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Research Article

Effect of Ultra Filtration Rate (UFR) on Blood Sugar in Diabetes Mellitus Patients with Complications of Chronic Rental Failure Undergoing Hemodialysis

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Abstract

Aims: Diabetes Mellitus is a disease that has a very high prevalence every year throughout the world. Data in America, about 38% of end-stage chronic kidney failure is caused by diabetes mellitus. While data in Asia, almost 60% of people with diabetes mellitus have chronic kidney disease. It is estimated that 30 - 40% of people with Diabetes Mellitus Type I and 20 - 30% Diabetes Mellitus Type II will experience complications of Chronic Kidney Disease. Currently, it is estimated that 25% of patients with chronic renal failure undergoing hemodialysis are caused by type II diabetes mellitus
Objective : Knowing the effect of UFR on blood sugar in diabetes mellitus patients with complications of chronic kidney failure undergoing hemodialysis.
Methods: Quasi-experimental with a pre-experimental one group pretest-posttest design. The sample in this study were all DM patients with CKD complications undergoing hemodialysis in the Jakarta Hajj Hospital Hemodialysis Room in November 2022 as many as 64 people, the sampling technique was total sampling.
Results: Most of the respondents were female 51.6%, aged ≥ 50 years 78.1%, and the standard UFR rate was 68.8%. The average difference in blood sugar levels before and after hemodialysis was 188.7 mg/dl. There is an effect of UFR hemodialysis on blood sugar in diabetes mellitus patients with complications of chronic kidney failure undergoing hemodialysis (p.value 0.000).
Conclusions: There is an effect of UFR hemodialysis on blood sugar in diabetes mellitus patients with complications of chronic kidney failure undergoing hemodialysis. Need to improve the quality of independent nursing care in patients with chronic kidney disease undergoing hemodialysis.

Keywords:
Blood Sugar, Diabetes Mellitus, Hemodialysis , Ultra Filtration Rate

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder disease characterized by hyperglycemia caused by impaired insulin sensitivity and insufficient pancreatic insulin production, resulting in decreased glucose use by body cells, increased fat metabolism, and decreased protein in body tissues (1). Diabetes Mellitus is a disease that has a relatively high prevalence and incidence worldwide each year. Diabetes Mellitus data in America show a five-fold growth in 30 years, with 5.5 million persons

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diagnosed with diabetes mellitus in 1980 increasing to 23.4 million adults diagnosed with diabetes mellitus in 2015. In 2017, the prevalence of diabetes mellitus in adults worldwide was 8.8%, or 425 million people; this number is expected to rise to 10.1%, or 629 million people, by 2045 (2)

According to Riskesdas data from 2018, the prevalence rate of diagnosed diabetes mellitus in Indonesia is 1.78% or 506,576 in women and 1.21% or 510,714 in men. According to these figures, Indonesia ranks seventh in the world in terms of diabetes mellitus incidence (3). Diabetes Mellitus, if not controlled, can lead to a variety of problems. Diabetes complications can lead to a variety of dangerous chronic diseases, one of which is microangiopathy in the kidney, which causes diabetic nephropathy, which is chronic and progressive and cannot be reversed, with the worst consequences occurring. Dialysis is required due to terminal renal failure (4). Diabetes mellitus (diabetic nephropathy) causes around 38% of end-stage chronic kidney failure in the United States. According to (5) research from Asia, about 60% of patients with diabetes mellitus have chronic renal disease. It is anticipated that 30-40% of patients with Diabetes Mellitus Type I and 20-30% of people with Diabetes Mellitus Type II will develop Chronic Kidney Disease problems. Type II diabetes mellitus is thought to be the cause of 25% of individuals getting hemodialysis for chronic renal failure.

According to data gathered by the researchers from the medical records of the Haji Hospital in Jakarta over the previous three years, the number of patients with chronic renal disease having hemodialysis has increased. In 2020, there were 178 chronic renal disease patients receiving hemodialysis, with 128 (71.9%) having a history of Diabetes Mellitus Type II. In 2021, there were 136 chronic kidney disease patients undergoing hemodialysis, with 98 people (72%) having a history of Diabetes Mellitus Type II, and in 2022, there were 123 patients with chronic kidney disease undergoing hemodialysis, with 90 people (73.2%) having a history of Diabetes Mellitus Type II. According to these data, the number of chronic kidney disease patients with a history of Diabetes Mellitus Type II who undergo hemodialysis each year has increased, with 71.9% of total patients undergoing hemodialysis in 2020, 72% of total patients in 2021, and 73.2% of total patients undergoing hemodialysis in 2022.

