Correlation Between Troponin I Levels and Electrolytes of Sodium and Potassium in Acute Coronary Syndrome Patients at Budhi Asih Hospital

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Abstract

Acute Coronary Syndrome (ACS) is one of the clinical manifestations of coronary heart disease that most often causes of death. A sensitive laboratory examination to assess the presence of signs of myocardial infarction such as troponin I is used to diagnose ACS. Electrolyte levels can also be impaired in myocardial infarction. Electrolyte imbalance in the blood can affect the conduction and contractility of the heart, especially sodium and potassium which are needed to produce activation of the heart muscle. The aim of this study was to determine the correlation between troponin I levels and sodium and potassium levels of serum in acute coronary syndrome patients with diabetes mellitus. The research design was used a cross sectional analytical observation with secondary data. This study was used the Spearman correlation test with an alpha value of 0.05. The data were taken from the medical records section of Budhi Asih Hospital. The samples were used 65 data of patients. The results showed that there was a correlation between troponin I levels and sodium with a p value 0.001 ($p < 0.05$), getting a fairly strong closeness level ($r = -0.390$) and negative direction. Likewise, the levels of troponin I with potassium showed a p value 0.000 ($p < 0.05$), getting a fairly strong level of closeness ($r = -0.487$) and a negative direction. From this study, it can be concluded that there was a relationship between troponin I levels with sodium and potassium with a negative correlation direction which indicates that the higher troponin I levels, so the lower the sodium and potassium levels. Electrolyte examination, especially sodium and potassium, is important to help diagnose acute coronary syndrome in knowing the balance of body fluids so as to prevent death.

Keywords: *Acute Coronary Syndrome, Levels of Troponin I, Sodium, Potassium.*

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A. INTRODUCTION

Acute Coronary Syndrome (ACS) is one of the clinical manifestations of Coronary Heart Disease (CHD) and is a major cardiovascular problem and most often causes death because it causes high hospitalization and mortality rates (PERKI, 2015). Acute Coronary Syndrome (ACS) is a not contagious disease where there are pathological changes or abnormalities in the walls of the coronary arteries that can cause myocardial ischemia, Unstable Angina Pectoris (UAP) and Acute Myocardial Infarction (AMI) such as Non-ST Elevation Myocardial Infarction (NSTEMI) and ST Elevation Myocardial Infarction (STEMI) (Tumade, 2014).

The World Health Organization (WHO) in 2015 reported that cardiovascular disease caused 17.5 million deaths or about 31% of all deaths globally, and that caused by acute coronary syndrome was 7.4 million. This disease is estimated to

reach 23.3 million deaths in 2030 (Muhibbah, Wahid, Agustina, & Illiandri, 2019). Meanwhile in Indonesia, based on research from the Jakarta Acute Coronary Syndrome (JAC) since 2014 at Jakarta and surrounding areas showed that there were 3015 people suffering from ACS, of which 1024 people have STEMI (Dharma et al., 2016).

Acute Coronary Syndrome occurs indirectly, usually a person will go through the process of narrowing of the coronary vessels in a long period of time, therefore everyone has a risk of coronary heart disease. Risk factors for acute coronary syndrome are divided into two major groups, namely: risk factors that cannot be corrected (cannot be prevented) and risk factors that can be repaired (preventable). Risk factors for acute coronary syndrome that cannot be prevented include age, gender, family history of disease. Risk factors that can be prevented include hypertension, smoking, diabetes mellitus, passive physical activity, and myocardial obesity (Brunner & Suddarth, 2013).

ACS is a dangerous condition because it capable of causing death up to seven times higher than stable coronary heart disease, so early diagnosis of ACS is very important, especially if it is accompanied by risk factors that can make it worse like diabetes mellitus causes vascular complication which is divided into macrovascular complication like coronary heart disease resulting in acute coronary syndrome, peripheral blood vessels desease and stroke, and microvascular such as retinopathy, nephropathy and neuropathy (Salans, 2009).

