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Serial Monitoring of Blood Glucose Using the AisyCare_GulaMU Application for the T2DM Back-Referral Program

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ABSTRACT

T2DM is a major problem in health services in Indonesia through the NHI system. The determination of back-referrals frequently presents a contentious issue between BPJS-FKTP and FKTL. The AisyCare-GulaMU application is an Android-based tool designed for the IT-based monitoring of blood glucose levels in T2DM patients who are PRB. The research was performed on a retrospective cohort of NHI patients diagnosed with T2DM in an outpatient setting during the initial six months of 2025 with pre and post analysis glucose profile. There are significant reduction in blood glucose serial monitoring 1st to 2nd month (p=0.002), 2nd to 3rd month (p=0.027) and hba1c after third month treatment (p=0.000). There also significant blood glucose(p=0.002) and hba1c (p=0.000) for group back referral and not to refer. The AisyCare-GulaMU application enables the assessment of patients' blood sugar levels on a monthly basis, facilitating the determination of subsequent service directions. The AisyCare-GulaMU application allows for effective monitoring of T2DM patients' treatment progress, enabling BRP to operate efficiently.

KEYWORDS:

Type 2 Diabetes Mellitus, Blood Glucose, Back-Referral Program, Monitoring, Application

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INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is one of the most prevalent chronic diseases and a significant financial burden on Indonesia's National Health Insurance (NHI) system. The Social Security Organizing Body for Health, or Badan Penyelenggara Jaminan Sosial (BPJS) Kesehatan, reported an increase in T2DM patients year after year.[1,2] The prevalence of diabetes in Indonesia in 1990 was 2593 per 100,000 population, while in 2019 it was 5943 per 100,000 population.[3] Diabetes mellitus ranks fifth in Disability-Adjusted Life Years (DALYs), or the largest measure of disease burden in Indonesia. Additionally, diabetes mellitus is also the leading cause of death, behind stroke and ischemic heart disease. [1,4,5]

Amidst the global diabetes incident, which is projected to continue increasing, a study in Indonesia indicated that the type of health insurance membership can influence the severity of Type 2

Diabetes Mellitus (T2DM). [6] Furthermore, it was found that using BPJS Kesehatan in T2DM patients could reduce the severity of the disease due to easier access to healthcare and a fairly complete availability of T2DM medication in the national formulary (Fornas). [6,7]

Type 2 diabetes mellitus also requires comprehensive management from First Level Health Facilities (FKTP) to Advanced Healthcare Facilities (FKTL).[6] [More than 1000 patients visit FKTL per month, especially at RSI Aisyiyah Malang, which has served over 2000 T2DM patients per month with various complications.

The Back-Referral Program (BRP) or *Program Rujuk Balik (PRB)* is a program by BPJS kesehatan for stable T2DM patients to continue their therapy at FKTP. [1,8] This program often sparks discussions about the stable criteria needed for patients to continue their therapy at FKTP after back-referral from FKTL. Researchers have developed worldwide IT-based diabetic management systems that connect patients with healthcare providers to facilitate blood glucose monitoring. Findings from various studies utilizing the Real World Database indicate that this IT application helps regulate blood glucose levels in T2DM patients, reduces potential complications, and improves the overall quality of care for these patients. [9–18] However, this application has not been significantly developed in Indonesia to integrate with the PRB program for T2DM patients.

This article aims to present an easier method for monitoring blood glucose levels in T2DM patients at RSI Aisyiyah Malang using the AisyCare-GulaMU application. The monitoring results will be presented in graphical form to track the progress of T2DM patients' treatment at RSI Aisyiyah Malang. The AisyCare-GulaMU application attempts to be an intuitive and transparent monitoring tool for determining the Back-Referral Program (BRP) for T2DM patients.

METHODS

We developed an Android-based AisyCare-GulaMU application that can be downloaded for free on patients' phones to monitor the development of T2DM patients' blood sugar levels during treatment at RSI Aisyiyah Malang. The results are presented as graphs to visualize the patient's treatment progress. The research involved a retrospective cohort of BPJS T2DM patients who were outpatients over the last 6 months. During this period, their treatment was assessed using this application. The AisyCare-GulaMu application was introduced and discussed with outpatient diabetes mellitus patients and their family members in August 2025 at the Internal Medicine Polyclinic of RSI Aisyiyah Malang. Education on how to use the application is provided directly to patients and accompanying family members. The research data was collected from patients' medical records from the previous six

months and subsequently inputted into the application to monitor blood glucose and HbA1c

levels. This data is used to determine patient eligibility for the Back Referral Program (BRP). Based on their educational characteristics, the majority of patients have completed their last level of education at Senior High School (SMA).