Hemodialysis is one of the treatments for chronic renal disease. Hemodialysis is a high-level technology used to replace kidney function by removing metabolic wastes or toxins from human blood circulation such as water, sodium, potassium, hydrogen, urea, creatinine, uric acid, and other substances via a semi-permeable membrane that serves as a separator for blood and dialysis fluids. diffusion, osmosis, and ultrafiltration processes occur in an artificial kidney (6). Hemodialysis has been demonstrated to be helpful in eliminating fluids, electrolytes, and metabolic waste from the body, particularly in stage 5 CKD. Hemodialysis treatment is time-consuming; the recommended length of time for hemodialysis is 10-12 hours per week, performed twice a week for 5- 6 hours (7).

Diabetes Mellitus patients receiving hemodialysis must be managed aggressively, swiftly, multidisciplinaryly, and by a large number of doctors. Patients with Diabetes Mellitus who receive hemodialysis may face problems. A drop in blood sugar is one of the problems that can arise. This is due to the high ultra filtration rate (UFR) (8). Hypoglycemia is the result of low blood sugar in diabetic people receiving hemodialysis. Hypoglycemia is defined as a drop in blood glucose levels below normal. This disorder has a negative impact on the eye organs. Blood vessels, the heart, and the brain. The symptoms that frequently occur are progressive, depending on how long the hypoglycemia lasts. Inadequate hypoglycemia care can lead to diminished quality of life, cognitive impairment, decreased consciousness, and even mortality (8).

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The findings of a preliminary study conducted by researchers in the hemodialysis room at Haji Hospital Jakarta from 8 Diabetes Mellitus patients with complications of kidney failure undergoing hemodialysis revealed that each patient had a different UFR value, with the lowest being 3.77 ml/hour/kg, the highest being 17.10 ml/hour/kg. While the highest blood sugar level before hemodialysis was 270 mg/dL and the lowest was 150 mg/dL, the highest blood sugar level after hemodialysis was 160 mg/dL and the lowest was 90 mg/dL. Based on the foregoing, the researcher wishes to carry out a study titled "The Influence of Ultra Filtration Rate (UFR) on Blood Sugar in Diabetes Mellitus patients with complications of chronic kidney failure undergoing hemodialysis at the Jakarta Haji Hospital in 2022."

METHODS

The study employs a quasi-experimental approach using a single group pretest-posttest design. Data was collected using primary data, which was gained from observations. An observation sheet was employed as the data gathering equipment. The population in this study comprised all DM patients with CKD problems having hemodialysis in the Jakarta Haji Hospital Hemodialysis Room in November 2022, with a total sample size of 64 participants. The Paired Samples Test is used in conjunction with univariate and bivariate analysis.

RESULTS

Table 1. Distribution of Respondents Based on Ultrafiltration Rate in Diabetes Mellitus Patients with Chronic Renal Failure Complications Undergoing Hemodialysis

No	*Ultrafiltration Rate* (UFR)	Frequency	Percentage
1.	Standard (UFR ≤13)	44	68,8
2.	Excessive (UFR >13)	20	31,3
	Total	**64**	**100,0**

Based on the table above, it can be seen that out of the 64 respondents, the majority with a standard UFR rate were 44 people (68.8%), and respondents with an excessive UFR rate were 20 people (31.3%).

Table 2. Average Blood Sugar Levels Before and After Hemodialysis at Jakarta Hajj Hospital in 2022

Blood Sugar Levels	N	Mean	Mean difference	Min	Max
Pretest	64	295,73	188,7	215	390
Postest	64	107,03		88	130

Based on the table above it can be seen that the average blood sugar level before hemodialysis obtained a value of 295.73 mg/dl, and the average blood sugar level after hemodialysis obtained a value of 107.03 mg/dl, so that the difference in the average value was obtained blood sugar levels before and after hemodialysis of 188.87 mg/dl.

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Table 3. Kolmogorov-Smirnova and Shapiro-Wilk Normality Test Results

Variable	Measurement	Kolmogorov-Smirnov[a]	Shapiro-Wilk	Information
Blood sugar levels	Pre test	0,200	0,714	Normal
	Post test	0,074	0,124	Normal

Based on the table, it was found that the normality test on blood sugar levels, both pre-test and post-test in the Kolmogorov-Smirnova test, obtained a pre-test value of p = 0.200 (p > 0.05) and post-test p = 0.074 (p > 0.05). In the Shapiro-Wilk test, the pre test value was p = 0.714 (p > 0.05) and the post test was p = 0.124 (p > 0.05). It is said that the data is normal or not by looking at the sig numbers, if sig > 0.05 then it is normal and if sig < 0.05 it can be said to be abnormal. Based on the results of the Kolmogorov-Smirnova test and the Shapiro-Wilk test, the above data is normally distributed.

