

ANALYSIS OF DIFFERENCES IN LEVELS OF BLOOD UREA NITROGEN (BUN) AND GLOMERULAR FILTRATION RATE (GFR) IN TYPE 2 DIABETES MELLITUS PATIENTS WITH CHRONIC KIDNEY FAILURE AND HYPERTENSION

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Abstract

Diabetes mellitus and its complications are a major threat to health status and are a heavy economic burden for individuals and society. Inconsistent and poorly managed diabetes care can lead to serious complications such as chronic kidney failure and hypertension. Decreased kidney function can be seen from a decrease in the glomerular filtration rate (GFR) and will be followed by an increase in blood urea nitrogen (BUN) levels. This study aims to measure differences in BUN and GFR levels in patients with type 2 diabetes mellitus who experience chronic kidney failure and hypertension. The study was conducted on 45 samples from 150 patient populations at M. Yunus Hospital Bengkulu City in 2022. Data were collected by taking venous blood samples. The blood sample is then checked for BUN and GFR levels in the laboratory. Data were analyzed using the paired sample T test for the paired sample, followed by the Independent T-test for the unpaired sample using the SPSS program. The results showed that the sig value (0.613) > 0.05 for the BUN level, and the sig value (0.554) > 0.05 for the GFR level. The conclusions of the study were: (1) there was no difference in the average bun levels of DM2 patients with CKD and hypertensive patients with CKD and (2) there was no difference in the average GFR of DM2 patients with CKD and hypertensive patients with CKD. Suggestions that can be put forward are that an early examination is needed if there are complaints that lead to urinary system disorders.

Keywords: Diabetes Mellitus, Kidney failure, Hypertension, BUN, GFR, Urea, Hemodialysis, Creatinine

INTRODUCTION

Diabetes mellitus (DM) type 2 is one of the epidemic diseases in the world in terms of prevalence. WHO in 2018 reported the number of people with type 2 DM reached 415 million people aged 20-79 years and according to the International Diabetes Federation (2018) this number will increase to 642 million in 2030 if prevention is not carried out. An increase in the number of people with type 2 DM also occurred in Southeast Asia reaching 19.4 million and the population is predicted to continue to increase [1]. Indonesia is ranked first in Southeast Asia with the number of sufferers reaching 8.2 million and is estimated to increase by 2.5 times to 21.2 million in 2030 [2]. Furthermore, the Ministry of Health in 2019 detailed the symptoms of the highest DM prevalence in East Nusa Tenggara 3.3%, while based on a doctor's diagnosis, the highest

DM prevalence was in Yogyakarta 2.6%, DKI Jakarta 2.5%, North Sulawesi 2.4%, East Kalimantan 2.3%, and Bengkulu 2.2%.

Diabetes mellitus and its complications are a major threat to health status and are a heavy economic burden for individuals and society [3]. Inconsistent and poorly managed diabetes care can lead to serious complications such as chronic kidney failure and hypertension. Chronic kidney failure caused by type 2 DM has increased every year. Data from the Global Burden of Disease Study 2017 shows that 1-2 million people die from chronic kidney disease. The global death rate for all ages increased by 41-45% in 2017. An increase in the number of people with kidney disease also occurred in Indonesia, reaching 0.38% (6.7% of the population) in 2018, an increase from the previous three years which was only 0.2%. Chronic kidney disease is the second largest for BPJS health financing in Indonesia.

A similar increase also occurred in hypertension caused by type 2 diabetes. The research concluded that hypertension is associated with 30% of deaths caused by type 2 diabetes mellitus. In relation to kidney failure and hypertension caused by type 2 diabetes, if there is a disturbance in blood flow to the kidneys, the kidneys will release the hormone renin which can cause an increase in blood pressure which can cause hypertension [4]. Incidence of hypertension can also occur due to narrowing between the two arteries that carry blood supply to the kidneys. This causes a decrease in kidney function.

