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Use of the Android-Based Application "LEUMYLO TRACKER" to Monitor Treatment Adherence in Chronic Myelocytic Leukaemia Patients

Tri Mochartini[1], Hurairoh[2], Achmad Fauzi[1,*], Ikhwan Rinaldi[2], Novita[1], Abdul Aziz Setiawan[3]

[1] Department of Nursing, Stikes Abdi Nusantara, Jawa Barat 17412, Indonesia
[2] Dr. Cipto Mangunkusumo National Central Public Hospital, Kota Jakarta Pusat, Daerah Khusus Ibukota Jakarta 10320, Indonesia
[3] Department of Pharmaceutical Technology and Natural Products, Faculty of Pharmacy, Muhammadiyah University A.R. Fachruddin, Kabupaten Tangerang, Banten 15720, Indonesia

ABSTRACT

Leukaemia is a life-threatening cancer globally, characterized by the replacement of normal bone marrow elements with abnormal blood cells. Among various types, Chronic Myeloid Leukaemia (CML) poses significant health concerns, particularly in Asia. Managing CML requires strict adherence to targeted therapies like tyrosine kinase inhibitors, which is often challenging due to complex treatment schedules and side effects. Information and communication technologies, such as Android-based applications, can offer innovative solutions to improve medication adherence. This study aims to design, develop, and evaluate the effectiveness of an Android-based application, "LEUMYLO TRACKER," in monitoring treatment adherence among CML patients. The research uses a quasi-experimental design with a developmental research approach. The study involved 51 CML patients undergoing therapy at the Haematology Oncology Medical Internal Medicine Polyclinic, Cipto Mangunkusumo Hospital, selected through systematic random sampling. The primary factors studied were medication adherence using the Probabilistic Medication Adherence Scale and clinical response. The application development involved needs analysis, user interface design, and implementation of features such as medication reminders, adherence tracking, side effect notes, educational information, and communication capabilities with medical personnel. The application was developed using the Android platform and tested with a small group of patients to gather feedback and assess usability. Results from the univariate analysis indicated that 52.9% of respondents had good clinical responses, while 74.5% adhered to their medication regimen. Bivariate analysis showed a significant relationship between medication adherence and clinical response ($p = 0.029$), with non-adherent patients having a sixfold higher risk of poor clinical response. The LEUMYLO TRACKER application proved beneficial in improving adherence by providing automatic medication reminders and allowing real-time data collection for clinical evaluation. In conclusion, the LEUMYLO TRACKER application effectively enhanced medication adherence and clinical outcomes in CML patients. Its features, such as medication reminders and educational information, supported patients in managing their treatment schedules more consistently. The application also facilitated better communication between patients and medical personnel, allowing timely interventions. Ensuring ease of use and data security is crucial for maximizing

Keywords:

Android application; Chronic myeloid leukaemia; Clinical response; LEUMYLO TRACKER; Medication adherence

[*] *Corresponding author.*
E-mail address: fauzi.umay@gmail.com

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the application's benefits. This study highlights the potential of mobile health applications in improving chronic disease management and patient outcomes.

1. Introduction

Leukaemia is a type of cancer that threatens human life throughout the world. This disease is a disorder of the hematopoietic tissue characterized by the replacement of normal bone marrow elements with abnormal (neoplastic) blood cells. Leukaemia can be divided into several main types based on cell maturity and cell origin, including Acute Lymphoblastic Leukaemia (ALL), Acute Myeloid Leukaemia (AML), Chronic Lymphocytic Leukaemia (CLL), and Chronic Granulocytic Leukaemia (LGK) [1-3]. The incidence of Leukaemia in Western countries is approximately 13 cases per 100,000 population per year, and Leukaemia accounts for approximately 2.8% of all cancer cases. This shows that Leukaemia is a significant health problem in many parts of the world. In Asia, in particular, Chronic Granulocytic Leukaemia (LGK) is the most common type of Leukaemia. Although the incidence of LGK in Asia tends to be lower than in the United States, this disease remains a major concern in the context of haematological health [4].