Table 1. Characteristics of Patients with T2DM Included in The Aisycare-GulaMu Application

Characteristic		Number
Gender	Male	12
	Female	18
Age	<50 years old	4
	51-60 years old	10
	61-70 years old	10
	>70 years old	6
Long Treatment	<1 year	16
	1-2 years	13
	>2 years	1

(Source : Bagus, 2025)

We used Jamovi version 2.3.2.1 and SPSS version 24 to analyze the data. We tested the normality of the data, and then we performed a pre and post analysis using t-test for normally distributed data and a Mann-Whitney or Kruskal-Wallis for data that was not normally distributed.

RESULT AND DISCUSSION

Over the past six months, we attempted to include 30 patients with type 2 diabetes mellitus from the outpatient department of the internal medicine at RSI Aisyiyah Malang.

The study included a total of 12 males and 18 females, with four patients under 50 years old, 10 patients aged 51–60 years old, 10 patients aged 61–70 years old, and six patients over 70 years old. Sixteen patients had been treated for less than 1 year, 13 patients for 1–2 years, and one patient for over 1 year. The characteristics of the patients involved in this study are presented in Table 1.

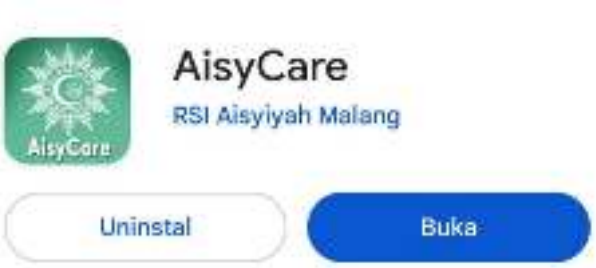

Figure 1. Aisycare Application in the App Store and the GulaMu Feature in The Aisycare Application

Figure 2. An illustration of A Patient's Progress Toward Treatment Objectives Using the Aisycare-GulaMu Application (RBG < 180 mg/dl and or HbA1c ≤ 6.5

The graph below shows the progress of our patient

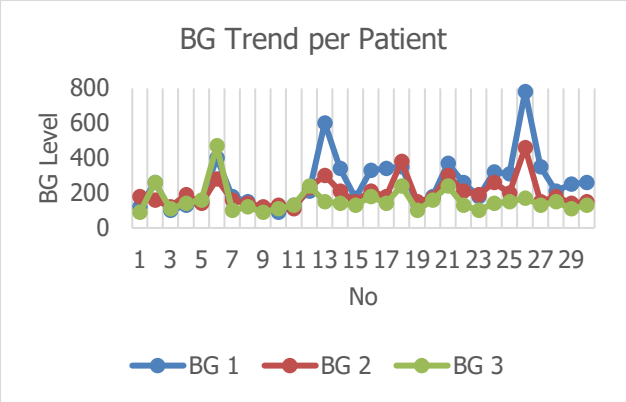

Figure 3. The Progression of Randomised Blood Glucose Levels in T2DM Patients

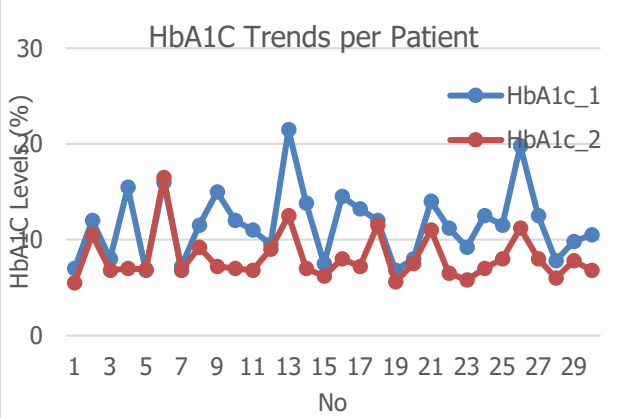

Figure 4. The Progression of the HbA1c Levels in T2DM Patients

Table 2. The Results of Monitoring T2DM Patients were Included in The AisyCare-GulaMu Application

Monitoring		N
Blood Glucose	≤180 mg/dl	24
	>180 mg/dl	6
Hba1c	≤6.5	14
	>6.5	16
Back-Referral Program	Yes	15
	No	15

Table 3. Pre and Post Analysis Glucose Profile T2DM Patients Recorded in The AisyCare-GulaMu Application

		Mean (SD)	pValue pre and post analysis	pValue per group back referral program
Blood Glucose	1st month	255.87 (±153.43)	1st to 2nd month (p=0.002)*	p=0.002**
	2nd month	195.77 ((±184.01)	2nd to 3rd month (p=0.027)*	
	3rd month	158.20 ((±176.32)		
Hba1c	First	11.57 (±3.89)	1st to 3rd month (p=0.000)*	p=0.000**
	After third month	7.76 (±2.51)	0.000	Significant

* pValue paired T-Test
**pValue T-test

The results above indicated that all patients using the AisyCare-GulaMU application showed a trend of improvement in their random blood glucose and HbA1c levels. A total of 50% of the patients (n = 15) were enrolled in a back-referral program. Among these, 14 patients achieved an HbA1c target of ≤ 6.5, while 24 patients reached a random blood glucose level of ≤ 180 mg/dl (see Table 2).

