Develop and Usable a Warfarin Mobile App with no-Code and Free: New Case Drug Management

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Abstract

Objectives: 1. To develop a medication tracking and patient care system through a no-code mobile application. 2. To promote medication adherence among patients. 3. To assess patient satisfaction with the mobile application.

Methods: This study was conducted among new warfarin users in the internal medicine and stroke wards at Sawanpracharak Hospital between July and August 2023. Patients were divided into two groups, each comprising 30 participants. The control group received standard medication counseling from pharmacists, while the experimental group received the same counseling plus medication tracking via the mobile application. Follow-up was conducted twice, to evaluate INR values, medication adherence, and application satisfaction.

Results: In the control group, the percentage of patients with INR values within the target range at the two follow-ups was 26.67% and 33.33%, respectively. In the experimental group, it was 90.00% and 96.67%, respectively. No severe adverse events were reported in either group. The experimental group had a lower INR variance than the control group (0.08 vs. 2.69, respectively). Chi-square testing showed that patients in the experimental group were significantly more likely to have INR values within the target range than those in the control group (p-value<0.05). Application satisfaction was rated as good, with scores exceeding 4.0 out of 5.0 across all categories. The findings suggest that mobile applications improved medication adherence and helped patients achieve target INR values from the first follow-up.

Conclusion: The no-code mobile application developed in this study effectively tracked warfarin use and represents a new option for individuals without a technology background who wish to create practical tools.

Keywords: Warfarin, Mobile Application, No-Code, Thunkable, Medication Adherence

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Introduction

Warfarin is a widely used anticoagulant, particularly in patients with cardiovascular diseases such as atrial fibrillation (AF), deep vein thrombosis (DVT), and pulmonary embolism (PE). However, warfarin has a narrow therapeutic index and a high risk of adverse effects, especially bleeding, if not used appropriately. Regular monitoring of the international normalized ratio (INR) and timely administration of medication are crucial for the effectiveness and safety of treatment. A study by Pisters et al. (2010)[1] reported that maintaining the INR within the target range (Time in Therapeutic Range: TTR) ≥ 65% is significantly associated with a reduced incidence of ischemic stroke and bleeding events in patients with AF. The American College of Cardiology/ American Heart Association (ACC/AHA Guidelines, 2019)[2] recommends frequent INR monitoring every four weeks or more in cases of new warfarin initiation or unstable INR, emphasizing the importance of patient education on proper medication use. Furthermore, a study by Heneghan et al. (2016)[3] found that using technology, such as mobile applications for medication reminders and INR recording, can improve medication adherence and reduce complications arising from poor INR control.

Nonadherence to medical recommendations or

forgetting to take medication is a common issue, especially in older adults, who often face multiple risk factors such as memory decline, polypharmacy, and a lack of understanding about treatment. These issues can negatively impact medication adherence and treatment effectiveness, potentially leading to adverse clinical outcomes. Research by Lam WY and Fresco P. (2015)[4] summarized adherence measurement methods, including subjective (self-reported questionnaires) and objective (medication-taking records and laboratory test results) approaches, highlighting that adherence levels are significantly associated with clinical outcomes across various diseases. Additionally, Kini & Ho (2018)[5] found that mobile applications for medication reminders and adherence support can improve medication adherence rates by up to 17% compared to control groups. Therefore, developing a mobile application with functions for medication reminders, tracking, and data recording presents a promising strategy to enhance adherence, especially when it can be designed and developed using no-code tools such as Thunkable, which reduces budgetary and technical barriers.

This study aims to

1. To develop a medication tracking and patient care system through a no-code mobile application.
2. To promote medication adherence among patients.
3. To assess patient satisfaction with the mobile application.

Methods

Study Design

This was a quasi-experimental study approved by the Human Research Ethics Committee of Sawanpracharak Hospital in 2023 under the approval number COA.34/2566.

Population and Sample

The population comprised newly prescribed warfarin patients admitted to the internal medicine and stroke wards at Sawanpracharak Hospital. The sample consisted of patients meeting the inclusion criteria: those with atrial fibrillation (AF), deep vein thrombosis (DVT), and pulmonary embolism (PE) with a target INR range of 2.0–3.0. Sixty patients were purposively selected and divided into two groups of 30 each. The significance level was set at p-value< 0.05 with a statistical power of 80%, based on the sample size calculation from the study by Shrestha et al. (2023)[6].