Chronic Granulocytic Leukaemia (LGK) is a myeloproliferative disease characterized by increased proliferation of myeloid series hematopoietic stem cells at various levels of differentiation. The disease is often diagnosed in the chronic phase, where one third of patients show no obvious symptoms. However, over time, LGK can develop into a more aggressive form, requiring more intensive medical attention and a more complex managerial approach [5,6].

Adherence to the treatment regimen is a crucial factor in the management of LGK. Therapy for LGK generally involves the use of targeted therapy agents, such as tyrosine kinase inhibitors, which require strict adherence to achieve optimal clinical outcomes. However, adherence to treatment is often a major challenge. LGK patients may face a variety of difficulties, including complicated treatment schedules, medication side effects, and a lack of understanding of the importance of medication adherence. These problems can significantly affect the effectiveness of therapy and the patient's quality of life. In this context, information and communication technologies can offer innovative solutions to improve adherence to treatment. Development of an Android-based application to monitor medication adherence can be an effective tool in addressing this problem. These applications can provide a variety of features that support patient compliance, including regular reminders for taking medications, medication tracking, and educational information about diseases and therapies.

Android-based applications have the potential to change the way patients interact with their treatment regimens. With an integrated reminder feature, this application can help patients follow treatment schedules more consistently. These reminders can be tailored to individual needs, including frequency and timing of medication, as well as additional information about dosage and how to use the medication. This is important to ensure that patients do not miss doses or experience errors in taking medication. Additionally, these applications can provide a platform for more structured medication tracking. Patients can record every time they take medication, as well as report any side effects they experience. This data can be used by medical personnel to monitor compliance and assess the effectiveness of therapy. Thus, this application not only helps patients in managing their treatment but also provides valuable information for clinical evaluation. Educational features in the app also play an important role in improving patients' understanding of their diseases and therapies. The information provided may include an explanation of the drug's mechanism of action, potential side effects, and strategies for dealing with those side effects. Good education can

increase patients' motivation to adhere to treatment regimens and reduce any anxiety they may feel related to their therapy.

Interaction between patients and medical personnel can also be improved through this application. Android-based apps can provide an easily accessible communication channel, allowing patients to ask questions or report concerns to their medical team. This can speed up problem management and provide better support for patients. Apart from direct benefits for patients, this application can also help medical personnel manage patient care more efficiently. Data collected through the app can be used for better analysis and assessment of medication adherence. This allows medical personnel to adapt treatment strategies according to patient needs, as well as provide timely interventions if necessary. However, developing Android-based applications to monitor medication adherence also faces several challenges. One of the main challenges is ensuring that the app is easy to use for patients with a variety of technical backgrounds. Intuitive user interface design and easy-to-access features are critical to ensuring that patients can get the most out of the app. In addition, data protection and patient privacy are aspects that must be taken seriously. This application must comply with data security and privacy protection standards to protect patient medical information. The use of encryption technology and strict security protocols is necessary to ensure that patient data remains safe from unauthorized access. The development of an Android-based application called "LEUMYLO TRACKER (Leukaemia Myelocytic Tracker)" this application was developed with the aim of monitoring treatment compliance in Chronic Granulocytic Leukaemia patients, offering a promising opportunity to improve the management of this disease, apart from that there is also an interactive feature that allows patients to interact with doctor. With reminder features, medication tracking, educational information, and improved communication channels, the app can help patients manage their medications more effectively and improve clinical outcomes. However, careful attention to application design and data security is required to ensure that these applications provide maximum benefit to patients and healthcare professionals.

2. Methodology

2.1 Research Design

This research uses a development approach (developmental research) with a quasi-experimental study design. This study aims to design, develop and evaluate an Android-based application that can help monitor treatment adherence in Chronic Myeloid Leukaemia (CML) patients. This design allows assessment of the app's effectiveness in a real-world context and provides insight into its impact on medication adherence and patient clinical outcomes. The population in this study were all LMK patients undergoing therapy/treatment at the Internal Medicine Haematology Oncology Medical Polyclinic, Cipto Mangunkusumo Hospital. The sampling method used was systematic random sampling, with a total sample of 51 respondents.