According to the American Heart Association (2012), approximately 65% of people with diabetes mellitus die from heart disease and stroke. Determination of a quick and easy diagnosis is needed because early treatment is expected to increase patient safety. Laboratory tests to assess the presence of myocardial signs such as CKMB, Troponin T and I, and myoglobin are used to establish the diagnosis of ACS. Troponin was chosen because it is more sensitive than CKMB (PERKI, 2015).

Troponin I plays an important role as a clinically relevant marker because it is specific to myocardial tissue, have a high sensitivity, and can detect the presence of small size myocardial necrosis that is not detected on electrocardiogram examination or by CKMB (Febriana & Nurulita, 2016). Uncontrolled diabetes mellitus Troponin T can also increase in skeletal muscle damage so that it is not very specific for heart muscle damage, while troponin I does not increase in skeletal muscle damage, making it more specific for heart muscle damage (Williamson & Snyder, 2015).

Electrolyte levels can also be disturbed in the state of myocardial infarction. Electrolyte imbalance in the blood can affect the conduction and contractility of the heart. Electrolyte ions, especially sodium and potassium, are needed to produce cardiac muscle activation. Both electrolyte ions have a continuous transfer between the intracellular and extracellular spaces, either passively or actively by diffusion. Damaged heart muscle cell membranes in a state of myocardial infarction will then affect sodium, potassium, and chloride, as well as the sodium-potassium pump, resulting in disruption of sodium and potassium levels in blood serum (Freddy & Muji, 2017). Sodium and potassium together play a role in the maintenance of fluid

and electrolyte balance and acid-base balance. Most of the potassium is inside the cells, while the sodium is mostly outside the cells. Sodium regulates osmotic pressure which keeps fluid from leaving the blood and entering into the cells. In the cell, the osmotic pressure is regulated by potassium so that it does not leave the cell.

Budhi Asih Hospital is one of the hospitals belonging to the DKI Jakarta Provincial Government located in East Jakarta, serving complete laboratory examinations to support diagnosis, and including health services that actively participate in the Jakarta Acute Coronary Syndrome registry data. Based on this description, the researcher is interested in knowing the extent of the relationship between sodium levels and potassium levels with troponin I in acute coronary syndrome patients with diabetes mellitus at Budhi Asih Hospital.

B. METHOD

The type of research used is an analytic observational study, with a cross-sectional design because it emphasizes the time of measurement or observation of independent and dependent variable data only once at a time. This study looked at the correlation between troponin I levels with serum sodium and potassium levels in acute coronary syndrome patients who have a history of diabetes mellitus in Budhi Asih Hospital in 2020. The study population was data from patients with acute coronary syndrome, and the sample was data from patients with acute coronary syndrome who had a history of diabetes mellitus in January-December 2020 who underwent examination of Troponin I and electrolyte levels (Na+ and K+). The data collected in this study is secondary data, by submitting a permit to collect data on acute coronary syndrome patients, selecting data for examination of troponin I, sodium and potassium along with other supports (examination number, gender, and age), taking notes, recapitulating in tabular form, and process the data. Data processing and analysis were carried out using SPSS computer software from univariate analysis to bivariate analysis.

C. RESULT AND DISCUSSION

The results of the study on acute coronary syndrome patients with diabetes mellitus who examined troponin I levels with sodium and potassium in the period January to December 2020 at Budhi Asih Hospital obtained as many as 65 data. The research data obtained from the results of laboratory examinations and medical records of patients at Budhi Asih Hospital can be described as follows:

Table 1. Frequency Distribution of Patients with Acute Coronary Syndromes with Diabetes Mellitus by Gender

Gender	Frequency (n)	Percentage (%)
Male	46	70,8
Female	19	29,2
Total	65	100

The occurrence of Acute Coronary Syndrome (ACS) is associated with several risk factors including irreversible factors such as age, gender, family history of disease, and modifiable factors such as smoking, hypertension, diabetes mellitus, hyperlipidemia, and obesity (Ghani et al., 2016). The risk factors that lead to ACS have been described in the Framingham Heart Study and other studies. These studies explain that modifiable risk factors have a strong influence on the occurrence of acute coronary syndromes (Torry et al., 2014). According to Price & Wilson (2012), people with diabetes tend to have a higher prevalence, cause premature death, and a higher severity of coronary atherosclerosis.

