Monitoring medication adherence using smart digital technology in patients with pulmonary tuberculosis

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Abstract

Pulmonary tuberculosis cases can arise due to various factors, including treatment fatigue resulting from prolonged therapy, insufficient patient knowledge about the condition, geographical distance between patients' residences and healthcare facilities, a lack of reminders from healthcare workers regarding medication adherence, and the perception that treatment provided at community health centers may be inadequate. This study aimed to investigate the effectiveness of digital smart applications in enhancing medication adherence among pulmonary tuberculosis patients. Utilizing a trial survey approach, the research focused on patients seeking treatment at the Surabaya Community Health Center. Smart digital applications were employed to monitor medication adherence, with patients inputting their data *via* cell phones. The study recorded data over one month and found that while some patients struggled to operationalize the smart digital application, many were able to utilize it effectively. Overall, the findings suggest that smart digital applications can be valuable tools for monitoring medication adherence among pulmonary tuberculosis patients, particularly for older adults.

Introduction

Tuberculosis (TB) remains a significant global health challenge, particularly prevalent in developing countries.[1,2] Factors contributing to the high number of TB cases include treatment fatigue resulting from prolonged therapy,[3] inadequate patient knowledge about pulmonary TB,[4,5] geographical barriers to accessing healthcare facilities, a lack of reminders from healthcare providers regarding treatment adherence,[6] and perceptions of treatment quality at community health centers.[7,8] These factors can lead to treatment non-adherence among TB patients.[9,10]

The compliance of TB patients with their treatment regimen plays a pivotal role in the management of the disease.[11] Studies have shown that non-adherence to treatment increases the risk of TB recurrence by about 2.5 times, highlighting challenges from medical, immunological, and psychological perspectives.[12] Treatment non-adherence contributes to a higher rate of treatment failure among pulmonary TB patients and exacerbates the burden of TB within communities.[13]

Factors influencing adherence to pulmonary TB medication include understanding of the treatment instructions,[14] quality of interactions with healthcare providers, family support, personal beliefs, attitudes, and personality traits.[15] Additionally, the lengthy and rigorous treatment regimen for pulmonary TB, spanning 6-8 months, poses another significant challenge.[16]

To enhance compliance with TB treatment, the use of directly observed treatment (DOT) by drug supervisors has been implemented.[17] However, traditional DOT methods have not effectively addressed TB management challenges.[18] Therefore, there is a need for innovative approaches to drug supervision, such as utilizing electronic and communication media to directly monitor drug intake by patients in the presence of healthcare workers. While health education and telenursing have been utilized to increase

knowledge among individuals with pulmonary TB,[19] they have not fully addressed long-term drug adherence challenges. In order to ensure sustained drug adherence over the entire treatment duration, which typically spans at least 6 months, the development and implementation of smart digital applications for TB patients are essential.[19,20]

Previous studies have examined the use of digital smart applications for assessing medication adherence in various settings.[21,22] However, these studies did not reveal the knowledge, attitudes, and behaviors of TB patients. This study aimed to specifically analyze the use of digital smart applications for controlling drug adherence in pulmonary TB patients.

Materials and Methods

Design and sample

This study employed a trial survey approach utilizing digital smart applications to monitor medication adherence. It was conducted at a community health center in Surabaya, targeting TB patients who regularly seek treatment there each month. Initially, there were eleven patients identified at the health center and its branches in the area. However, after coordination and collaboration with the TB program team, it was found that three patients had already been declared cured. Subsequently, the study focused on the remaining nine pulmonary TB patients who possessed digital media in the form of cell phones. Data collection commenced from May to August 2023, beginning with the assessment of respondents' behaviors (knowledge, attitudes, and actions) related to medication intake and adherence.

Instruments

The methods used to measure adherence, including patient self-reports, pill counts, refill levels, biological monitoring, and electronic monitoring, have their limitations, particularly concerning reminder sounds displayed on digital smart devices. The reports displayed typically rely on patients' personal data, memory, and medication schedules provided by the treating doctor. Although the name and quantity of the medication are recorded, they are not always factored into the data analysis and processing. Reminder sounds are programmed to alert patients at the same time each day, but some respondents may not be sensitive to these reminders, leading to instances where medications are not taken as prescribed. All data entered into the smart digital system is recorded for one month, from the 1st to the 31st of August. Monitoring medication intake through digital smart devices includes recording patient names, ages, the names of the medications taken, and the quantity of medications consumed through electronic monitoring.