Inclusion Criteria

1. Newly prescribed warfarin patients
2. Ownership of an Android smartphone
3. Willingness to participate in the study

Exclusion Criteria

1. No smartphone ownership
2. Inability to use the application
3. Failure to maintain medication history records

Research Instruments

1. An online medication-tracking mobile application (M-App) was developed using the Thunkable no-code platform.
2. A patient satisfaction questionnaire (5-point Likert scale) for the M-App
3. A data recording form for newly prescribed warfarin patients (including INR levels, medication history, etc.)

Mobile Application Development

The mobile application was developed using Thunkable, a no-code platform that allows for drag-and-drop visual programming without requiring coding skills. Thunkable is accessible via web browsers and compatible with Android and iOS systems. Data privacy and secure integration with free online spreadsheet platforms like Google Sheets were prioritized.

The no-code development process with Thunkable involved the following steps

1. Registration and login at thunkable.com
2. Creation of a new project by selecting “Create New App.”
3. Designing the user interface (UI) by dragging and dropping components such as buttons, texts, and images
4. Setting up application logic using blocks to determine actions (e.g., notifications, data recording, automatic uploads to spreadsheets)
5. Testing the application using the Thunkable Live App
6. Exporting the application as an .apk file for Android deployment (iOS deployment incurs additional costs)

Thunkable’s ease of use makes it an ideal platform for quickly developing mobile applications without requiring technical coding expertise.

Application Implementation in Patient Care

The mobile application was introduced at the initiation of warfarin therapy. Pharmacists provided comprehensive instructions, including installation, user account setup, and security features. A demonstration of core features was conducted, covering medication reminders, medication intake logging (automatically sent to caregivers via online spreadsheets), INR recording, and educational resources on warfarin and dietary interactions based on the Heart Association of Thailand[13] guidelines. Patients could access this information conveniently anywhere, supporting continuous and appropriate medication adherence (Figure 5).

Study Procedure

Participants were allocated into two groups

- Control group: Standard care
- Intervention group: Standard care plus the M-App mobile application

The study followed up participants twice between July and August 2023.

Study Procedure Steps

1. Preparation of pharmacists and research team, including a literature review and adaptation of tools with technological innovation, developing mobile applications for medication tracking and online patient care.
2. Selection of newly prescribed warfarin patients admitted to the internal medicine wards using defined inclusion and exclusion criteria.
3. First follow-up per physician appointment: Researchers monitored research progress, documented observations, and addressed emerging issues.
4. Second follow-up per physician appointment: Researchers continued monitoring and summarizing outcomes and challenges.
5. Assessment of patient satisfaction with the application using a structured questionnaire.
6. Statistical analysis of research data and final report preparation aligned with the study objectives for dissemination.

Pharmacist-Delivered Warfarin Counseling (Standard Care)

1. Screening of new warfarin patients using the Trigger Tool Screening IPD program.
2. Warfarin education and/or review for patients/caregivers during hospitalization or before discharge.
3. Issuing a patient-specific warfarin record booklet and documenting Pharmacist Notes in the HOSxP program, including start date and indications.
4. Recording patient profiles in the Warfarin Registry Network (www.crhospital.org/warn) for comprehensive access by pharmacists and relevant hospitals.
5. INR baseline monitoring in the patient's record booklet during hospitalization.
6. Evaluation of INR and investigation of factors (medication adherence, drug interactions, adverse reactions).
7. Coordination with patients and healthcare providers if medication/food/behavioral issues arise.
8. Upon discharge, review medication history, treatment plans, and physician follow-up instructions; resolve issues before dispensing.
9. Dispensing medications with counseling on new doses, including calendar-based warfarin dosing, for some patients to improve adherence.
10. The patient's booklet records the final INR assessment, dosage documentation, and follow-up appointments.

Data Analysis

Descriptive statistics (percentages, means, standard deviations) were used. Comparisons of INR levels and patient satisfaction were conducted using t-tests and chi-square tests, with p-values < 0.05 considered statistically significant.

Results

A total of 60 patients were equally divided into two groups: the control group, which received standard pharmacist-led warfarin counseling, and the intervention group, which received the same counseling along with the mobile medication adherence application (M-App). The mean ages of the control and intervention groups were similar, at 61.6 and 63.7 years, respectively. In the control group, the proportion of patients achieving target INR values (2.0–3.0) was 26.7% at the first follow-up and 33.3% at the second follow-up. In contrast, the intervention group showed target INR achievement rates of 90.0% and 96.7% at the first and second follow-ups, respectively.

Table 1 General characteristics, underlying diseases, and INR values of newly prescribed warfarin patients in the control and intervention groups.