The decline in kidney function as described above can be seen from a decrease in the glomerular filtration rate (GFR) and will be followed by an increase in blood urea nitrogen (BUN) levels. BUN is a waste product of the body that is produced after eating because the liver breaks down the protein contained in the food we consume. BUN will be excreted from the liver into the blood, and finally into the kidneys. When the kidneys are in good condition, BUN will be excreted through urine, but if there are kidney abnormalities, BUN cannot be disposed of properly and its levels in the blood will increase. Normal BUN levels are 7-20 mg/dL. If the detected BUN value is higher than normal, then it can indicate impaired kidney function. Meanwhile, the GFR test aims to determine the ability of the kidneys to filter metabolic waste substances. The GFR test is used to determine the stage of kidney disease.

Several studies on BUN and GFR have been conducted. One of them was carried out by Kong et al (2015) with a cohort study in patients with DMT 2 who found a decrease in GFR <15 ml/min/1.73m², patients with lower GFR, had a long duration of diabetes and showed higher results in total cholesterol, LDL-C and TG, but low levels are aimed at HDL-C. Another study showed that the increased risk of macrovascular and microvascular disease in type 2 DM caused progressively by endothelial cell dysfunction and atherosclerosis was

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mediated by higher BUN levels in patients with type 2 diabetes who did not experience moderate decline in renal function, defined by BUN <60 ml/min/1.73 m² [5].

METHODS

Research Design and Subject

This study aims to measure differences in BUN and GFR levels in patients with type 2 diabetes mellitus who experience chronic kidney failure and hypertension. The study was conducted on 45 samples from 150 patient populations at M. Yunus Hospital Bengkulu City in 2022. Data were collected by taking venous blood samples. The blood sample is then checked for BUN and GFR levels in the laboratory.

Instruments and Data Analysis Procedures

The data were analyzed using the paired sample T test for the paired sample, followed by the Independent T test for the unpaired sample using the SPSS program. This research has passed the ethical test from the Bengkulu Ministry of Health Poltekkes Number: KEPK/136/04/2022.

FINDINGS

The results showed that the sig value (0.613) > 0.05 for the BUN level, and the sig value (0.554) > 0.05 for the GFR level. The conclusions of the study were: (1) there was no difference in the average bun levels of DM2 patients with CKD and hypertensive patients with CKD and (2) there was no difference in the average GFR of DM2 patients with CKD and hypertensive patients with CKD.

Group Statistics

PASIEN		N	Mean	Std. Deviation	Std. Error Mean
BUN	DM2	22	74.3500	49.879166	10.634274
	Hipertensi	23	81.2478	40.274861	8.397889

6 Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
BUN	Equal variances assumed	.023	.880	-.511	43	.612	-6.897	13.485	-34.094	20.298
	Equal variances not assumed			-.509	40.372	.613	-6.897	13.550	-34.276	20.481

16 Group Statistics

	PASIEN	N	Mean	Std. Deviation	Std. Error Mean
GFR	DM2	22	22.3545	12.030427	2.564896
	Hipertensi	23	20.3391	10.621665	2.214770

7 Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
GR	Equal variances assumed	.781	.382	.596	43	.554	2.015415	3.379	-4.799	8.830
	Equal variances not assumed			.595	41.806	.555	2.015415	3.388	-4.824	8.855

DISCUSSION

In this study, a small percentage of normal blood urea nitrogen levels were found. During in-depth interviews with patients who had normal blood urea nitrogen levels, it was found that the patient had diseases related to the liver but also had problems related to malnutrition and lack of protein

consumption. In hypertensive patients with chronic kidney failure, the results of blood urea nitrogen examination will definitely increase due to failure of kidney function. In patients who have normal blood urea nitrogen levels, blood urea nitrogen levels can be influenced by various things, one of which is the patient's food intake, it can also be influenced by the input and output of fluids consumed by the patient. Patients on a low protein diet were found to have normal blood urea nitrogen levels, this is in line with research conducted at the Sanjiwani Hospital, Gianyar which stated that a decrease in levels was caused by patients undergoing a low protein diet as one of the requirements of patients with stage kidney failure. further [6].

