

The Relationship Between Viral Load Levels and CD4+ Count with the Incidence of Opportunistic Infections in HIV/AIDS Patients at Ibnu Sina Hospital Makassar

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ABSTRACT

Background: HIV/AIDS is a global health problem that continues to be a challenge, especially in developing countries. One important aspect in the management of HIV/AIDS is the monitoring of viral load and CD4+ levels which serve as indicators of the patient's immune status. As the disease progresses, HIV/AIDS patients are at high risk of opportunistic infections that can worsen health conditions and shorten life expectancy. **Objective:** To determine the relationship between viral load and CD4+ levels in HIV/AIDS patients at Ibnu Sina Hospital. **Method:** Analytic observational research method with cross sectional approach, the research subjects were 10 subjects for viral load examination and 32 subjects for CD4+ examination. **Results:** The highest percentage of opportunistic infections was in oral candidiasis infection as many as 16 people (50%). The chi-square test showed a significant relationship between CD4+ levels and opportunistic infections in HIV/AIDS patients at Ibnu Sina Hospital Makassar with a p-value of 0.000 while for viral load could not be determined because secondary data were incomplete. **Conclusion:** There is a significant relationship between CD4+ levels with opportunistic infections in patients with HIV/AIDS at Ibnu Sina Hospital Makassar.

Introduction

Human Immunodeficiency Virus (HIV) is a type of virus that attacks the human immune system by infecting or targeting human white blood cells. Meanwhile, Acquired Immunodeficiency Syndrome (AIDS) is a collection of disease symptoms that arise after being infected with the HIV virus due to a weakened immune system¹.

The first case of HIV/AIDS in the world was reported in 1981, while in Indonesia, the first case was discovered in a Dutch citizen in Bali in 1987². According to data from the Indonesian Ministry of Health in 2021, the estimated number of people living with HIV in Indonesia in 2020 was 543,100, with 29,557

new infections and 30,137 deaths. The number of reported HIV-positive cases has tended to increase from year to year³. According to the Indonesian Ministry of Health, South Sulawesi is one of the ten provinces with the highest number of HIV infections in 2022. The cities of Makassar, Pare-Pare, and the Jeneponto Regency had the highest HIV prevalence in the province⁴.

CD4+ lymphocytes are the primary targets of HIV infection because the virus has an affinity for the CD4+ surface molecules. CD4+ lymphocytes play an essential role in coordinating various critical immunological functions. The loss of these functions results in a progressively weakened immune response,

making it easier for opportunistic infections to develop. Clinically, the CD4+ lymphocyte count is used as an indicator for the emergence of opportunistic infections in AIDS patients⁵.

The decline in CD4+ levels is caused by the death of CD4+ cells due to HIV. The normal CD4+ count ranges from 410–1,590 cells/mm³ of blood. When the count drops below 350 cells/mm³, the condition is already classified as AIDS. Opportunistic infections commonly occur when CD4+ levels fall below 200 cells/mm³ or even lower⁷. Meanwhile, HIV infection is measured using viral load as an indicator to assess treatment response, transmission risk, and the potential spread of infection. According to research conducted by Veronika et al. (2022), a decrease in CD4+ levels significantly influences the incidence of opportunistic infections in HIV patients by 49%, while viral load and neutrophil-to-lymphocyte ratio (NLR) showed no significant effect⁸.

The most common opportunistic infections found in Indonesia include pulmonary tuberculosis, *Pneumocystis jirovecii* pneumonia, candidiasis, diarrhea, dermatitis, herpes zoster, herpes simplex, persistent generalized lymphadenopathy, toxoplasmosis, and encephalopathy⁹. Indonesia's tropical climate, with high humidity levels, along with its status as a developing country, facilitates the proliferation of various pathogens, making people living with HIV more vulnerable to diverse opportunistic infections¹⁰.

The purpose of this study is to determine the relationship between viral load and CD4+ levels with the incidence of opportunistic infections in HIV/AIDS patients at Ibnu Sina Hospital in Makassar, by identifying the types of opportunistic infections experienced by patients that can worsen their condition. This research is expected to contribute to knowledge that can help improve the quality of life and extend life expectancy among HIV/AIDS patients by paying close attention to the factors

that influence the onset of opportunistic infections.

Materials and Methods

Research Design

This study employed an observational analytic design with a cross-sectional approach. The research was conducted on Tuesday, June 5, 2024.