Topic	Control group	M-app group
Number of patients (n)	30	30
Average age (year)	61.6	63.7
Maximum age (year)	84	91
Minimum age (year)	19	26
Diagnosis		
Atrial Fibrillation: AF	18	16
Deep Vein Thrombosis: DVT	9	8
Pulmonary Embolism: PE	3	6
Number of patients with target INR (2.0–3.0)		
Before Implementation	0 (0 percent)	0 (0 percent)
First Follow-up	8 (26.7 percent)	27 (90.0 percent)
Second Follow-up	10 (33.3 percent)	29 (96.7 percent)

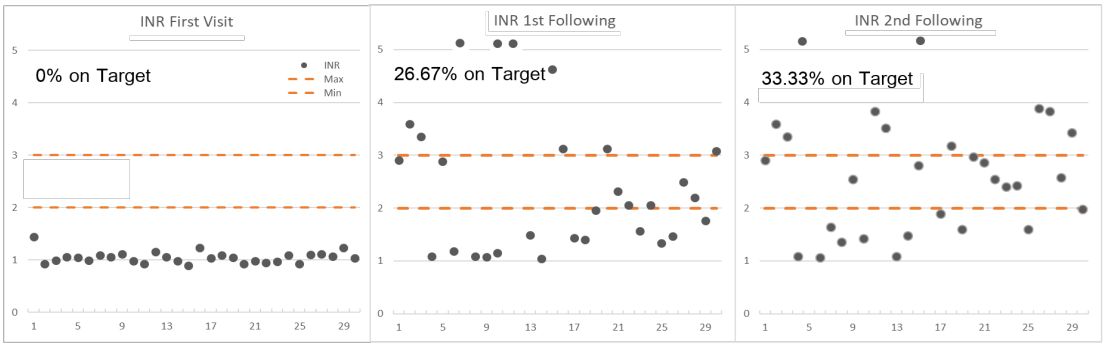

Figure 1 INR values of individual patients in the control group at the first and second follow-ups.

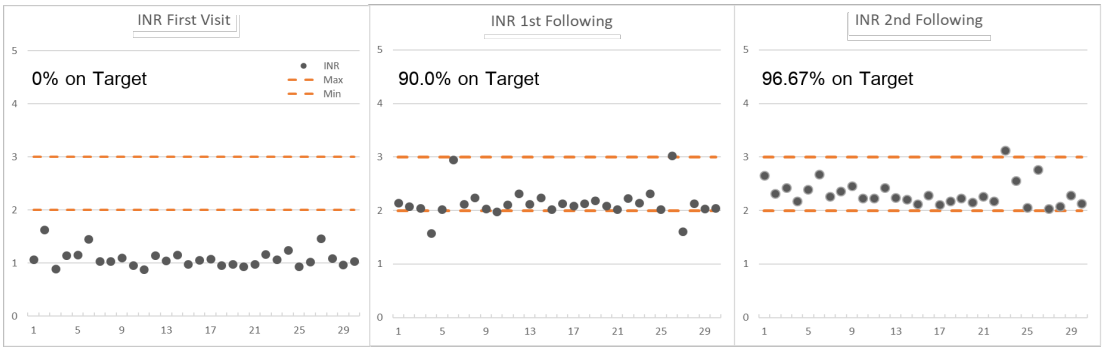

Figure 2 INR values of individual patients in the mobile application user group at the first and second follow-ups.

The average INR values for the control and experimental groups were 2.08±1.37 and 2.25±0.07, respectively. T-test analysis showed no statistically significant difference between the groups (*p*-value=0.14). However, the variance of INR in the experimental group was lower than that in the control group, with variance values of 0.08 and 2.69, respectively. Chi-square analysis examining the relationship between the use of the M-app in the experimental group and the control group showed that a significantly greater number of patients in the experimental group had INR values within the target range (*p*-value<0.05).

The satisfaction with using the mobile application in the experimental group was high, with average scores in all categories above 4.0 (out of a maximum score of 5.0). Satisfaction was evaluated in four aspects: content, design and notification layout, practical usefulness, and system security (Table 2). Notably, the system security aspect achieved the highest possible score of 5.0 in all items, indicating that the application is practical and meets users' needs.

