



Analysis of Potassium Levels in Patients with Pulmonary Tuberculosis Who Take Anti Tuberculosis Drugs

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Abstract. Pulmonary Tuberculosis is an infectious disease caused by the bacteria *Mycobacterium tuberculosis*. Pulmonary Tuberculosis is treated with antituberculosis drugs, but these drugs can be toxic to the body and have side effects such as diarrhea, nausea, and vomiting. These side effects can disrupt the body's fluid balance with the loss of potassium. The purpose of this study was to analyze the side effects of taking anti-tuberculosis drugs (OAT) on potassium (K) electrolyte levels in Pulmonary Tuberculosis patients at UPT Puskesmas Perumnas 1. This study used a descriptive design with a cross sectional approach to describe or give an overview of electrolyte levels in Pulmonary Tuberculosis patients who took anti-tuberculosis drugs. The population in this study were 37 Pulmonary Tuberculosis patients, and the samples in this study were 26 Pulmonary Tuberculosis patients who were still on OAT treatment at UPT Puskesmas Perumnas 1. The potassium electrolyte examination method used in this study was the sodium tetraphenylboron method. From the results of the study, it was found that Lung Tuberculosis patients with normal potassium levels amounted to 8 people (30.8%) and Lung Tuberculosis patients who experienced hypokalemia amounted to 18 people (69.2%). The side effects felt from taking OAT were digestive disorders, namely diarrhea totaling 7 people (26.9%), nausea totaling 4 people (15.4%), and vomiting totaling 7 people (26.9%).

Keywords: Potassium, Pulmonary Tuberculosis, Antituberculosis Drugs

Introduction

Tuberculosis (TB) is an infectious disease that can infect all groups ranging from infants, children, adolescents to the elderly and causes the death of more than 1 million people every year. The disease is caused by a pathogenic bacterium known as *Mycobacterium tuberculosis* (MTB) which is a gram-positive rod-shaped bacterium (bacillus). In most people, tuberculosis infects the lungs, but it can also be found in almost all organs of the body such as the brain, spine and kidneys. Indonesia is ranked as the third country with the highest incidence of tuberculosis in the world (Yanti, 2021)

According to WHO Global Surveillance, tuberculosis disease in the world in 2019-2020 has decreased. However, the number of sufferers is still predicted to be around 10 million. With a death rate estimated at 1.2 million. In the human body, these bacteria more often cause infections in the lungs compared to other organs, known as pulmonary tuberculosis (TB Paru). Cases of pulmonary tuberculosis disease are common in Indonesia, even throughout the world pulmonary TB disease is a major problem in public health. This disease can be transmitted through the air when the patient sneezes or coughs (M. Surip, Elly Prihasti W, 2020).

West Kalimantan is a province that is still burdened with infectious disease problems. The results of the health profile analysis show that the CFR (Case Fatality Rate) of TB has increased from 1.3% in 2015 to 3.3% in 2019. The trend of TB cases in the 2015-2019 period experienced an increase in the number of cases, from 5,262 cases in 2015 to 8,364 cases in

2019(Sudaryo & Suprayogi, 2022).

The population density in West Kalimantan, especially Pontianak City, which is the capital of the province that has the largest population, is directly proportional to the high number of Tuberculosis cases in Pontianak City. From the data there were 950 cases in 2017, with an incidence rate of 70.21 per 100,000 population in West Kalimantan. (Septiawan et al., 2018). And Tuberculosis cases in Pontianak City in 2019 ranked first with the highest number of cases at 1,511 cases(Sudaryo & Suprayogi, 2022).

UPT Puskesmas Perumnas 1 which is located in the Pontianak City area is an outpatient health center that handles cases of Pulmonary TB disease. In 2018, the number of BTA positive pulmonary tuberculosis cases at UPT Puskesmas Perumnas 1 was 21 male patients and 9 female patients. And in 2022 Pulmonary Tuberculosis cases in the UPT Puskesmas Perumnas 1 coverage area amounted to 31 cases, with an incidence rate of 7.3 cases per 10,000 population in the UPT Puskesmas Perumnas 1 coverage area(Kesehatan Pontianak, 2022).

One of the efforts in controlling and overcoming the number of Tuberculosis patients is through treatment. The indicator used to evaluate treatment is the success rate of the program. The success rate is formed from the cure rate and the complete treatment rate. There are many factors that can affect the success of Tuberculosis treatment. The TSR or Treatment Success Rate is influenced by several factors, including; patient factors: patients who do not comply with taking anti-tuberculosis drugs (OAT), patients who move health care facilities, and Tuberculosis that is resistant to OAT. The factor of drug supervisor (PMO): PMO was absent, PMO was present but lacked monitoring. Drug factors: OAT supply was disrupted so that patients delayed or did not continue taking medication, and OAT quality decreased because drug storage was not in accordance with standards(Fadila, 2019).