Sample

The study sample consisted of all members of the target population, meaning all patients diagnosed with HIV/AIDS at Ibnu Sina Hospital Makassar who had complete and relevant medical record data. The sampling technique used was total sampling, where all available medical records that met the research criteria were included. A total of 10 samples were obtained for viral load examination and 32 samples for CD4+ examination.

Data Collection Techniques

Data were collected using secondary data from the patients' medical records at Ibnu Sina Hospital Makassar. The medical records provided the necessary information regarding viral load levels, CD4+ counts, and the occurrence of opportunistic infections. Additional demographic and clinical data, such as age, gender, duration of antiretroviral therapy (ART), and treatment adherence, were also extracted to enrich the analysis and provide a more comprehensive understanding of the patients' clinical profiles..

Data Analysis Techniques

Data analysis was performed using univariate analysis with descriptive statistics (frequencies) to describe the distribution and characteristics of each variable, such as age, gender, CD4+ levels, viral load, and the presence of opportunistic infections. Additionally, bivariate analysis was conducted to examine the relationships between variables

using the chi-square test. All statistical analyses were carried out with the assistance of the SPSS (Statistical Product and Service Solutions) software to ensure accurate data processing and interpretation.

Ethical Consideration

This study utilized secondary data from medical records, and no direct contact with patients was involved. The research maintained patient confidentiality and anonymity by not disclosing any personal identifiers. The study was ethically feasible and followed the principles of medical ethics and data protection. Approval from the hospital or relevant ethics committee would be required to access patient records and ensure ethical compliance.

Results

The data of HIV/AIDS patients at Ibnu Sina Hospital Makassar from 2022 to 2023 involved a total of 32 patients. The distribution of patients based on gender, age, duration of treatment, CD4+ levels, incidence of opportunistic infections, types of opportunistic infections, and viral load levels is presented as follows:

Table 1 shows the distribution of study subjects, consisting of 32 individuals, with the majority being male (28 people, 87.5%). The largest age group was 26–45 years, totaling 17 individuals (53.1%), and the majority had a treatment duration of more than 1 year (19 people, 59.4%). Based on CD4+ examination results, 24 individuals (75%) had CD4+ levels of less than 200 cells/mm³. Additionally, 25 patients (78.1%) experienced opportunistic infections. The most common opportunistic infection among HIV/AIDS patients was oral candidiasis, affecting 16 individuals (50%), while 7 patients (21.9%) did not have opportunistic infections. Based on viral load examination results from 10 samples, 5 patients (50%) had detectable viral load levels (>50

copies/ml), while 5 patients (50%) had undetectable viral load levels (<50 copies/ml).

Table 1. Sample Distribution

Variable	Frequency	Percentage (%)
Gender		
Male	28	87.5
Female	4	12.5
Age (years)		
15–25	9	28.1
26–45	17	53.1
45–65	6	18.8
Duration of Treatment		
< 1 year	13	40.6
> 1 year	19	59.4
CD4+ Levels		
< 200	24	75.0
201–500	8	25.0
Opportunistic Infections		
Yes	25	78.1
No	7	21.9
Types of Opportunistic Infections		
Oral Candidiasis	16	50.0
Cryptosporidium	3	9.4
Diarrhea		
Toxoplasmosis	3	9.4
Pneumocystis	3	9.4
Pneumonia		
None	7	21.9
Total (CD4+ Sample)	32	100.0
Viral Load Levels		
Detectable	5	50.0
Undetectable	5	50.0
Total (Viral Load Sample)	10	100.0

Source: Ibnu Sina Hospital Makassar, 2023.

Table 2 shows that the majority of patients with opportunistic infections had CD4+ counts of less than 200 cells/mm³, totaling 23 individuals (95.8%), while those with CD4+ counts of 201–500 cells/mm³ totaled 2 individuals (25%). Based on gender, 22 male patients (78.6%) and 3 female patients (75%) experienced opportunistic infections. The age group of 26–45 years had the highest number of opportunistic infections, with 16 individuals (94.1%). Among patients with a treatment duration of less than 1 year, 9 individuals (69.2%) experienced opportunistic infections, while among those with more than 1 year of treatment, 16 individuals (84.2%) were affected. Table 2 also shows a significant relationship between CD4+ levels and

opportunistic infections, as indicated by the Chi-Square test p-value of 0.000 ($p < 0.05$), as well as a significant relationship between age group and opportunistic infections with a Chi-

Square test p-value of 0.013 ($p < 0.05$). In contrast, gender and duration of treatment do not show significant relationships ($p > 0.05$).

