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Information System for Adherence Assessment of Tuberculosis Patients Connected with Smartphone

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Abstract: At present, the adherence of treatment activities for infectious diseases such as tuberculosis has resulted in poor clinical outcomes and ongoing infectivity. Directly Observed Treatment Shortcourse (DOTS) has now become the standard of care for monitoring Tuberculosis treatment, but this method has a number of limitations. At present, the use of conventional medication records systems is considered ineffective because it requires a long service time and large numbers of medical staff. This research proposes the method of developing information systems connected to smartphones to facilitate therapies observed remotely. This study developed a Swallowing Companion system integrated with telegram to provide medication reminders and facilitate taking photos of Tuberculosis drug consumption at a predetermined time every day, to be uploaded and then reviewed by medical personnel. Testing was carried out in public health services involving 17 respondents. Test results that have been validated by expert experts obtained a score of 61.5 (good), while the results of the validation of practitioners obtained a score of 64.5 (very good). The feasibility test results of the information system that was built using PSSUQ overall satisfaction has received a score of 85.28% (very feasible). The system test results show the significance value of 2-way (t-tailed) 0,000 <0.05 which means there are significant differences before and after the intervention of the information system that has been built. This study can be concluded that the information system that has been built is feasible, effective and easy to use as a self monitoring of tuberculosis patient adherence.

Keywords: adherence, tuberculosis, information systems, smartphone, self monitoring

I. INTRODUCTION

Tuberculosis is the leading cause of death from communicable diseases in the world, more than HIV / AIDS. Every year there are more than 10 million new Tuberculosis cases, of which 600,000 are caused by drug-resistant ARVs, which cause 1.6 million deaths. In 2016, the burden of Tuberculosis in Indonesia was ranked 2 in the world, in 2017 it was ranked 3 after China. While the burden of Indonesian Drug Resistant Tuberculosis is ranked 7th in the world after Nigeria. Tuberculosis was ranked 10th highest cause of death in the world in 2016. Tuberculosis is a health problem that must be addressed by the government. Therefore Tuberculosis is still a top priority in the world and is one of the goals in the SDGs (Sustainability Development Goals) program [1].

In the mid-1940s, Tuberculosis's clinical management was revolutionized with the introduction of antibiotic therapy. Because the initial antibiotics against Tuberculosis are given by injection in the hospital, Tuberculosis Treatment, by default, is monitored directly. But for now the anti-Tuberculosis treatment regimen is given orally which allows outpatient treatment, this is important especially after the cessation of sanatoria [2].

One of the causes of the high cases of pulmonary tuberculosis in Indonesia is the non-compliance of patients with pulmonary tuberculosis in treatment. Based on this, it is necessary to develop a model to improve compliance with pulmonary tuberculosis patients in their treatment. The initial step needed is to explore patient compliance based on the King Interaction System theory [3]. Pulmonary tuberculosis is an infectious disease which is still a problem, both in diagnosis and treatment. Pulmonary tuberculosis can be cured with Anti-Tuberculosis Drugs through the DOTS (Direct Observed Treatment Short-Course) strategy, but the success of pulmonary tuberculosis treatment is greatly influenced by many factors including the adherence (compliance) of patients, comorbid, smoking habits and including one of them namely nutritional status [4]. The most important thing in the treatment of tuberculosis is patient compliance in taking medication. The problem that often occurs is that patients often do not comply with the dosage and use of drugs that are required or there are also patients who stop taking drugs because they feel bored consuming in a prolonged period of time. Unwittingly, this can have a fatal impact on patients, namely the emergence of resistance to anti-tuberculosis drugs.

Synchronous video observation (S-VOT) and asynchronous (A-VOT) therapies have been carried out as health solutions for remote monitoring of drug consumption. This research synthesized the literature until December 2018 to describe the existing VOT approach, summarize evidence, identify knowledge gaps, evaluate the strengths and weaknesses of VOT, and examine patient and provider factors that influence the eligibility and acceptance of high levels of VOT adherence and patient acceptance still using the VOT method [5].