Mengacu pada kondisi tersebut diperlukan adanya *Directly Observed Treatment Success Rate* (DOTS) yaitu strategi penyembuhan Tuberkulosis paru jangka pendek dengan pengawasan secara langsung sehingga proses penyembuhan Tuberkulosis paru dapat berlangsung secara cepat hingga pasien dinyatakan sembuh. Kategori kesembuhan penyakit Tuberkulosis yaitu kondisi dimana individu telah menunjukkan peningkatan dalam kesehatan dan memiliki salah satu indikator kesembuhan penyakit TBC, diantaranya: menyelesaikan pengobatan secara lengkap dan melakukan pemeriksaan ulang dahak hasilnya negatif pada akhir pengobatan. Strategi DOTS direkomendasikan oleh WHO secara global untuk menanggulangi Tuberkulosis paru, karena menghasilkan angka kesembuhan yang tinggi yaitu 95%. Berdasarkan data Kemenkes RI (2017) jumlah kejadian tuberkulosis di Indonesia sebanyak 360.565 kasus dengan keberhasilan pengobatan sebanyak 279.703 kasus (77,57%). (Fadila, 2019)

Clinical management of MDR (multidrug resistant tuberculosis) TB treatment is more complicated because Mycobacterium tuberculosis bacteria in TB patients are resistant to rifampicin and isoniazid OAT simultaneously, with or without other first-line anti-tuberculosis drugs (OAT) such as ethambutol, streptomycin, and pyrazinamide. The management of sensitive TB uses only 4 drugs and takes 6 months, while the management of MDR TB uses at least 5 drugs, namely capreomycin (Cm), para-aminosalicylic acid (PAS), levofloxacin (Lfx), kanamycin (Km), and ethionamide (Eto). The treatment time lasts for 18 to 24 months (Kusnanto et al., 2013).

The most common side effect of OAT therapy is the reddish color of urine, which is felt by all patients undergoing treatment for pulmonary TB. This side effect in the form of reddish urine is not dangerous for patients. This occurs due to the metabolic process of taking rifampicin. Nausea is the second side effect that is often felt by patients, as many as 72.73%,

where this side effect will be felt by patients immediately when the patient finishes taking rifampicin and isoniazid drugs. Other OAT side effects that are often complained of by patients include weakness 54.54%, vomiting and indigestion (ulcer, stomach pain, constipation, diarrhea) 36.36%, joint pain and dizziness 27.27%, skin itching, drowsiness, and tingling 9.09% (Farhanisa et al.).

Judging from the side effects that are often felt by patients in the form of nausea, vomiting and gastrointestinal disorders (ulcers, abdominal pain, difficulty defecating, diarrhea) can cause fluid balance disorders in the body, especially potassium electrolytes which are the main intracellular cations. Potassium plays an important role in cellular metabolism, regulating neuromuscular excitability, muscle contraction, maintaining osmotic balance, maintaining the heart's resting potential and the electrical potential of cell membranes and for moving glucose into cells. (Basic Nursing, n.d.) Signs and symptoms resulting from disturbances in the balance of potassium levels to the body, namely Hypokalemia: weak or irregular pulse, bilateral muscle weakness starting from the quadriceps and can rise to the respiratory muscles, abdominal distension, decreased bowel noise, constipation and dysrhythmia. Hyperkalemia: irregular or slow pulse, hypotension, anxiety, bilateral muscle weakness in the quadriceps, transient abdominal cramps, diarrhea, dysrhythmia, heart palpitations or abnormal beats and can have a heart attack if severe (Ernihera & Wariaka, 2017). Magnesium is a cofactor of adenosine triphosphate in potassium and sodium pumps, so potassium loss is a result of hypomagnesium (Suparyatmo et al., 2014).

2. Methods

2.1 Research Design

The type of research method used in this study is descriptive research with a cross sectional approach, which is a study that describes or describes research variables with data collection carried out simultaneously at one time between risk factors and their effects.

2.2 Population and Sample

The population in this study were all outpatients who had been diagnosed with Tuberculosis at UPT Puskesmas Perumnas 1 Pontianak, totaling 37 respondents. The number of samples taken with total sampling technique with the criteria, all outpatients who were diagnosed positive with Tuberculosis and still in the OAT therapy period and aged 17 years and over were 26 respondents at UPT Puskesmas Perumnas 1 Pontianak.