Table 2 Satisfaction assessment results of 30 patients using the M-app application

Aspect of Assessment	Mean ± SD
Content	
1.1 Clarity, accuracy, and completeness	4.91 ± 0.29
1.2 Relevance and alignment with user needs	4.48 ± 0.71
1.3 Appropriateness of content volume	4.82 ± 0.39
1.4 Organized content, easy to search and understand	4.58 ± 0.66
1.5 Credibility and practical usefulness	4.88 ± 0.33
Design and Notification Layout	
2.1 Aesthetic appeal and appropriateness	4.15 ± 0.87
2.2 Easy-to-read and user-friendly layout	4.58 ± 0.50
2.3 Notification system works well and is easy to use	4.76 ± 0.44
2.4 Application usefulness	4.94 ±0.24
2.5 Easy installation	4.48 ± 0.51
Practical benefits	
3.1 Tool to support medication adherence	4.85 ± 0.36
3.2 Helps avoid prohibited foods	4.85 ± 0.36
3.3 Useful for learning about medications	4.82 ± 0.39
System Security	
4.1 Secure data access	5.00 ± 0.00
4.2 Registration and permission-only access	5.00 ± 0.00
4.3 Privacy and data protection	5.00 ± 0.00

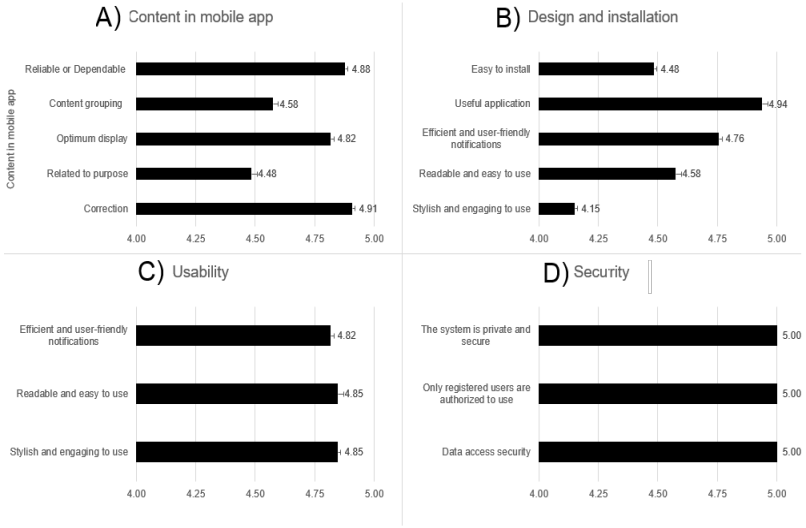

Figure 3 Satisfaction evaluation results from 30 patients using the M-app mobile application in various aspects: content (A), design and notification layout (B), practical benefits (C), and system security (D).

The development of a medication tracking and patient care system via a no-code mobile application demonstrated its effectiveness in enhancing medication adherence. The study found that in the experimental group using the mobile application with a medication reminder system, 90.00% and 96.67% of patients achieved target INR levels at the first and second follow-ups, respectively. Compared to the control group, the experimental group had a significantly higher proportion of patients within the target INR range (p-value< 0.05). Moreover, patient satisfaction with the app was high in all areas. The work has been endorsed for application within healthcare systems and was recognized for its practical benefits by the Health Center 2, Phitsanulok, on December 12, 2024.

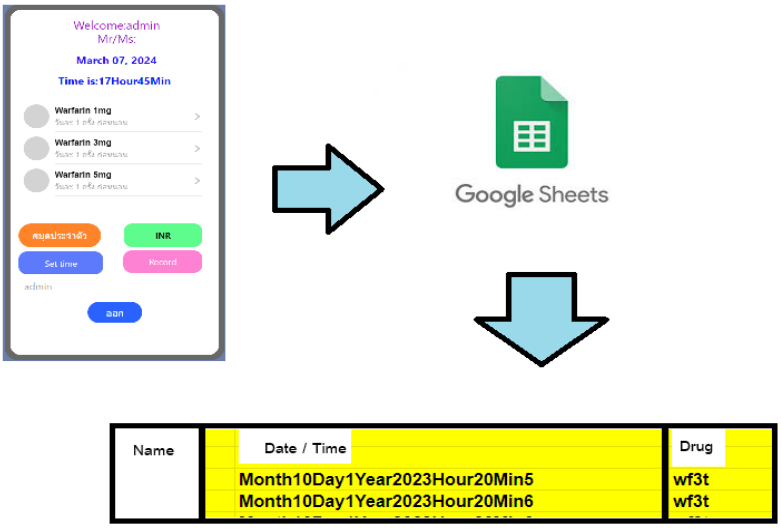

Figure 4 QR code linking to the online medication tracking application (M-App).