This study only describes the characteristics of LMK patients who visited the Internal Medicine Haematology Oncology Medical Polyclinic at Cipto Mangunkusumo Hospital from January to March 2022 using the LEUMYLO TRACKER application. The factors studied were compliance in taking medication using the Probabilistic Medication Adherence Scale method [7] and clinical response [8]. This type of research is descriptive, quantitative, and with a cross-sectional design [9]. The data obtained was then analysed with the help of SPSS to determine the level of respondent compliance with the clinical impact experienced based on an odds ratio certainty index of 95% [9].

2.2 Application Development

2.1.1 Design phase

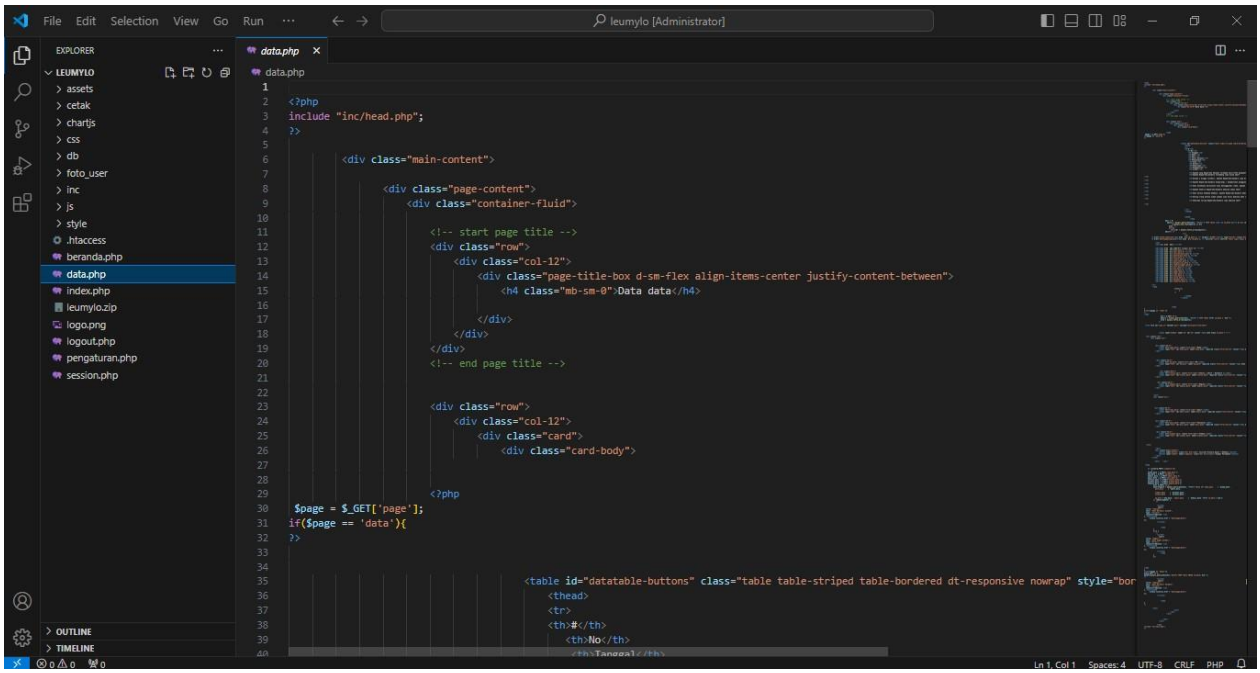
The application design phase will be carried out by following a design process that involves:

i. Needs Analysis: Conduct interviews with medical personnel, patients, and information technology experts to identify the features needed in the application. This analysis also includes a review of the literature regarding similar applications and practical recommendations for improving medication adherence.
ii. User Interface (UI) Design: Develop a user interface design prototype that is user-friendly and intuitive, taking into account aspects of ease of access and use by patients.
iii. Main feature: The app will include features such as medication reminders, adherence tracking, side effect notes, educational information regarding LMK, and the ability to communicate with medical personnel.