The factors that influence positive medication adherence and treatment success are largely self-motivation, awareness about the disease, motivational counseling, family support, nutrition and social support that encourage Tuberculosis treatment compliance [6]. Cases and controls do not know the symptoms and how to avoid Tuberculosis infection, which may cause delays in diagnosis. It is difficult to change current living conditions, thus, the regulation of the Tuberculosis community-based education program seems to be needed research [7].

Based on experiments that have been conducted, a knowledge-based system that was built using the CBR (Case-Based Reasoning) method is able to diagnose Tuberculosis well. The average accuracy of the system in diagnosing Tuberculosis in various conditions is worth around 85% and the highest accuracy rate of the system reaches 90%. This value is considered quite satisfying because it meets the minimum qualifications determined by WHO, and is able to achieve the average ability of doctors in Indonesia in diagnosing Tuberculosis [8]. Community mobilization showed a success rate of treatment reaching 92% compared to the previous one which was 71.77%. This study shows that mobilizing the field team community is an effective strategy to improve Tuberculosis treatment, reduce mortality and loss of visit to patients and improve Tuberculosis treatment outcomes [9].

Digital compliance technology can provide an acceptable alternative approach to monitoring Tuberculosis treatment, especially in places where DOT is difficult to implement. A study has shown the appropriateness, acceptance, and accuracy of compliance support and smartphone-based monitoring systems. This system has the potential to complement and support the administration of DOT for tuberculosis and also to improve adherence to other conditions such as HIV and hepatitis C [10].

II. METHODS

This type of research uses Research and Development with one group pretest-posttest experimental methods. The concrete steps in the research procedure developed are in the form of: (1) preliminary stage; (2) development stage; and (3) validation stage. Validity test is carried out by expert experts and practitioner experts. The study was conducted at Public Health Center in Semarang involving 17 respondents, where the respondent was an active drug companion swallowing TB patients. Questionnaire sheets are used to evaluate the quality of engineering, quality of media, and quality of education. While the instrument in the form of a test is used to determine the extent of the achievement of student learning outcomes before and after using this developed information system, named PEMOO.

A systematic smartphone application as a tool to monitor the adherence of Tuberculosis is needed to facilitate experts in monitoring compliance with taking Tuberculosis medication and can detect early non-compliance with taking medication so that experts can provide appropriate treatment. This is consistent with the research objective, which is to develop a smartphone-based system to facilitate therapies observed remotely. The flow of research on developing pulmonary TB information systems follows the stages in accordance with the FAST (Framework of the Application of Systems Thinking) methodology including: preliminary studies, problem analysis, needs analysis, decision analysis, design, system development stage, implementation stage and testing phase. After the respondent is given socialization about PEMOO and downloading Telegram, then the respondent is guided to download the PEMOO application. The data flow diagram of the system built is shown in Figure 1.

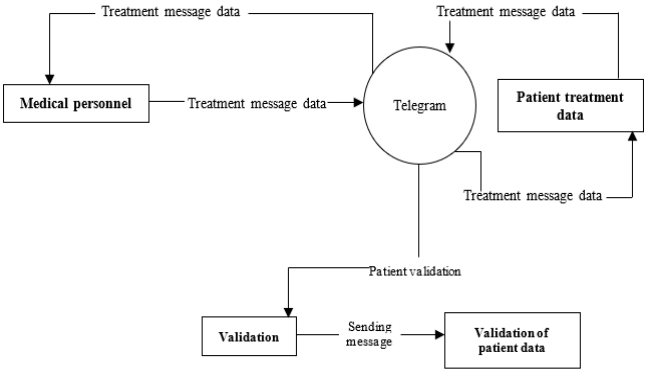

Figure 1. Flow chart of information system for using drug reminders online

III. RESULT AND DISCUSSION

This TB patient adherence information system device was developed using a smartphone that is integrated with the telegram application. The development of a smartphone-based TB patient adherence information system is called PEMOO. PEMOO is a bot on the telegram that can provide reminders to swallow drugs and analyze photos sent by PMO. The flow of research on the development of the pulmonary TB information system follows the stages in accordance with the FAST (Framework of the Application of Systems Thinking) methodology including: preliminary studies, problem analysis, needs analysis, decision analysis, design, system development stage, implementation stage and testing phase. After the respondent is given socialization about PEMOO and downloading Telegram, then the respondent is guided to download the PEMOO application. PEMOO software display shown in figure 2.