2.3 Sample Preparation

Sample preparation is carried out in several stages. First, in taking blood samples, laboratory staff use personal protective equipment (PPE) such as laboratory coats, gloves, and masks. The steps include preparation of tools such as a 3cc syringe, tourniquet, 70% alcohol swab, plaster, and yellow cap vacutainer tube. Next, the patient should be seated with straight arms, and the cubital vein is selected as the blood collection site. After that, a tourniquet was used to stem the cubital vein, followed by disinfecting using a 70% alcohol swab and puncturing with a 3cc syringe. After the blood stopped flowing, a 70% alcohol swab was placed on the puncture site for ± 2 minutes and a plaster was applied. The blood obtained was put into a yellow-capped vacutainer tube containing a gel separator. Furthermore, for the preparation of research serum, blood samples were allowed to clot at room temperature for 20-30 minutes before being centrifuged at 3500 rpm for 3-5 minutes. Qualified serum should not look red (lysis), cloudy, and fatty (lipemic).

Finally, in the examination of research samples, the working procedure for potassium (K) examination using the sodiumtetraphenylboron method was carried out. The steps include

mixture of materials/reagents such as blank, standard, serum control, and sample with RI reagent, incubation at 25°C for 5 minutes, measurement of sample absorbent, standard against reagent blank using a spectrophotometer with a wavelength of 578 nm.

2.4 Data analysis

The processed data will be presented in tabular form and then described in the form of narration and percentage of potassium content values.

2.5 Research ethics and informed consent

The research protocol was approved by the ethics commission of the Health Polytechnic of the Ministry of Health Pontinak with registration number 195/KEPK-PK.PKP/VIII/2022 and written consent was obtained from all respondents.

3. Results

The results of the examination of blood potassium levels in 26 Pulmonary Tuberculosis patients were then processed with descriptive analysis.

Table 1 Descriptive of Potassium (K) Electrolyte Levels in Pulmonary Tuberculosis Patients Taking OAT

Potassium Content	n	(%)
Normal	8	30.8%
Low	18	69.2%
Total	26	100 %

Based on table 1, it is known that potassium electrolyte levels in Pulmonary Tuberculosis patients at UPT Puskesmas Perumnas 1 who consume OAT mostly experience hypokalemia as many as 18 (69.2%) respondents, while in Pulmonary Tuberculosis patients who consume OAT with normal potassium electrolyte levels as many as 8 (30.8%) respondents.

Table 2 Descriptive of Potassium (K) Electrolyte Levels in Pulmonary Tuberculosis Patients Consuming OAT Based on Gender.

Gender	n	Potassium Content		Total
		Normal	Rendah	
Male	18	6 (33.3%)	12 (66.7%)	18 (69.2%)
Female	8	2 (25.0%)	6 (75.0%)	8 (30.8%)
Total	26	8 (30.8%)	18 (69.2%)	26 (100.0%)

Based on table 2, there were 18 male pulmonary tuberculosis patients (69.2%) and 8 female pulmonary tuberculosis patients (30.8%). Male Pulmonary Tuberculosis patients with normal potassium electrolyte levels amounted to 6 people (33.3%) while with low potassium electrolyte levels amounted to 12 people (66.7%). And in female Lung Tuberculosis patients with normal potassium electrolyte levels amounted to 2 people (25.0%) while with low potassium electrolyte levels amounted to 6 people (75.0%).

Table 3 Descriptive side effects felt by pulmonary tuberculosis patients taking OAT.

Side Effects	Potassium Content		Total
	Normal	Rendah	
Diarrhoea	0 (0%)	7 (26.9%)	7 (26.9%)
Nausea	0 (0%)	4 (15.4%)	4 (15.4%)
Vomiting	0 (0%)	7 (26.9%)	7 (26.9%)
None	8 (30.8%)	0 (0%)	8 (30.8%)
Total	8 (30.8%)	18 (69.2%)	26 (100.0%)

Based on Table 3, it is known that Pulmonary Tuberculosis patients with low potassium levels who felt side effects from taking OAT amounted to 18 people (69.2%). Side effects felt by Pulmonary Tuberculosis patients in the form of indigestion, namely diarrhea amounted to 7 people (26.9%), nausea amounted to 4 people (15.4%) and vomiting amounted to 7 people (26.9%). Meanwhile, Lung Tuberculosis patients with normal potassium levels did not feel any side effects from taking OAT, totaling 8 people (30.8%).