2.2.2 Development phase

Application development will be carried out using the Android platform with appropriate programming languages, such as Java or Kotlin as in Figure 1. The development team will work closely with haematologists to ensure that the application meets medical standards and patient needs. This process includes:

i. Programming: Implement the features that have been designed in the application.
ii. Internal Testing: Perform internal testing to ensure application functionality and identify bugs or technical issues.



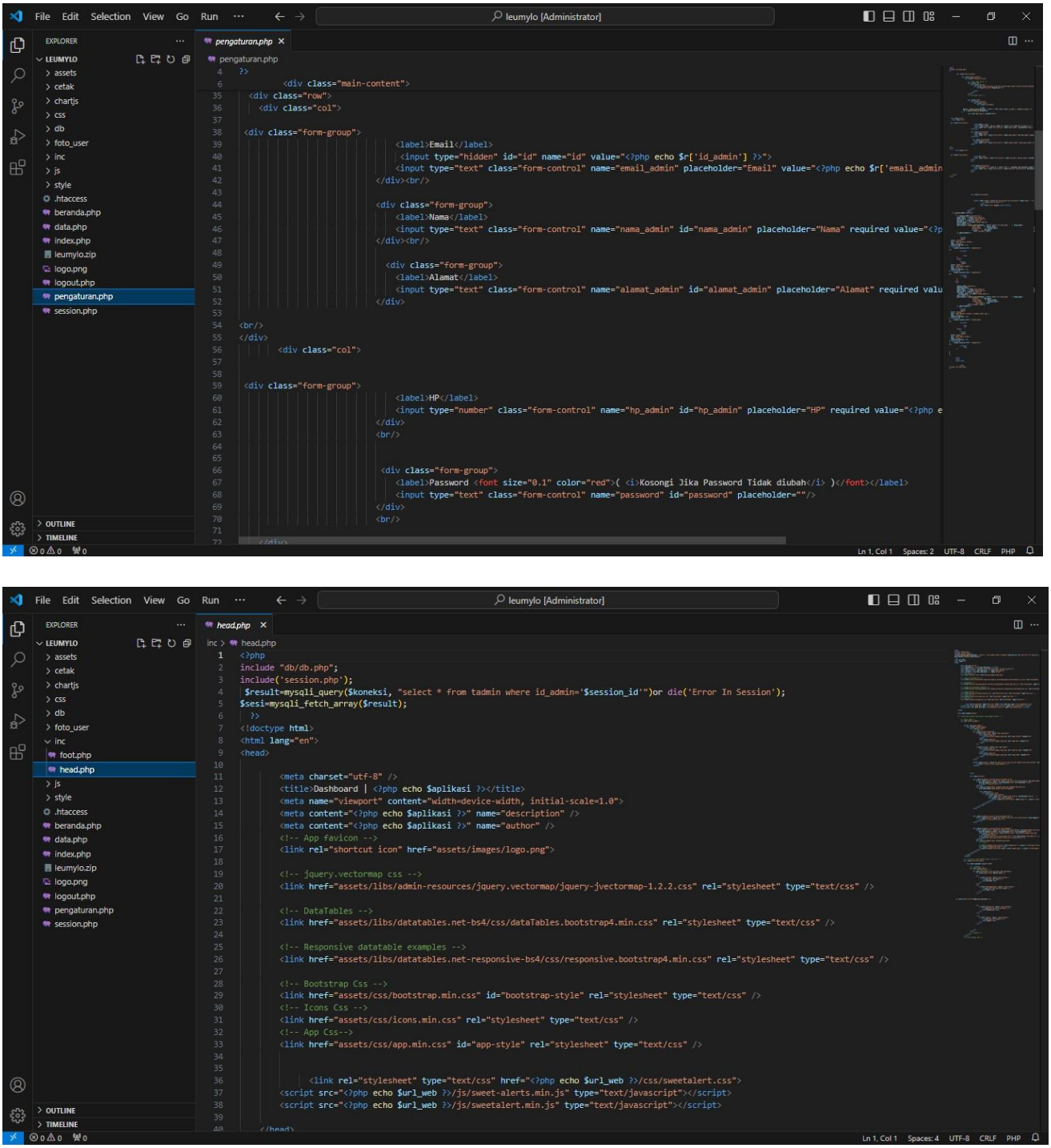


Fig. 1. LEUMYLO TRACKER application programming

2.2.3 Trial phase

The application will be trialled on a small group of CML patients to assess its functionality and usability. This trial involves:

i. Beta Testing: Conduct application testing with a number of patients to gather feedback regarding the interface, ease of use, and effectiveness of features.
ii. Evaluation: Use questionnaires and interviews to evaluate user experience and identify areas for improvement.

2.2.4 Data collection

Data Collection Instruments Data will be collected using several instruments, including:

i. Medication Adherence Questionnaire: Measuring the level of medication adherence before and after application use.
ii. Application Usage Journal: Record the frequency and type of patient interaction with the application.