Medication adherence behavior was assessed based on two indicators: adherence and non-adherence. Adherence is recorded if there is consistent charging on the smart digital device for one consecutive month. Each respondent's cell phone was equipped with a digital smart application called Pamio TB. Following installation, researchers provided detailed explanations of the mechanism and operation of the Pamio TB smart digital application to the respondents.

Development of adherence to taking medications

Some methods aim to improve medication adherence among patients with pulmonary TB. However, this study specifically focuses on the implementation of a digital smart application called Pamio TB (short for "compliant to taking TB medicine"). This application includes an alarm that sounds every day at 7 a.m., reminding respondents to take their medication. When using the digital smart application, respondents input their identity, the name of the drug, and the quantity of medication taken. Additionally, the application features a questionnaire designed to assess the knowledge, attitudes, and actions of individuals with pulmonary TB. Knowledge levels are categorized as high, medium, or low, while attitudes and actions are assessed using similar indicators.

Habit of reminding

In patients with pulmonary TB, the medication-taking process requires attention from both healthcare workers and family members. Often, a family member serves as a medication supervisor to ensure adherence. However, the use of digital smart applications can potentially reduce the need for this role. When it is time to take medication, the alarm in the digital smart app will ring, prompting the respondent to press a button on their cell phone. This alarm serves as a reminder for individuals with pulmonary TB to take their medication, thus minimizing their reliance on external supervision.

Analysis

Utilizing a digital smartphone application represents a novel approach to enhancing medication adherence among individuals with pulmonary TB. This application offers constant accessibility, actively engages patients, and serves as a repository for pertinent medication adherence-related information. With the presence of alarms on patients' smartphones, reminders to take medication are automatic, eliminating the need for family members to prompt medication intake.

By employing digital smart applications for monitoring medication adherence in pulmonary TB patients, there is a shift towards a more patient-centered approach. This transition highlights the potential value of such applications as effective tools for monitoring medication adherence, reducing reliance on external supervisors, and empowering individuals with pulmonary TB to take charge of their treatment regimen.

Table 1. Attributes and ratings of the five apps that were installed and subjected to user testing.

Application name	Online data entry	Complex instruction	Cloud data storage	Database of medication	Multiplatform app	Final record data	Final posting record	iPhone
My med schedule Pamio TB	X	X	X	X	X	1	4	X
MyMeds	X		X	X	X	2	4	X
Med Agenda		X	X	X	X	3	5	X
Remid Me Prescription		X			X	4	4	X
Med Memory				X	X	5	4	X

Results and Discussion

The discussion on medication adherence among patients with pulmonary TB encompasses various aspects, drawing insights from existing literature and research findings. However, in this paper, the authors focus on areas related to improving drug adherence through digital smart applications to improve medication adherence and reduce the risk of anti-TB drug withdrawal.

Developing a digital smart application to monitor medication intake aims to prevent patients from discontinuing their anti-TB drugs.[21] This app ensures adherence to medication schedules and minimizes confusion, particularly among elderly patients. Therefore, this paper introduces a smart digital application designed to monitor adherence to TB treatment in patients with pulmonary TB.[21] The proposed application features audible alerts from the patient's mobile alarm set for specific times.

Table 1 shows a multidisciplinary approach aimed at establishing a medication adherence monitoring system using an effective and reliable digital smart application. The integration of Internet of Things and wireless body area networks represents a significant advancement in healthcare, particularly for patients with pulmonary TB, enhancing the quality of healthcare services and the overall quality of life for these individuals.[23] Essentially, smart digital applications facilitate healthcare services by facilitating the collection, aggregation, transmission, and analysis of medical data.[24]

This digital smart application proposes a design for monitoring medication adherence in patients with pulmonary TB, with implementation trials planned for 2023. The implementation of this application is intended to address the concerns of caregivers, ensuring the security of full treatment. Through automatic reminders, the application will prompt patients at the correct time for medication intake, minimizing the risk of errors in dosage and medication type.

Conclusions

This study proposes and implements smart digital applications to monitor medication adherence in elderly patients with pulmonary TB, providing significant assistance. The smart digital application automatically prompts patients at the onset of pulmonary TB, reminding them of the timing for medication intake. This feature is particularly beneficial for elderly patients, ensuring they remember to take their medicine on time.

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