This is also confirmed by the research of Heriansyah and Aji where they also found that the decrease in blood urea nitrogen levels could be caused by hypervolemia (overhydration), severe liver damage, low protein diet, malnutrition, pregnancy and prolonged addition of intravenous glucose fluids as well as consumption phenothiazine drugs (Heriansyah, Aji Humaedi, 2019). The increase in blood urea nitrogen levels was identified as one of the factors of kidney function failure [7]. In this case hypertension and chronic renal failure affect each other. Hypertension causes chronic kidney failure, on the other hand chronic kidney failure can cause hypertension. Long-standing hypertension can result in structural changes in arterioles throughout the body, characterized by fibrosis and hyalinization of blood vessel walls. The main target organs are the heart, brain, kidneys and eyes [8].

During in-depth interviews with patients who had abnormal blood urea nitrogen levels, it was found that the patients had comorbid diseases other than hypertension, namely diabetes mellitus which could affect the increase in blood urea nitrogen values. This finding is in line with research conducted at the Wahidin Sudirohusodo Hospital Makassar which stated that diabetes mellitus was associated with an increase in blood urea nitrogen levels, where people with diabetes were 12.37 times more likely to experience chronic kidney failure than those without diabetes mellitus [9]. In addition to having other comorbid diseases such as diabetes mellitus, almost some patients who have abnormal urea levels are also elderly patients. With age, kidney function will also decline, as some nephrons, which are important filters in the kidneys, begin to lose. Every ten years of age, kidney function decreases by 10 ml/minute/1.73 m². there is a progressive decrease in the glomerular filtration rate that occurs after the age of 40 years to the age of 70 years, to less than 50% of normal [10].

Blood urea nitrogen or urea is the end result of protein and amino acid metabolism produced by the liver and channeled through extracellular and intracellular fluids into the blood and then filtered by the glomerulus [11]. Kidneys are important organs to get rid of the body's metabolic waste that is not needed. The main function of the kidneys is to excrete the end products or waste products of the body's metabolism, such as urea, creatinine and uric acid. The rest of the body's metabolism if allowed to accumulate will be toxic to the body, especially the kidneys themselves. Kidney disease is a disease caused by a decrease in kidney function until the kidneys are unable to do their job properly [12]. Hypertension is a circulatory system disorder that causes an increase in blood pressure above the normal value ($> 140/90$ mmHg) (Nisa, 2017). Hypertension can increase the risk of coronary artery disease such as myocardial infarction or dementia; angina; atrial fibrillation; or atrial fibrillation [13]. A prolonged increase in pressure will cause a blockage. Blockage of arteries and arterioles will result in glomerular damage and tubular atrophy, so that all nephrons are damaged, which causes chronic kidney disorders. Other studies also state that people with hypertension are 21.45 times more at risk of developing chronic kidney failure compared to those who do not have hypertension.

Patients with hypertension with high blood pressure will make the blood vessels in the kidneys depressed. Eventually, blood vessels become damaged and cause kidney function to decrease until they experience kidney failure [9]. One of this kidney damage is measured by measuring blood urea nitrogen levels in patients with hypertension. Another study also stated that 25.52% of the 427 samples with hypertension had blood urea nitrogen levels that exceeded the normal value of 42-94 mg/dL [8]. Chronic kidney failure is a clinical condition characterized by an irreversible decline in kidney function, where there is progressive and continuous destruction of kidney structures [10]. One of the factors causing chronic kidney failure is type 2 diabetes mellitus, where diabetic nephropathy is one of the complications of kidney function disorders that can cause kidney failure in DM patients. A person with diabetes who has experienced complications of kidney failure accompanied by an increase in blood pressure will result in decreased glomerular filtration and ultimately end-stage renal failure. Kidney failure will result in an increase in creatinine levels, this is because creatinine will no longer be able to be filtered and secreted perfectly by the kidneys so hemodialysis therapy is needed to reduce creatinine levels [11].

After hemodialysis therapy, the results of creatinine levels returned to normal, due to permanent and irreversible damage to the kidneys that reached this stage requiring renal replacement therapy such as hemodialysis. Hemodialysis therapy is only an effort to control the symptoms of uremia

and maintain patient survival, not an action to cure CKD disease [5]. The average value of creatinine levels in 29 samples after hemodialysis was 3.9752 which means that after hemodialysis the creatinine levels decreased because the hemodialysis process functions to take toxic nitrogen substances from the blood and excrete excessive water. In hemodialysis, toxic blood flow and nitrogenous waste are transferred from the patient's body to a dialyzer where the blood is cleaned and then returned to the patient's body [6]. In line with Handarsari's research, reference one is at the Manado Adventist Hospital.