Table 2. The Relationship Between CD4+ Levels, Gender, Age, and Duration of Treatment with Opportunistic Infections

Variable	Opportunistic Infections			P Value
	Yes (%)	No (%)	Total (%)	
CD4+ Levels				
<200	23 (95,8)	1 (4,2)	24 (100,0)	0,000
201-500	2 (25,0)	6 (75,0)	8 (100,0)	
Gender				
Male	22 (78,6)	6 (21,4)	28 (100,0)	0,872
Female	3 (75,0)	1 (25,0)	4 (100,0)	
Age				
15-25 years	4 (44,4)	5 (55,6)	9 (100,0)	0,013
26-45 years	16 (94,1)	1 (5,9)	17 (100,0)	
46-60 years	5 (83,3)	1 (16,7)	6 (100,0)	
Duration of Treatment				
<1 year	9 (69,2)	4 (30,8)	13 (100,0)	0,314
>1 year	16 (84,2)	3 (15,8)	19 (100,0)	

Source: Ibnu Sina Hospital Makassar, 2023.

Table 3. The Relationship Between Gender, Age, and Duration of Treatment with CD4+ Levels

Variable	CD4+ Levels		Total (%)	p-value
	<200 cells/mm ³ (%)	201-500 cells/mm ³ (%)		
Gender				
Male	21 (75,0)	7 (25,0)	28 (100,0)	1,000
Female	3 (75,0)	1 (25,0)	4 (100,0)	
Age				
15-25 years	4 (44,4)	5 (55,6)	9 (100,0)	0,031
26-45 years	14 (82,4)	3 (17,6)	17 (100,0)	
46-60 years	6 (100)	0 (0)	6 (100,0)	
Duration of Treatment				
<1 year	7 (53,8)	6 (46,2)	13 (100,0)	0,022
>1 year	17 (89,5)	2 (10,5)	19 (100,0)	

Source: Ibnu Sina Hospital Makassar, 2023.

Table 3 shows a significant relationship between age group and CD4+ levels, as indicated by the Chi-Square test p-value of 0.031 ($p < 0.05$). There is also a significant relationship between the duration of treatment and CD4+ levels, with a Chi-Square test p-value of 0.022 ($p < 0.05$). In contrast, gender

does not show a significant relationship ($p > 0.05$). These results suggest that age and treatment duration are influential factors in the immune status of patients, possibly due to physiological changes over time and the cumulative benefits of consistent antiretroviral therapy. Further investigation is recommended

to explore other potential contributing factors that may impact CD4+ levels, such as nutritional status, comorbidities, and treatment adherence.

Discussion

Relationship between CD4+ and Opportunistic Infections

Opportunistic infections are infections that take advantage of the weakened immune system in humans. CD4+ count is an important indicator in assessing the immune system function in individuals with HIV. The lower the CD4+ count, the weaker the immune system, making the individual more susceptible to opportunistic infections. Patients with CD4+ counts of less than 200 cells/mm³ are more vulnerable to various opportunistic infections. This explains why, based on the study results, 23 individuals (95.8%) in this group experienced opportunistic infections. Although most experienced infections, other factors such as individual genetic variation, adherence to antiretroviral therapy, and lifestyle can also influence susceptibility to opportunistic infections¹¹.

Furthermore, the results of the bivariate analysis using the Chi-Square test showed a significant relationship between CD4+ count and opportunistic infections, as evidenced by a p-value of 0.000 ($p < 0.005$). Similar findings were reported in a study by Veronika et al. (2022) with a significance value of 0.000. This indicates that the lower the CD4+ count (<200 cells/mm³), the higher the risk of infections in HIV/AIDS patients. A low CD4+ count reflects immune system damage, which also increases susceptibility to opportunistic infections¹².

Relationship between Gender and Opportunistic Infections

Based on the results of this study, the majority of opportunistic infection cases were found in male patients, totaling 28 individuals (87.5%). Medical records indicated that most of these

males belonged to the MSM (Men who have Sex with Men) group, highlighting a link with their sexual behaviors. MSM refers to men who engage in sexual activities with other men. Some of them also maintain relationships or are married to women. Anal sexual activity among MSM carries a high risk of HIV infection because the anus is not designed for sexual activity and cannot naturally lubricate like the vagina. This makes the anus more prone to tears or abrasions, facilitating the entry of the HIV virus into the bloodstream¹³.