2.2.5 Data analysis

The collected data will be analysed using appropriate statistical methods. Analysis will include:

i. Descriptive Analysis: To describe sample characteristics and application usage.
ii. Comparative Analysis: Use statistical tests such as t tests or ANOVA to compare treatment compliance before and after application use.
iii. Qualitative Analysis: Analyse feedback from interviews to identify key themes and recommendations for improvement.

3. Results

3.1 Univariate Analysis

The respondents in this study downloaded the LEUMYLO TRACKER application and filled out the questionnaire available in the application as shown in Figure 2.

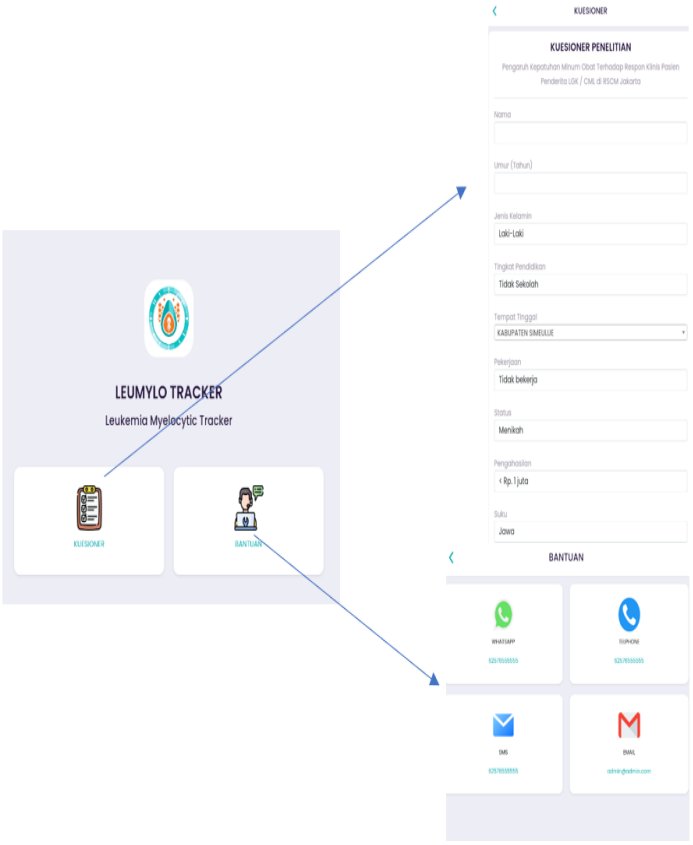


Fig. 2. Use of the LEUMYLO TRACKER application

Based on the data received, it was found that the frequency distribution of respondents according to clinical response variables indicated that out of the 51 respondents studied, the majority of respondents had good clinical responses, which was 52.9% (Table 1). In contrast, respondents with less favourable clinical responses accounted for 47.1%. Furthermore, regarding the compliance variable, it was found that the majority of respondents were compliant in taking their medication, which was 74.5%, while only 25.5% of respondents were non-compliant.

