.

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