From a total of 65 data, the frequency distribution of patients with acute coronary syndrome with diabetes mellitus at Budhi Asih Hospital shows the frequency distribution of 46 (70.8%) male patients and 19 (29.2%) female patients. The risk of coronary atherosclerosis is greater in men than women. Women are relatively more immune to the disease until the age after menopause, and then become just as susceptible as men. This is because women have the hormone estrogen which is known to protect blood vessel walls from fat that causes blockages in blood vessels (Zahara et al., 2012). The results of this study are in accordance with the WHO statement which states that the majority of patients diagnosed with acute coronary syndrome occur in men, and in line with Muhibbah's research (2019) which states that the most ACS sufferers are men with a total of 38 (74.51%) people from a total of 51 respondents.

Table 2. Frequency Distribution of Patients with Acute Coronary Syndromes with Diabetes Mellitus by Age

Age Group (Year)	Frequency (n)	Percentage (%)
< 35	2	3,1
35-44	2	3,1
45-54	12	18,5
55-64	24	36,9
65-74	19	29,2
> 75	6	9,2
Total	65	100

Based on table 2, the results of the study describe patients with acute coronary syndrome with diabetes mellitus suffered by the age group <35 years as many as 2 (3.1%) people, the age group 35-44 years as many as 2 (3.1%) people, the age group 45 -54 years as many as 12 (18.5%) people, age group 55-64 years as many as 24 (36.9%) people, age group 65-74 years as many as 19 (29.2%) and over 75 years as many as 6 (9.2%) people. The majority of people with ACS are more than 45 years old. A person who is at risk of suffering from acute coronary syndrome susceptibility to coronary atherosclerosis increases with age. This is due to a decrease in the compliance of blood vessels to an increase in blood flow pressure making them more susceptible to endothelial injury (Brashers, 2008).

In line with Tumade's research (2014), the older a person is, the higher the likelihood of developing acute coronary syndromes than younger people. This is due to the accumulation of atherosclerotic plaque that occurs over the years which can eventually lead to narrowing of the lumen of the heart's blood vessels. Acute Coronary Syndrome is a chronic disease that takes a long time to cause symptoms due to damage to blood vessels, and its pathophysiology can begin when the individual is young and appear when the individual is old.

Table 3. Frequency Distribution of Troponin I, Sodium and Potassium Levels in Acute Coronary Syndrome Patients with Diabetes Mellitus (N = 65)

Variable	Lowest	Highest	Average	Standard Deviation
Troponin I Levels (ng/mL)	0,001	0,854	0,21	0,22
Natrium (mEq/L)	115	147	131,52	5,48
Kalium (mEq/L)	1,8	4,3	3,405	0,39

Based on Table 3, the results showed that the average level of troponin I in acute coronary syndrome patients with diabetes mellitus at Budhi Asih Hospital was 0.21 ng/mL with the lowest level of 0.001 ng/mL and the highest level of 0.854 ng/mL. The average results of these levels are above the normal value of troponin I. According to Ford et al. (2016), troponin concentrations are able to predict coronary disorders and serial troponin measurements also have great potential for assessing cardiovascular risk. This is in line with the research of Iriana, Asvin, & Rauf (2018) which found an average troponin I level above the normal value of 0.89 ng/mL. The study concluded that an increase in troponin I levels can give an idea of the severity of the degree of stenosis in coronary artery disease.

Similar results are also found in Meidhiyanto's research (2016) with an average troponin I level of 1.16 ng/mL and Indriani Sari's (2014) study with an average of 1.45 ng/mL. Research by Indriani Sari (2014) states that high levels of troponin I are associated with increased damage, and conversely if the amount is small, it means that there is little damage (Barstow et al., 2014).

Troponin I has a sensitivity of 100% at 6 hours after acute myocardial infarction and a specificity of 96%. These biochemical markers are not affected by skeletal muscle disease, skeletal muscle trauma, kidney disease or cardiac surgery. The specificity of troponin I is helpful in diagnosing patients with complex physical problems. The disadvantage of troponin I is that it has a long presence in the serum so that it can make re-infarction difficult, but on the other hand, this prolonged increase is useful for detecting myocardial infarction if the patient is admitted to the hospital a few days after the onset of chest pain, replacing the role of the LDH isoenzyme.