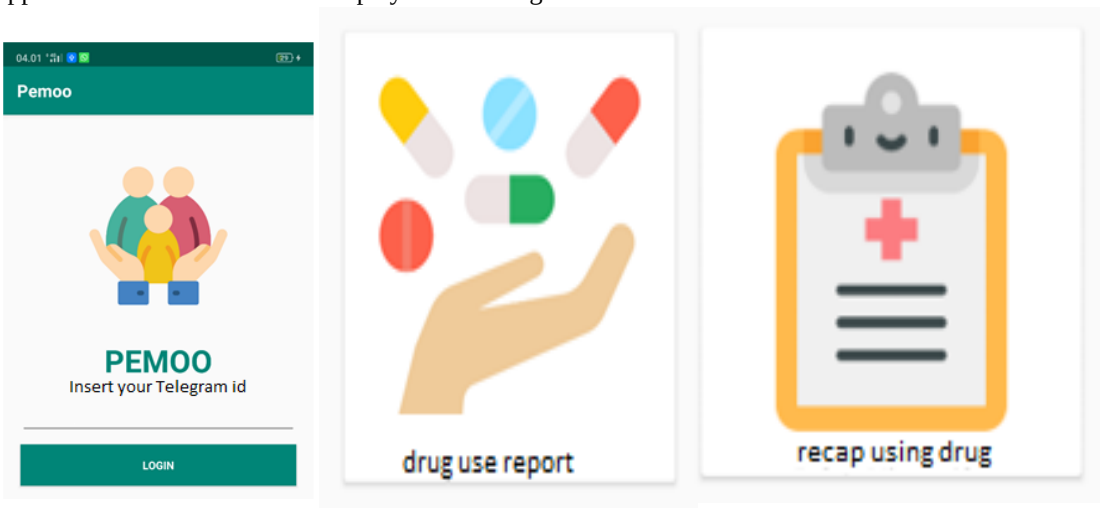

Figure 2. Information system for reminder the use of drugs online

Validity test from expert experts aims to determine the criteria of ease of access, readability and display quality, documentation quality, flexibility, and accuracy of the application-based information system model of patient adherence for TB patients. Based on the validity test results from expert experts, obtained an average score of validity worth 59 or in good criteria. The validity test of the practitioners aims to determine the criteria for planning, implementing, and evaluating the TB patient's adherence. Based on the results of the validity test of the practitioners, a score of 60 or within the criteria of either the main principle used as a measure of the success of the development of information systems (SI) or software (PL) is usability. The usability level determines whether the system will be useful, user accepted and last long in its use. A system with high usability will make the system popular for a long time and wide use because many people will feel the benefits. And vice versa, systems with low usability, are often ultimately ignored by users even though they are made based on needs and consume less resources.

Measuring usability is to find out how the system can complete user tasks properly. According to ISO 9421-11 that a good standard of usability is effective, efficient and satisfaction. It is clear that it is better as a

user to do effectively (race on results), efficiently (race on the way) and satisfaction (get satisfaction) [11]. In this study to measure the success of system development using the PSSUQ questionnaire package (Post Study System Usability Questionnaire) that can be used to measure usability. PSSUQ is a research instrument developed for use in evaluating usability at IBM. PSSUQ is used to assess user satisfaction based on usability aspects by grouping into four categories namely, usefulness system (SYSUSE), information quality (INFOQUAL, interface quality (INTERQUAL) and overall satisfaction (OVERALL).