Comparative analysis show that significant reduction blood glucose from first to second month (p=0.002), and second to third month (p=0.027), and also HbA1c first to third month (p=0.000). Between group refer and no to refere, there alson significant different blood glucose (p=0.002) and hba1c (p=0.000)(see Table 3, Figure 3, and Figure 4).

Mobile phone-based management of T2DM patients has been extensively developed in numerous countries globally. A study by Gosak et al. demonstrated that mobile apps influence the public's understanding of the risks associated with poorly managed T2DM. Moreover, mobile applications assist patients in understanding their blood glucose patterns and effectively managing their diet, medication, and medical consultations, thereby

optimizing associated costs. The intuitive and interactive interface of these mobile applications is essential to their efficacy for T2DM patients. [19–21]

The Aisycare-GulaMu application offers a clear visualization of random blood sugar trends and HbA1c levels, enabling patients to monitor their treatment progress.

Studies in Italy conducted through the TELEMECHRON Study show that mobile apps enhance the management of blood sugar levels in patients with T2DM. These apps offer benefits such as easy access to medications, streamlined communication with specialist doctors, and improved access to healthcare facilities. The TELEMECHRON study combines mobile app data with input from healthcare professionals, healthcare facilities, the Ministry of Health, and health insurance agencies in Italy, enabling the formulation of efficient and effective policies for advancing T2DM patient treatment. [22,23] The Italian study indicated that the application did not significantly lower glycemic profiles, which was the main clinical outcome. The application, however, offered numerous benefits beyond medical outcomes, such as enhancing patient satisfaction and facilitating communication between patients and providers. The application may also be useful for gathering data in a systematic way to help assess health services and make policy decisions based on facts. These findings indicate that, even in the absence of direct clinical enhancement, digital health applications can significantly benefit healthcare systems by improving services and facilitating informed decision-making.

A study conducted in China showed that the target for referring T2DM patients from hospitals to lower-level facilities or healthcare provider-based practices is based on the patients' blood glucose profile and complications. Healthcare facilities, where providers possess the expertise to manage specific issues, treat T2DM patients with complications. These facilities are equipped with essential medications and resources, which include rehabilitation services and radiographic facilities for early detection of complications. Patients unable to pick up their T2DM medication can visit the nearest healthcare facility, provided they have a prescription from the FKTL. When medication is available, the FKTP will subsequently communicate with the advanced-level healthcare facility to arrange for the medication to be dispatched to the FKTP via an integrated mobile application system. [24–26] The primary advantage of the AisyCare-GulaMu app in this study is not its direct impact on reducing blood glucose levels, but rather its facilitation of clinical data management, systematic patient monitoring, and care coordination within the Back Referral Program (PRB). The application allows for the longitudinal display of blood glucose and HbA1c data, assisting healthcare providers in evaluating patients' responses to pharmacological therapy

during routine outpatient visits. This approach may enhance the quality of clinical decision-making and the implementation of PRB, although glycemic improvement among PRB patients is generally achievable through standard pharmacological management without the use of the application.

The policy in Indonesia regarding the back-referral program for T2DM patients has not yet targeted specific treatment goals, ensured continuity in the treatment of T2DM patients, or fostered effective communication among patients, FKTP, FKTL, BPJS, and the Ministry of Health. The back-referral program follows the BPJS policy, which states that patients who have been on the same prescription for three months and are in stable condition qualify for PRB. The Aisycare-GulaMu application can at least provide an overview of treatment trends dan indicate that referred patients have achieved therapeutic targets (blood glucose ≤180 mg/dl and HbA1c ≤ 6.5) at a rate of 50%, thereby enabling data to be supplied to BPJS and FKTP regarding the continuity of T2DM patient treatment and monitoring of their progress.

The Aisycare-GulaMu application can provide an overview of treatment trends and indicate that referred patients have achieved therapeutic targets (blood glucose ≤ and HbA1c ≤ 6.5) at a rate of 50%, thereby facilitating the provision of data to BPJS and FKTP concerning the continuity of T2DM patient treatment and the monitoring of their progress.

CONCLUSION

The AisyCare-GulaMu application facilitates effective monitoring of treatment outcomes for patients with Type 2 Diabetes Mellitus, resulting in clearer therapy targets, as demonstrated by significant reductions in HbA1c levels.

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