In addition, the results of the study also found that the average sodium level of patients with acute coronary syndrome patients with diabetes mellitus at Budhi Asih Hospital was 131.52 mEq/L. The average level is below the recommended normal value of 135-155 mEq/L. The theory states that the normal concentration of sodium in the extracellular compartment functions to help maintain the balance of

water, acid and base of the extracellular fluid and plays an important role in muscle contraction and nerve function required for the electrical activity of the heart.

Meanwhile, the average potassium level was 3,405 mEq/L. These levels are also below the normal value of 3.7-5.6 mEq/L, normal potassium levels in cardiac cells play an important role in repolarization and depolarization in maintaining a stable condition. Changes in its concentration alter the irritability and rhythm of the myocardium.

This is slightly different from the research by Mudaraddi (2015), which is from 60 patients with acute myocardial infarction, the average sodium level is 132.5 mEq/L and the average potassium level is 3.88 mEq/L. The average sodium level is below the normal value but the average potassium level is still within the normal range. Another study by Marzoq, Jaber, and Azzam (2016) also showed that the average low sodium level in acute myocardial infarction patients with a history of diabetes was 126.6 mEq/L, while the average potassium level was 4.652 mEq/L which was still within the normal range. According to this study, electrolyte levels in acute coronary syndrome will experience changes that affect the body's fluid balance. Decreased cardiac output that occurs can cause a decrease in renal blood flow directly accompanied by impaired renal excretion and electrolytes.

Low sodium levels are caused by hypoxia, ischemia, and infarction in acute coronary syndromes that affect the contractility of the heart muscle so that the pressure in the atria of the heart will decrease and left ventricular dysfunction in response to pain, nausea and stress, this results in the release of the hormone vasopressin in the kidneys. which will increase water reabsorption in the kidney tubules, resulting in a decrease in sodium levels (Wijayanti & Adipireno, 2020). The effect of ischemia on cardiac muscle cells will also affect sodium channels in the cardiac muscle cell membrane, causing increased permeability to sodium and easier diffusion into cells, then decreased function of Na+ & K+ pumps so sodium cannot be pumped out of cells (Freddy & Muji, 2017).

In this study, the average potassium level obtained tends to be low so that it can be said that the majority of patients with acute coronary syndrome with diabetes mellitus at Budhi Asih Hospital have hypokalemia (potassium levels <3.7 mEq/L). Hypokalemia in acute coronary syndrome occurs due to the catecholamine response stimulated by stress, especially epinephrine which functions as a hormone that causes increased absorption of potassium into cells. Decreased potassium levels can indicate heart work or electrical abnormalities in myocardial infarction patients, changes in the value of potassium levels cause characteristic changes in the electrocardiogram that can reflect the electrical events of the heart. Lack of potassium ions can cause the heart rate to slow down. Increased serum potassium can cause cardiac arrhythmias, even higher concentrations can cause cardiac arrest (Indriani, 2013).

Table 4. Spearman Correlation Test Results Between Troponin I Levels with Sodium and Potassium Levels

Variable	Troponin I Levels	
	Sig (p)	Correlation Coefficient (r)
Natrium Levels	0,001	-0,390
Kalium Levels	0,000	-0,487

Based on the results of the Spearman correlation test on the variable levels of troponin I with sodium levels, the p value was 0.001 (p <0.05). In addition, the results of the correlation test on the variable levels of troponin I with potassium levels had a p value of 0.000 (p < 0.05). Thus, it can be concluded that there is a correlation between troponin I levels with sodium and potassium levels in acute coronary syndrome patients with diabetes mellitus with a correlation strength of -0,390 and -0.487. This shows the strength of the correlation is quite strong with a negative correlation direction, namely the higher the troponin I level, the lower the sodium and potassium levels.