The trial on the SYSUSE variable aims to measure the level of user eligibility after the pulmonary TB adherence information system is tested. The results obtained score of 81.12%, the usefulness system information system adherence of pulmonary TB patients is included in the very feasible category. In the INFOQUAL variable, it aims to assess the appropriateness of system information by users after the system is tested. The results obtained were 87.17%, then the information quality of the immunization information system was included in the very feasible category.

Trials were conducted on 17 respondents who were already trained. The results before being given a system trial, get an average score of 19.06. Then the score increased to 48.41, after being tested on an application-based TB patient adherence system. This shows that there was an increase before and after the trial of an application-based TB patient adherence system. The results of the pre-test and post-test system values are shown in table 1. The results of the system trial are shown in table 2.

Table 1. Results of the pre-test and post-test system values

	N	Mean	SD	Min	Max
Pre-test	17	19.06	1.638	16	22
Post-test	17	48.41	4.199	42	54

Table 2. System test results

	N	Correlation	Sig.	Sig (2-tailed)
Pre-test & Post-test	17	.169	.517	0,000

The results of the system trial show the significance value of 2-way (t-tailed) 0,000 <0.05, this shows that there are significant differences before and after the trial of an application-based TB patient adherence system in Semarang City. In a Spanish study language barriers were not associated with worse adherence. We believe that providing information written in language can increase understanding of the importance of TB disease and its treatment. Non-adherence was associated with births abroad (p = 0.048) and family of foreign origin p = 0.001), but language barriers were not statistically significant as a factor of non-compliance [13]. Telegram text in PEMOO uses simple language that is easy to understand, so users have no difficulty in operating it.

Digital Adherence Technologies (DAT) or digital compliance technology including telephone and smartphone-based features, digital pillboxes, and digestible sensors can facilitate a more patient-centered approach to monitoring compliance, even though the available data is limited. In specific technology, DAT can help remind patients to take medication, facilitate digital observation of pill making, compile dosage history and arrange triage of patients based on their level of adherence, which can facilitate the provision of individualized care by TB programs for patients with varying degrees of risk [12]. There are many free instant messages available now that allow people to communicate with friends by text, phone calls, videos, by sharing files, in groups or not, and to maintain contact with them even internationally. But only a few of the instant message senders gained popularity and recognition Recent studies have shown that the most popular instant message senders are WhatsApp, Viber and Telegram. Facebook acquired WhatsApp because of the huge number of users. Viber is another messenger with many integrated features that allows for phone calls and sending text messages for free, and like WhatsApp there is no subscription, while Telegram offers users a free open-source platform without ads, a clean interface, and (the biggest selling point) security . So, which instant message is the best? Telegram is currently the most downloaded messaging application on the Google Play Store. But at this time WhatsApp is still a winner [13].

Mobile Direct Observation Treatment (MDOT) is technically feasible. Both patients and health professionals are empowered by the ability to communicate with each other, receive MDOT remotely and health messages via mobile. Further research must be conducted to evaluate whether MDOT increases TB treatment compliance, which is cost effective, can be used to improve treatment compliance for other diseases such as AIDS [14]. Technology reduces the waiting time for TB patients to be diagnosed by developing machine learning techniques and new health technologies. Cellular technology has the potential to reduce the burden of TB by providing cellular computing and techniques and communication tools for better diagnosis, treatment and prevention in marginalized communities [15].

IV. CONCLUSION

Based on the results of research and discussion, it can be concluded that the smartphone-based patient Tuberculosis adherence information system that is developed is tailored to the needs of users, is feasible, effective and efficient is used as a self-monitoring of Tuberculosis patient adherence. The application-based Tuberculosis patient adherence information system has a name that is PEMOO and can be accessed by anyone who needs it. The validity test of the application-based Tuberculosis patient adherence system application developed was stated by both expert experts and practitioners. The OVERALL recapitulation results for the application-based Tuberculosis patient adherence information system developed as a whole get a score of 85.28%, which means that overall satisfaction of the information system for the patient's Tuberculosis Adherence is very feasible. The application-based Tuberculosis patient adherence information system has a significance value of 2-way (t-tailed) 0,000 <0.05 which means there are significant differences before and after PEMOO intervention.

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