Table 1
Frequency Distribution of Respondents According to Dependent and Independent Variables

Variable	Category	Amount	Percentage (%)
Clinical response	Not good	24	47.1
	Good	27	52.9
Compliance with taking medication	Not obey	13	25.5
	Obedient	38	74.5
Gender	Man	26	51.0
	Woman	25	49.0
Level of education	elementary school	3	5.9
	Junior High School	3	5.9
	Senior High School	26	51.0
	College	19	37.3
Residence	Jakarta	30	58.8
	Bogor	9	17.6
	Depok	1	2.0
	Tangerang	7	13.7
	Bekasi	3	5.9
	The others	1	2.0
Economy	1 million	7	13.7
	2-4 million	26	51.0
	5-7 million	7	13.7
	8-10 million	5	9.8
	> 10 million	6	11.8
Ethnic group	Java	25	49.0
	R	12	23.5
	Betawi	6	11.8
	Batak	3	5.9
	Field	1	2.0
	Manado	1	2.0
	Chinese	3	5.9
Age	Mean	46.75	
	Median	49	
	Mode	57	
	Range	45	
	Minimum	21	
	Maximum	66	

The results of distributing questionnaires via the patient's LEUMYLO TRACKER application obtained information about the patient's demographic data, such as gender, age, education level, ethnicity, place of residence, and monthly income (economic). First, the results of univariate analysis show that the distribution of respondents between men and women is almost even, namely 51.0% men and 49.0% women. Second, the average age of respondents is 46 years, with the youngest respondent being 21 years old and the oldest respondent being 66 years old. Third, the frequency of respondents based on education level shows that the majority of respondents have high school

education, namely 51.0%, followed by tertiary education 37.3%, and those who have elementary and junior high school education are evenly distributed, namely 5.9% each. Fourth, the distribution of respondents based on ethnicity shows that the majority of respondents are Javanese, namely 49.0%, followed by Sundanese 23.5%, Betawi 11.8%, and the rest are Batak, Padang, Manadonese and Chinese. Fifth, the frequency of respondents based on place of residence shows that the majority of respondents live in Jakarta, namely 58.8%, followed by Bogor 17.6%, and the rest live in Depok, Tangerang, Bekasi and outside these areas. Sixth, the frequency of respondents based on monthly economic income shows that the majority of respondents have a monthly income of 2-4 million per month, namely 51.0%, followed by income of 5-7 million and 1 million respectively at 13.7%, and the rest are those who earn 8-10 million and > 10 million. With data coordinated through the LEUMYLO TRACKER application, it makes it easier for researchers to carry out data analysis and follow-up plans with related patients.

3.2 Bivariate Analysis

The distribution of clinical responses based on respondents' compliance in taking medication as monitored through the LEUMYLO TRACKER application shows that of the 13 respondents who were non-compliant in taking medication, the majority of them had a poor clinical response, namely 76.9%, and those who had a clinical response good by 23.1%. Furthermore, of the 38 respondents who were compliant in taking medication, it was found that only 36.8% of respondents had a poor clinical response; the majority felt the clinical response was good, namely 63.2% (Table 2).