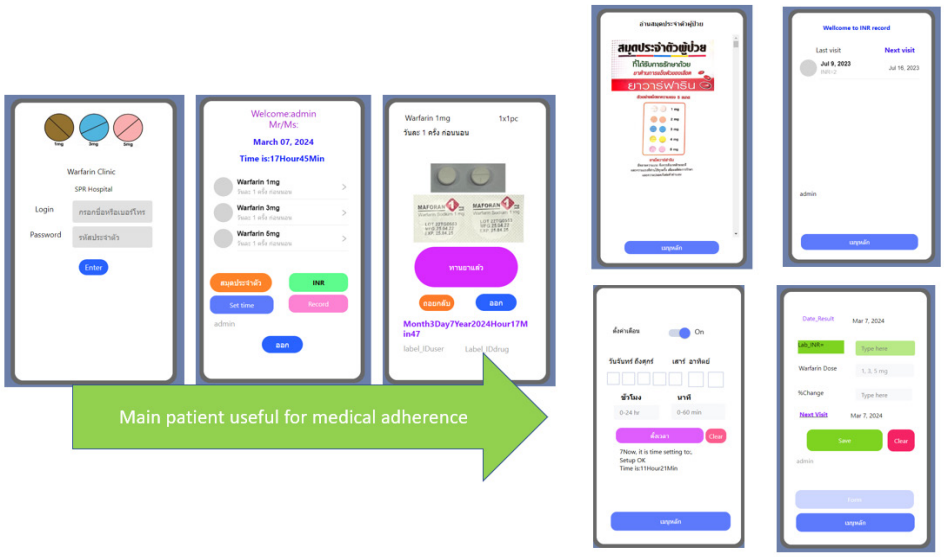

Figure 5 The M-app mobile application for home use by patients, starting with login and password screens. After successful login, the main menu appears, featuring core functions such as following medical advice starting with warfarin, providing educational information about warfarin, displaying INR test results, setting medication reminders, and recording INR levels when visiting the hospital.

Discussion

This study demonstrates that a mobile application developed with no-code tools has the potential to enhance the care of patients taking warfarin, particularly in monitoring treatment outcomes and promoting medication adherence. Patients in the experimental group had significantly higher INR target range achievement than the control group, consistent with studies by Shrestha et al. (2023)6 and Saffian et al. (2021)[7], which highlighted the role of mHealth (mobile health) in improving adherence among cardiac patients.

Similarly, Lee et al. (2014)[8] reported that older adults have a positive attitude toward mHealth if the technology is user-friendly and compatible with their lifestyle, which is consistent with this study's high satisfaction levels among elderly patients. Gurol-Urganci et al. (2013)[9] noted that mobile reminders reduce missed appointments and improve treatment continuity, aligning with mHealth's role in promoting adherence and ongoing care. Labovitz et al. (2017)[10] proposed AI applications for predicting nonadherence behavior, reinforcing the idea that digital health tools can evolve from "tracking" to "predicting and preventing." Sunderji et al. (2013)[11] supported the use of point-of-care INR testing, aligning with encouraging patient involvement in self-management as in this study. Merone et al. (2021)[12] also underscored mobile apps' potential to monitor and advise on health, emphasizing the need for continuous quality control and clinical evaluation.

All these studies reflect that mHealth tools not only "remind" or "track" but also foster healthy behaviors and patient engagement in chronic disease management, such as heart disease, or for patients on anticoagulation therapy, where patient participation and adherence are crucial for health outcomes.

Notably, this study found that although the average INR values did not differ significantly between groups, the experimental group had lower INR variability, indicating more consistent medication use and more stable clinical outcomes. Furthermore, patient satisfaction was high in all aspects, especially in ease of use and the usefulness of medication reminders, addressing challenges like forgetfulness among older adults.

Limitations

However, this study had limitations: a short follow-up period and the app's compatibility only with Android devices, limiting broader generalizability. Future studies should consider expanding target populations, extending the study duration, and assessing other outcomes such as quality of life or healthcare cost burdens.

Recommendations

1. Continuous development of the application: The app should be updated to support other operating systems (e.g., iOS) and incorporate data linkage with electronic medical records to enable broader, integrated use.
2. Expansion to other chronic diseases: The app should be adapted for use in other chronic conditions like diabetes, hypertension, or dyslipidemia to improve medication adherence and clinical outcomes.
3. Long-term follow-up studies: Further studies should assess the app's effectiveness and clinical outcomes over extended periods, including impacts on quality of life and complications.
4. User training and support: Developing systematic user manuals or video tutorials for patients and caregivers and providing healthcare personnel training will support sustained and practical use.

Conclusion

This study demonstrates that a mobile application developed with no-code tools for tracking and managing patients taking warfarin has the potential to improve adherence to medical instructions, enhance medication compliance, and enable patients to achieve target INR ranges significantly better than those without the app. Patients also reported high satisfaction with content, usability, security, and design, especially older adults requiring ongoing medication. This approach can be effectively extended to other chronic diseases and represents an example of integrating technology into health services, offering a model adaptable to different contexts or hospitals without requiring substantial resources, as no advanced coding skills or high costs are needed.

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