In accordance with research conducted by Wijayanti & Adipireno (2020) which states that there are strong negative relationship between sodium, potassium, chloride, and magnesium with the cardiac marker troponin I in acute coronary syndromes. This is also in line with Siti Sidaryanti's research (2020) which states that there is a weak correlation between high sensitivity troponin levels and serum electrolytes (sodium, potassium, chloride) simultaneously in patients with heart disease with a significance value of 0.041 (p < 0.05).

The limitations in conducting this study are that there is no specific information related to data regarding the length of suffering from diabetes mellitus, other diseases that may be suffered, lifestyle, use of drugs or therapy, and the patient's diet which may be able to better explain the condition of patients with acute coronary syndrome with a history of diabetes. mellitus. These limitations are beyond the control of the researcher.

D. CONCLUSION

Based on gender, the proportion of male patients (70.8%) was higher than the proportion of female patients (29.2%). Most (36.9%) of patients with acute coronary syndrome with diabetes mellitus are aged 55-64 years. The average level of troponin I in acute coronary syndrome patients with diabetes mellitus in this study was 0.21 ng/mL with the lowest level being 0.001 ng/mL and the highest level being 0.854 ng/mL. The average sodium level in this study was 131.52 mEq/L, with the lowest level being 115 mEq/L and the highest level being 147 mEq/L. The average potassium level in this study was 3,405 mEq/L with the lowest level being 1.8 mEq/L and the highest level being 4.3 mEq/L.

The results of the Spearman correlation test showed that there was a relationship between troponin I levels with sodium and potassium, namely both p < 0.05, with a fairly strong level of closeness (r = -0.390) and the direction of the

negative correlation means that the higher troponin I levels, the lower the level of troponin I. as well as sodium and potassium levels.

REFERENCES

1. American Heart Association. (2012). *New Heart Disease and Stroke Prevention Guidelines Released*. Retrieved from https://www.heart.org/en/news/2020/12/12/new-heart-disease-and-stroke-prevention-guidelines-released
2. Barstow, C., Rice, M. S., & McDivitt, J. D. (2017). Acute Coronary Syndrome: Diagnostic Evaluation. *American family physician*, *95*(3), 170-177.
3. Brunner & Suddarth. (2013). *Buku Ajar Keperawatan Medikal Bedah*. Jakarta: EGC.
4. Dharma, S., Andriantoro, H., Purnawan, I., Dakota, I., Basalamah, F., Hartono, B., & Rao, S. V. (2016). Characteristics, Treatment and In-Hospital Outcomes of Patients with STEMI in a Metropolitan Area of a Developing Country: An Initial Report of The Extended Jakarta Acute Coronary Syndrome Registry. *BMJ Open*, *6*(8), e012193. https://doi.org/10.1136/bmjopen-2016
5. Febriana, S., Nurulita, A., & Bahrun, U. (2018). Penilaian Uji Troponin I dengan Point of Care Testing. *Indonesian Journal of Clinical Pathology and Medical Laboratory*, *22*(2), 114-118.
6. Freddy, C., & Muji. R. (2017). The Differences Of Sodium, Potassium and Chloride Levels NSTEMI and NSTEMI Patients. *Indonesian Clinical Pathology Magazine and Medical Laboratory*, *21*(3), 261–265.
7. Ghani, L., Susilawati, D. M., & Novriani, H. (2016). Faktor Risiko Dominan Penyakit Jantung Koroner di Indonesia. *Health Research Bulletin*, *44*(3), 153-64.
8. Iriana, D., Nurulita, A., & Rauf, D. (2019). Hubungan kadar troponin I dan high-sensitivity troponin I dengan angiografi koroner pada pasien suspek coronary artery disease: studi di Rumah Sakit Umum Pusat dr. Wahidin Sudirohusodo Makassar-Indonesia tahun 2017. *Intisari Sains Medis. 10 (2)*, 420-425.
9. Marzoq, L. A., Jaber, W. H., & Azzam, D. K. H. (2016). Electrolyte level changes in acute myocardial infarction patients as compared to healthy individuals in Khan Younis Governorate, Gaza Strip. *Advances in Biochemistry*, *4*(2), 9-15.
10. Meidhiyanto, R., Uddin, I., & Sofia, S. N. (2016). Hubungan Jumlah Leukosit Terhadap Kadar Troponin I Pada Pasien Infark Miokard. *DIPONEGORO MEDICAL JOURNAL (JURNAL KEDOKTERAN DIPONEGORO)*, *5*(4), 1546-1551.
11. Muhibbah, M., Wahid, A., Agustina, R., & Illiandri, O. (2019). Karakteristik Pasien Sindrom Koroner Akut Pada Pasien Rawat Inap Ruang Tulip Di Rsud Ulin Banjarmasin. *Indonesian Journal for Health Sciences*, *3*(1). https://doi.org/10.24269/ijhs.v3i1.1567
12. Mudaraddi, R., Shrirang, P. K., & Dhiraj, J. T. (2015). Association of Serum Electrolytes and Urea Levels with Cardiac Markers in Acute Myocardial Infarction. *International Journal of Clinical Biochemistry and Research*, *2*(4), 233-235.
13. Perhimpunan Dokter Spesialis Kardiovaskular Indonesia (PERKI). (2015). *Pedoman Tatalaksana Sindrom Koroner Akut*. Retrieved from