During in-depth interviews with patients who had abnormal creatinine levels, it was found that the patients had comorbid diseases other than type 2 diabetes mellitus, namely hypertension, heart disease, liver failure, gout and kidney cancer which could affect the increase in creatinine values. This finding is in line with research conducted at the Wahidin Sudirohusodo Hospital Makassar which stated that diabetes mellitus was associated with an increase in creatinine levels, where people who had diabetes were 12.37 times more likely to experience chronic kidney failure than those who did not have diabetes mellitus. In addition to having other comorbid diseases such as hypertension, heart disease, liver failure, gout and kidney cancer, almost some patients who have abnormal creatinine levels are also elderly patients. With increasing age, kidney function will also decline as some nephrons begin to lose, which are important filters in the kidneys. Each decade of age, kidney function decreases by about 10 ml/min/1.73 m². After the age of 40 years there will be a decrease in the glomerular filtration rate progressively until the age of 70 years, less than 50% of normal (Ibrahim et al., 2017). From the research that has been conducted on 29 samples of urea levels in patients with chronic kidney failure who have type 2 diabetes mellitus after undergoing hemodialysis therapy in the Hemodialysis room of RSUD Dr. M. Yunus Bengkulu, it is known that most patients have normal urea levels, and almost some patients have abnormal urea levels or exceed normal levels. The results showed that most patients with chronic kidney failure had normal urea levels.

When interviewed on patients who had abnormal urea levels, it was found that patients still consume foods with high protein sources such as eggs, meat, tempeh, and tofu which trigger an increase in blood urea levels. In patients with abnormal urea levels, it was also found that the patient had comorbidities, namely type 2 diabetes mellitus which could affect urea levels. This is in line with research conducted by Gabriellyn Sura Pongsi Field which states that diabetes mellitus is associated with an increase in urea levels where people who have diabetes are 12.37 times more likely to experience chronic kidney failure than those who do not have diabetes mellitus. In patients with chronic kidney failure who experience type 2 diabetes mellitus

after undergoing hemodialysis therapy, there is a decrease but not all of them reach normal values due to damage to kidney function. This finding is in line with what was conveyed who stated that the urea and creatinine levels of patients with chronic kidney failure before undergoing hemodialysis on average experienced hyperuremia, but with frequent hemodialysis therapy did not show a decrease in urea and creatinine levels again in normal value limit. Hemodialysis cannot completely replace kidney function even though patients undergo hemodialysis routinely, but hemodialysis therapy is only an effort to control uremia symptoms and maintain patient survival, not an action to cure chronic kidney failure.

The most co-morbidities in hemodialysis patients were hypertension, 50%, then diabetes mellitus, which was 23%. Hypertension and diabetes mellitus are referred to as initiation factors for chronic kidney disease, namely factors that can directly initiate kidney damage. This initiation factor if not controlled will worsen and accelerate kidney damage, so it is also called a progression factor is in line with research which states that there is a significant relationship between diabetes mellitus and the incidence of chronic kidney failure. High blood sugar levels in people with diabetes mellitus make the kidneys have to work harder in the blood filtering process and result in leakage in the kidneys which leads to chronic kidney failure. Diabetes mellitus is referred to as an initiation factor for chronic kidney disease, which is a factor that can directly initiate kidney damage. This initiation factor if not controlled will worsen and accelerate kidney damage, so it is also called a progression factor.

CONCLUSION AND SUGGESTION

The results showed that the sig value (0.613) > 0.05 for the BUN level, and the sig value (0.554) > 0.05 for the GFR level. The conclusions of the study were: (1) there was no difference in the average bun levels of DM2 patients with CKD and hypertensive patients with CKD and (2) there was no difference in the average GFR of DM2 patients with CKD and hypertensive patients with CKD. Suggestions that can be put forward are that an early examination is needed if there are complaints that lead to urinary system disorders.

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