Table 2
Effect of Adherence to Taking Medication on Clinical Response in Patients with Chronic Myeloid Leukaemia at the Home Medical Haematology Oncology Clinic Sick Cipto Mangunkusumo in 2022

Medication Adherence	*Clinical Response*		Total	*P value*	*Odds Ratio (95% Certainty Index)*
	Not good n (%)	Good n (%)	N (%)		
Not obey	10 (76.9)	3 (23.1)	13 (100.0)	*0.029*	*2,768 (1.1-6.5)*
Obedient	14 (36.8)	24 (63.2)	38 (100.0)		
Amount	24 (50.0)	27 (50.0)	51 (100.0)		

The results of the "chi-square test" statistical test obtained a value of p = 0.029 (p-value < alpha 0.05); The decision taken was Ho rejected and Ha accepted, which means there is a significant relationship between compliance in taking medication and clinical response in Chronic Myeloid Leukaemia sufferers. The conclusion is that there is a difference in clinical response between those who adhere to taking medication and those who do not comply. The statistical test results show an Odds Ratio value = 5.714 (rounded to 6), which means that respondents who are not compliant in taking medication have the potential to experience a poor clinical response six times greater than respondents who are compliant in taking medication. Then, based on the data obtained through the LEUMYLO TRACKER application, the doctor can directly evaluate the patient and carry out follow-up actions to prevent the worst possibility from happening to the patient.

4. Discussion

The results of the analysis of the influence of medication adherence on clinical response in patients suffering from Chronic Myeloid Leukaemia at Cipto Mangunkusumo Hospital using the

LEUMYLO TRACKER application show that the p value = 0.029 (p-value < alpha 0.05), which means there is a significant relationship between adherence to taking medication. with clinical response in Chronic Myeloid Leukaemia sufferers (there are differences in clinical response between those who adhere to taking medication and those who do not comply) [10-12]. The results of this analysis show that respondents who are not compliant in taking medication have the potential to experience a poor clinical response six times greater than respondents who are compliant in taking medication.

The results of this study are in line with research conducted by Tanting Wang [13], which explains that regular consumption of medication can maintain the physical stability of Chronic Myeloid Leukaemia sufferers. Additionally, a study by Somarnam *et al.,* [14] analysed medical record data of adult Chronic Myeloid Leukaemia patients who sought treatment at the Haematology Oncology Internal Medicine Polyclinic at Dr. Saiful Anwar Malang who was diagnosed with Chronic Myeloid Leukaemia with BCR-ABL1 positive and in the chronic phase and received imatinib mesylate therapy for at least 12 months when data was taken to see the predictive value between Sokal score and Hasford score in Chronic Myeloid Leukaemia patients treated with imatinib mesylate [15-18] .

The results of this study show that respondents who regularly take medication tend to experience better clinical responses [19-21]. On the other hand, respondents who are non-compliant in taking medication tend to experience poor clinical responses [22]. The number of respondents who adhere to taking medication will have a significant impact on those who have a good clinical response. As in this data analysis, regarding the distribution of clinical responses based on respondents' compliance in taking medication, it was found that of the 13 respondents who were not compliant in taking medication, the majority of them experienced a poor clinical response, namely 76.9%, of the 38 respondents who were compliant. in taking medication, it was found that the majority felt the clinical response was good, namely 63.2%.

The previous theory stated that the occurrence of Chronic Myeloid Leukaemia was usually characterized by the accumulation of abnormal white blood cells in the bone marrow [23-25]. This abnormal number of cells can cause bone marrow failure, an increase in the number of circulating white blood cells, and infiltration of other organs. Common features of Leukaemia include abnormal white blood cells in the peripheral blood, increased total white blood cell count, and manifestations of bone marrow failure in, for example, the liver, spleen, lymph nodes, meninges, brain, skin, and testicles. Chronic Myeloid Leukaemia is a type of blood cancer that can be treated by taking medication [26-28]. However, patients must take medication for life even though they have undergone intensive treatment for 18 months. After 18 months, the drug should be handled properly every day and should not be stopped. If patients are not compliant with taking medication, there is a concern that resistance will occur, so they will have to switch to second-line drugs. If the medication they take does not provide an optimal response, then the treatment will not be successful [10,11].