http://www.inaheart.org/upload/file/Buku–ACS-2018.pdf
14. Price Sylvia, A., & Wilson Lorraine, M. (2012). *Patofisiologi: Konsep Klinis Proses-Proses Penyakit*. Jakarta: EGC.
15. Putri, R. N., Suryanti, S., & Lestari, S. (2018). Gambaran Serum Elektrolit Pada Pasien Acute Miocard Infark (AMI) di Ruang Intensive Cardiovaskuler Care Unit (ICVCU) RSUD Dr. Moewardi Di Surakarta. *Global Journal of Nursing, 3*(2),119–131. https://doi.org/10.37341/jkg.v3i2.59
16. Salans L. B. (2009). *New Treatments for Diabetes Mellitus: Outlook for the Future*. New York: McGraw-Hill Medical Publishing Division.
17. Samsu, N., & Sargowo, D. (2007). Sensitivitas dan Spesifisitas Troponin T dan I pada Diagnosis Infark Miokard Akut. *Indonesian Medical Magazine, 57*(10).
18. Sari, I. (2013). Hubungan Kadar Kolesterol HDL dengan Kadar Troponin I pada Pasien Infark Miokard Akut. (*Skripsi Universitas Muhammadiyah Yogyakarta*).
19. Sidaryanti, S. (2020). Korelasi Antara Kadar HS Troponin dan Serum Elektrolit Pada Penderita Penyakit Jantung di RSUD Sidoarjo Periode April 2019-Februari 2020. (*Thesis Universitas Airlangga*).
20. Smeltzer, S. C., & Brenda, G. B. (2008). *Keperawatan Medikal Bedah 2*. Jakarta: EGC.
21. Tamsuri, S. (2009). *Konsep dan Penatalaksanaan Nyeri*. Jakarta: EGC.
22. Tumade, B., Jim, E. L., & Joseph, V. F. F. (2014). Prevalensi Sindrom Koroner Akut di RSUP Prof. Dr. R. D Kandou Manado Periode 1 Januari 2014. *Jurnal e-Clinic (eCI), 4*(1), 223-300.
23. Wijayanti, E., & Adipireno, P. (2020). Hubungan Kadar Elektrolit Dengan Petanda Jantung Pada Sindrom Koroner Akut. *Medica Hospitalia: Journal of Clinical Medicine, 7*(1), 27–33. https://doi.org/10.36408/mhjcm.v7i1.424
24. Williamson, M. A., & Snyder, L. M. (2015). Wallach's Interpretation Of Diagnostic Tests
25. Williamson, M. A., Snyder, L. M., & Wallach, J. B. (2011). *Wallach's Interpretation of Diagnostic Tests*. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins Health.
26. Zahara, F. Syafri, M., & Yerizel, E. (2013). Gambaran Profil lipid Pada Pasien Sindrom Koroner Akut di Rumah Sakit Khusus Jantung Sumatera Barat Tahun 2011-2012. *Andalas Health Journal, 3*(2).