4. Discussion

This study was conducted on Pulmonary Tuberculosis patients by measuring potassium electrolyte levels at the Integrated Laboratory of the Poltekkes Kemenkes Pontianak. Based on the results of research conducted on the examination of potassium electrolyte levels in Pulmonary Tuberculosis patients who were on treatment at UPT Puskesmas Perumnas 1, the results of 26 Pulmonary Tuberculosis patients who experienced hypokalemia were 18 (69.2%) patients, and patients with normal potassium levels were 8 (30.8%) patients.

Based on the side effects felt by pulmonary tuberculosis patients while taking OAT, patients with low potassium levels who experienced indigestion in the form of diarrhea were 7 people (26.9%), nausea was 4 people (15.4%), and vomiting was 7 people (26.9%). While Lung Tuberculosis patients who did not experience side effects from taking OAT amounted to 8 people (30.8%). The side effects of nausea and vomiting from taking OAT felt by Pulmonary Tuberculosis patients caused the patient's appetite to decrease so that potassium intake in the body was not fulfilled which could result in disturbance of the balance of potassium levels in the blood. In addition to nausea and vomiting, side effects of diarrhea from taking OAT are also felt by patients with pulmonary tuberculosis. The occurrence of diarrhea side effects that are continuously felt can also cause fluid depletion in the body and can cause weakness. Most Pulmonary Tuberculosis patients who feel the side effects of taking OAT experience low blood potassium levels or hypokalemia, this can also occur due to patient age factors where some patients are approaching old age or pre elderly (45-59 years) totaling 12 patients and some patients who have entered old age (60-69 years) totaling 7 patients, as well as the length of the Lung TB treatment period which is more than 1 month of treatment totaling 20 patients.

Potassium is an ion that plays a role in maintaining electrolyte balance in the human body. Potassium can also maintain membrane potential for the life of a cell. Potassium also functions in protein synthesis, muscle contraction, nerve conduction, hormone release, fluid transport and fetal development (P. Siregar, 2014).

Hypokalemia can occur due to insufficient intake, transfer of potassium into cells or renal or non-renal potassium loss. Hypokalemia is a common occurrence in the clinic. There are 3 mechanisms of hypokalemia, namely reduced potassium intake, increased potassium excretion through the kidneys and urinary tract and redistribution of potassium from extracellular to intracellular (Bakhtiar et al., 2015).

The clinical picture of hypokalemia is highly variable, and its severity depends on the degree of hypokalemia. Symptoms are rare unless potassium is less than 3.10 mEq/L. Myalgia is a frequent complaint of Pulmonary Tuberculosis patients, which is a condition where muscles experience cramps due to reduced body fluids, which can occur in the thigh muscles and can rise to the respiratory muscles. More severe hypokalemia can also cause progressive weakness, which is the weakening of muscles that can lead to the failure of organs such as the heart, hypoventilation, which is a condition where the process of

inhalation slows down so that it inhibits the fulfillment of oxygen needed by the body, and complete paralysis, which is a condition where the nerves experience interference in regulating muscle movement and can result in paralysis. Potassium depletion or severe hypokalemia can also increase the risk of arrhythmia, which is a disturbance in the rhythm of the heart pump that becomes faster or slower than the normal heart pump rhythm and can cause rhabdomyolysis, a condition where muscle tissue is disturbed due to hypokalemia, causing the disturbed muscle tissue to release protein into the blood which can damage the kidneys. Smooth muscle function can also be impaired with a clinical picture of paralytic ileus, which is a disorder of bowel movements. In severe hypokalemia, there are complaints of weakness and constipation where a person experiences constipation due to lack of fluid in the body. In conditions of potassium < 2.5 mmol/L, muscle necrosis will occur which is a condition where tissue cells experience death which can cause disruption of nerve endings and in conditions of potassium < 2 mmol/L there will be ascending paralysis or muscle weakness and paralysis syndrome which can be caused by hypokalemia. Nerve weakness varies from mild nerve weakness to total nerve paralysis. The occurrence of complaints is in line with the speed of decline in serum potassium levels. In patients without heart disease, there can be unusual cardiac muscle conduction abnormalities even with potassium levels of less than 3 mmol/L (Bakhtiar et al., 2015).

5. Conclusion

Based on the results of the analysis of potassium (K) electrolyte levels in 26 Pulmonary Tuberculosis patients at UPT Puskesmas Perumnas 1, it can be concluded that 69.2% of patients experienced hypokalemia, while 30.8% of patients had normal potassium levels. The side effects felt by Pulmonary Tuberculosis patients while taking antituberculosis drugs (OAT) were gastrointestinal disorders, namely diarrhea (26.9%), nausea (15.4%), and vomiting (26.9%). Meanwhile, 30.8% of patients did not experience any side effects from taking OAT.

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