Based on the explanation above, according to researchers, every Chronic Myeloid Leukaemia sufferer must comply/orderly take medication to prevent the potential for greater cell damage and speed up the healing process. Chronic Myeloid Leukaemia treatment must be carried out correctly according to the doctor's instructions, the long-time of taking medication (done for life) has the potential to result in boredom and forgetting to take medication in patients suffering from Chronic Myeloid Leukaemia[29,30]. If this occurs, it will impact resistance, and the clinical response will not be optimal. Compliance with taking medication is related to routine behaviour that patients must carry out during the therapy period. Patients who regularly take medication will get an optimal response, whereas for those who do not take medication it will cause resistance, as in research conducted by Lixiao Song [4], which confirms that there is a relationship between compliance in taking medication and recurrence rate in patients.

The patient has responsibility for his recovery. Therefore, the success of treatment is determined by the patient's compliance with all medical recommendations. Patient compliance is related to the patient's actions or behaviour in following medical procedures recommended by doctors/health workers. Patient compliance influences the success of treatment. As stated by Karen B. Farris [6], therapy results will only reach optimal levels with the patient's own awareness, which can even lead to therapy failure and cause detrimental and fatal complications.

Successful treatment of Chronic Myeloid Leukaemia requires the role of medical personnel. Medical personnel are responsible for educating patients in undergoing treatment at home. Patients need education and encouragement to know that they are willing and able to undergo treatment therapy according to applicable procedures. Patient compliance is the extent to which patient behaviour complies with the provisions given by health workers. The role of doctors and nurses will help the patient's healing process. The skills of doctors and nurses in caring for patients are very important so that patients comply with the treatment they are undergoing. Has the ability to increase compliance by creating written instructions about things to remember in everyday language and providing clear information about medication. Compliance is directly proportional to the goals achieved in the prescribed treatment program. Compliance is the ultimate goal achieved in a prescribed treatment program. The role of medical personnel can improve patient behaviour in undergoing medical therapy to speed up the healing process and prevent drug resistance [31,32].

In this study, the use of the LEUMYLO TRACKER application also played an important role in monitoring treatment compliance of Chronic Myeloid Leukaemia patients. The app helps patients record and remember their medication schedules, provides automatic reminders to take medication, and allows patients to complete questionnaires regarding their medication adherence. Data collected through this application provides valuable insight into patient compliance levels and its relationship to their clinical response [33-35]. By using LEUMYLO TRACKER, patients can more easily adhere to their prescribed treatment schedule, ultimately contributing to improving their clinical response. The app also provides real-time data that can be analysed by medical personnel to monitor treatment progress and provide necessary interventions on time.

5. Conclusions

Based on the research results and discussion in the previous paragraph, it can be concluded that the use of the LEUMYLO TRACKER application can coordinate the results of univariate investigations showing that of the 51 respondents studied, the majority of respondents had a good clinical response, namely 52.9%. Then in the compliance variable, it can be seen that the majority of respondents are compliant in taking medication, namely 74.5%, while 25.5% of other respondents are not compliant. The next conclusion is that there is an influence of treatment compliance on clinical response in Chronic Myeloid Leukaemia patients at Cipto Mangunkusumo Hospital, showing that the p value = 0.029 (p-value < alpha 0.05), which means there is a significant relationship between treatment compliance and clinical response and can be followed up directly via the LEUMYLO TRACKER application. In Chronic Myeloid Leukaemia patients (there is a difference in clinical response between those who adhere to taking medication and those who do not). These findings indicate that respondents who are non-compliant in taking medication have the potential to experience a poor clinical response six times greater than respondents who are compliant in taking medication. The benefit of the LEUMYLO TRACKER application in this study is very important, because this application helps monitor patient medication adherence by providing automatic reminders to take medication and recording their medication schedule. The app also allows patients to complete questionnaires regarding their medication adherence, which provides real-time data that can be

analysed by medical personnel to monitor treatment progress and provide necessary interventions in a timely manner. Thus, LEUMYLO TRACKER contributes significantly to improving patients' treatment compliance and, ultimately, their clinical response.

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