Relationship between Age and Opportunistic Infections

The age distribution in this study showed that opportunistic infections were most prevalent in the young adult age group (26–45 years), accounting for 17 individuals (53.1%). This age group is typically at the peak of sexual and social activity, which increases the risk of exposure to HIV and other sexually transmitted infections. High sexual activity combined with insufficient use of protective methods can further elevate vulnerability to opportunistic infections.

The results of the relationship test between age and opportunistic infections indicated a significant association ($p=0.013$). A previous study conducted by Sutini et al. (2022) with a sample size of 1,362 also reported a similar finding ($p=0.001$). This may occur because the age range of 25–45 years is a high-risk group, often associated with sex workers, high-risk partners, and the MSM (Men who have Sex with Men) population¹⁴.

Relationship between Duration of Treatment and Opportunistic Infections

Patients with a treatment duration of less than one year have not yet achieved optimal viral control, placing them at a higher risk of developing opportunistic infections. In this study, 13 patients (40.6%) had been on treatment for less than one year, and among

them, 9 patients (69.2%) experienced opportunistic infections. During the early stages of treatment, the immune system has not fully recovered, making these patients more susceptible to infections. In contrast, patients who have undergone treatment for more than one year tend to have better viral control and a more significant recovery of immune function¹⁵.

Relationship between Gender and CD4+ Levels

Biologically, gender is not considered a direct factor influencing CD4+ levels in HIV patients. The decline in CD4+ levels is primarily driven by the pathogenic mechanisms of HIV itself, which targets the immune system regardless of gender. Both males and females experience a decrease in CD4+ levels as the disease progresses, depending on factors such as the duration of infection, the severity of the disease, and the response to antiretroviral therapy¹⁶.

Relationship between Age and CD4+ Levels

As individuals age, a natural process called immunosenescence occurs, which is the gradual decline of immune system function associated with aging. This includes a reduction in both the number and function of immune cells, including CD4+ cells. In older individuals, this decline in immune function accelerates the damage to the immune system caused by HIV, resulting in a faster decrease in CD4+ levels compared to younger individuals¹⁷.

In this study, a significant relationship was found between age and CD4+ levels, as evidenced by a p-value of 0.031 ($p < 0.005$). Similarly, research by Desta et al. (2019) explained that age is positively associated with CD4+ count improvement, stating that starting antiretroviral therapy (ART) at a younger age (< 40 years) tends to result in a better

immunological response. Conversely, older individuals (> 40 years) typically have a poorer immunological response, as increasing age is often associated with the presence of comorbidities and lower CD4+ levels¹⁸.

Relationship between Treatment Duration and CD4+ Levels

The results of this study indicate that the duration of treatment has a significant relationship with CD4+ levels in HIV/AIDS patients, as evidenced by a p-value of 0.022 ($p < 0.005$). This finding is consistent with previous research conducted by Ema Yunita et al. (2020), which showed that the longer the use of antiretroviral combination therapy (ARV) in HIV/AIDS patients, the greater the increase in CD4+ cell count. The study emphasized that a meaningful increase in CD4+ typically requires a minimum treatment duration of 18 months. CD4+ response can increase by approximately 50–60 cells/mm³ within the first four months of treatment. On average, CD4+ levels rise by 50–100 cells/mm³ per year following ARV administration. Patients who never achieve CD4+ levels above 100 cells/mm³, or those whose CD4+ counts decline progressively after initially reaching high levels without other underlying medical conditions, should be suspected of experiencing immunological treatment failure¹⁹.

In this study, the most common opportunistic infection was oral candidiasis. Candida, the fungus responsible for candidiasis, normally exists in small amounts in the mouth and gastrointestinal tract of healthy individuals without causing issues. However, when the immune system is weakened, Candida can multiply excessively and lead to infection. Risk factors such as smoking, the use of dentures, and poor oral hygiene can further increase the likelihood of developing oral candidiasis in HIV patients²⁰.

Conclusion

Based on the results of the study, it can be concluded that the types of opportunistic infections found in HIV/AIDS patients include oral candidiasis, cryptosporidial diarrhea, toxoplasmosis, and pneumocystis pneumonia. There is a significant relationship between CD4+ count and the occurrence of opportunistic infections in HIV/AIDS patients. However, the relationship between viral load and opportunistic infections in HIV/AIDS patients at Ibnu Sina Hospital Makassar could not be determined due to incomplete secondary data. In this study, the incomplete secondary data for the viral load variable was caused by the limited availability of testing equipment at Ibnu Sina Hospital. Therefore, it is recommended that the hospital provide the necessary equipment for viral load testing.

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