Table 4. Effect of UFR on Blood Sugar in Diabetes Mellitus Patients With Chronic Renal Failure Complications Undergoing Hemodialysis

Blood sugar levels	Mean	SD	Mean difference	Selisih SD	*P value*
Pre test	295,73	40,839	188,7	29,992	0,000
Post test	107,03	10,847			

Based on the table above, it shows that the average difference in blood sugar levels before and after hemodialysis is 188.7 mg/dl with a standard deviation of 29.992 mg/dl. The results of the analysis obtained p value (0.000) < α (0.05) which means that there is a significant difference in blood sugar levels between before and after hemodialysis. And it can be concluded that there is an effect of Ultrafiltration Rate hemodialysis on blood sugar in diabetes mellitus patients with complications of chronic kidney failure undergoing hemodialysis.

DISCUSSION

Average blood sugar levels before and after hemodialysis

According to the study's findings, the average blood sugar level before hemodialysis was 295.73 mg/dl, whereas the average blood sugar level after hemodialysis was 107.03 mg/dl, resulting in a difference in the average value. Blood sugar levels of 188.87 mg/dl before and after hemodialysis. Blood glucose is a type of sugar found in the blood that is produced by carbohydrates in food and stored as glycogen in the liver and skeletal muscles. The amount of glucose in blood plasma is referred to as the blood sugar level. Increased food consumption, increased stress and emotional elements, weight growth and age, and sports activity are all factors that might impact blood glucose levels (9). The level of glucose in the blood is referred to as the blood sugar level. In the body, blood sugar concentration or serum glucose level is tightly regulated. Blood glucose is the primary energy source for bodily cells. Hypoglycemia is a condition in which blood glucose levels are lower than usual, which can arise as a result of an imbalance in the food consumed, physical activity, and medicines utilized. Clinical signs of hypoglycemia syndrome include dizziness, weakness, tremors, blurred and dark vision, cold chills, elevated heart rate, and, in severe cases, loss of consciousness (hypoglycemic shock). If hypoglycemia occurs in Diabetes Mellitus patients, it will be difficult to restore normal blood sugar

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levels because unstable insulin interferes with the function of the counter insulin hormone, glucagon. Hemodialysis is used to eliminate hazardous nitrogenous compounds from the blood. The work of hemodialysis is based on three principles: diffusion, osmosis, and ultrafiltration. Hemodialysis will save the lives of patients with Chronic Kidney Failure (CKD). However, hemodialysis does not cure kidney disease and cannot compensate for the loss of metabolic or endocrine activity performed by the kidneys, as well as the impact of kidney failure and treatment on the patient's quality of life. Osmosis is the process through which excess water is eliminated from the body. Water removal in the dialysis machine can be managed by establishing a pressure gradient; this gradient can be enhanced by adding negative pressure, which is known as ultrafiltration. until isovelemia (fluid balance) is achieved (10).

The findings of this study are consistent with Adrian's (2018) findings, which stated that the average blood sugar value of respondents before hemodialysis was 188.30 mg/dl with a standard deviation of 66.324 mg/dl. The lowest blood sugar level is 93 mg/dl and the highest is 398 mg/dl, with an average blood sugar value of 174.11 mg/dl and a standard deviation of 63.454. A minimum blood sugar level of 91 mg/dl and a maximum blood sugar level of 366 mg/dl are required. According to the researchers' expectations, it was discovered that there were variations in blood sugar levels before and after hemodialysis, because the cleaned blood was subsequently returned to the body through the veins. If the hemodialysis method uses dialysate that does not contain glucose (glucose-free dialysate), the body will lose a significant amount of aminoacids, approximately 10 grams per hemodialysis session. When employing glucose-containing dialysis solutions, aminoacid loss is restricted to roughly 1-3 grams every hemodialysis session. When employing dialysate without glucose, underweight individuals require special consideration. Aminoacid waste, combined with increased protein catabolism, can cause glucose loss to the dialysate compartment and, potentially, a negative protein balance. For diabetic nephropathy patients and the elderly, the recommended glucose content in dialysis fluid is 1-2 grams/L.

Effect of UFR on Blood Sugar in Diabetes Mellitus Patients With Chronic Renal Failure Complications Undergoing Hemodialysis

The average difference in blood sugar levels before and after hemodialysis was 188.7 mg/dl, with a standard deviation of 29.992 mg/dl, according to the study's findings. The analysis yielded a p value of (0.000) (0.05), indicating that there is a significant difference in blood sugar levels before and after hemodialysis. And it can be inferred that there is an effect of Ultrafiltration Rate hemodialysis on blood sugar in diabetes mellitus patients undergoing hemodialysis who have problems of chronic kidney failure. Convection is another term for ultrafiltration. Convection is the simultaneous movement of a solvent (solvent) and a solute (solute) via the dialyser membrane from the blood compartment to the dialysate compartment (and vice versa, i.e. backfiltration). The speed of convection transport is determined by the hydraulic permeability factor, the sieving coefficient of the membrane's solute (solute) surface area, the concentration of solutes in the blood, and the pressure difference across the membrane (11).

The ultrafiltration method involves concurrently transferring solutes and solvents from the blood compartment to the dialysate compartment across a semipermeable membrane. The permeability of the dialyzer membrane to water varies according on the size of the pores and the membrane. The ultrafiltration coefficient (KUf) is the amount of fluid (ml/hour) that passes through the membrane per mm Hg pressure gradient or transmembrane pressure differential (TMP). A dialyzer standard is KUf, also known as water permeability. Kuf is divided into three

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categories: low KUf 2.0, medium KUf 4.0, and high KUf and high flux >10.0. For example, TMP 500 is required for 1000 ml ultrafiltration in KUf 2.0, whereas only 125 ml TMP is required in KUf 8.0. The ultrafiltration method involves concurrently transferring solutes and solvents from the blood compartment to the dialysate compartment across a semipermeable membrane. The permeability of the dialyzer membrane to water varies according on the size of the pores and the membrane. The amount of fluid (ml/hour) that passes through the membrane per mm Hg pressure gradient or TMP differential across the membrane is denoted by KUf. A dialyzer standard is KUf, also known as water permeability. Kuf is divided into three categories: low KUf 2.0, medium KUf 4.0, and high KUf and high flux >10.0. For example, TMP 500 is required for 1000 ml ultrafiltration in KUf 2.0, whereas only 125 ml TMP is required in KUf 8.0. The water permeability influences the dialyzer selection. If an ultrafiltration controller is available, a high water permeability (Kuf > 6.0) dialyzer will be an option. If an ultrafiltration controller is not available, a dialyzer with a lower Kuf can be used instead. When using a dialyzer with a low Kuf, a larger transmembrane pressure is required to alter the amount of fluid extracted. The influence of fluctuations in transmembrane pressure on fluid evacuation is minimized in this condition. If no ultrafiltration controller is provided, the in vivo dialyzer KUf (ml/hour/mmHg) will be approximately four times the estimated fluid removal rate in litres/hour. The rate of ultrafiltration is determined by the pressure difference across the membrane. Insulin requirements differ following hemodialysis. Many diabetic patients with end-stage renal disease have lower insulin requirements. At the commencement of hemodialysis, many diabetic patients require insulin and some blood sugar management using sulfonylureas. A certain amount of glucose will be transferred from the blood to the dialysate compartment during each hemodialysis operation, estimated at 25-30 mg.

Researchers hypothesized that hemodialysis would reduce respondents' blood sugar levels because it removes metabolic waste products more quickly. Patients with diabetes mellitus will see a decrease in blood sugar levels, especially when the ultrafiltration rate is high, because of the fluid shift from high concentrations to lower concentrations, which causes patients to experience a decrease in blood sugar along with symptoms of headaches. start throwing up. Because of the time-sensitive nature of this issue during hemodialysis, it is imperative that the medical staff in charge of the procedure work together to find a solution. In cases like the one described above, it is common practice to advise patients not to gain more than 5 percent of their dry body weight. In order to ensure the smooth operation of hemodialysis with minimal discomfort for the patient.

CONCLUSION

Most of the respondents were female 51.6% and aged ≥ 50 years 78.1%, and the standard UFR rate was 68.8%. The average difference in blood sugar levels before and after hemodialysis was 188.7 mg/dl. There is an effect of UFR hemodialysis on blood sugar in diabetes mellitus patients with complications of chronic kidney failure undergoing hemodialysis (p.value 0.000).

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