ORIGINAL ARTICLE

Smartphone apps to improve compliance: The Sathyan Eye Care Hospital and Coimbatore Glaucoma Foundation and Eye Drop Reminder Lite

Prasanna Venkatesh Ramesh[1], Sathyan Parthasarathi[2], Padma Sathyan[3]

[1]Medical Officer, Department of Glaucoma and Research, Mahathma Eye Hospital Private Limited, Trichy, [2]Director, [3]Senior Medical Officer, Department of Medical Retina, Sathyan Eye Care Hospital and Coimbatore Glaucoma Foundation, Coimbatore, Tamil Nadu, India

Abstract

Aim: The study aimed to develop a smartphone-based app to improve compliance and adherence to glaucoma medications.

Methods: Two smartphone apps were developed on iOS and Android platforms. The complete app, Eye Drop Reminder App is an integrated app, which is hospital-based and used only for registered patients. The Lite version, Eye Drop Reminder Lite, is an offline reminder app that can be used by anybody. An overall report about the compliance of all patients to anti-glaucoma medications is arrived at by an inbuilt feature in the two apps. The apps include features to schedule appointments, refill prescriptions, store documents and photos, medication reports, history, and a contact us section.

Results: The Eye Drop Reminder App has been downloaded and used by 100+ patients and the Eye Drop Reminder Lite by 500+ patients.

Conclusion: Smartphone-based apps are supplements that may help patients improve compliance and adherence to glaucoma management strategies. Their role in the management of glaucoma and improving compliance has to be evaluated further.

Introduction

Glaucoma is the second leading cause of blindness worldwide.[1] An estimated 64.3 million people were affected with glaucoma worldwide in the year 2013 and the prevalence is expected to increase to 76.0 million by 2020 and 111.8 million by 2040.[2] The prevalence of PACG and POAG in India is 2.54 million and 6.48 million, respectively.[3,4] One of the major challenges in glaucoma management is poor compliance with treatment.[1] Nearly 50% of the patients do not adhere to their medication over 75% of the time.[5] Non-compliance to glaucoma treatment is a risk factor for progressive visual field loss.[6,7] Causes of poor compliance include forgetfulness (30%), other priorities (11%), lack of information (9%), and emotional factors (7%).[8,9] If once-daily medication lasts only 24 h and the patient misses one dose per week, then 6 weeks of therapy are missed per year.[1] If the patient misses two doses per week, then 12 weeks of therapy per year are missed.

Poor medication adherence costs around 100 billion dollars a year and it is the reason for approximately 33–69% of medication-related hospitalizations.[8] Compliance and adherence may be enhanced by notifying the patient through telecommunication by means of a reminder app. Smartphone apps are a novel approach to improving patient adherence and behavior. Hence, two smartphone apps were developed to improve compliance with medication in persons with glaucoma and this study reports on the features of these two smartphone apps.

Methods

The apps, named Eye Drop Reminder App and Eye Drop Reminder Lite, were developed on both iOS and Android platforms. These apps, offered free of charge, serve as invaluable tools in the health-care landscape. The Eye Drop Reminder App is a hospital-based integrated app and used exclusively for registered patients. The

patient activity and follow-up can be monitored from the hospital as the hospital server is connected to the database of each individual. The app includes a plethora of dynamic features including reminders for eye drops [Figure 1], attachment capabilities for records and images (My attachments) [Figure 2], My charts, medication reports, appointment scheduling feature [Figure 3], document appointment history, reorder medicine [Figure 4], post-operative order documentation, and discharge summary. The app facilitates seamless communication with profile settings and a "Contact Us" section, demonstrating a commitment to technological sophistication and patient engagement in health-care delivery.

The "My Attachments" feature is used to attach patients' medical records such as visual fields, optical coherence tomography pictures, fundus pictures, photographs of prescribed medications, images of prescriptions, and other pertinent details. This attachment functionality enables patients to autonomously upload their records by utilizing either their device's camera or gallery.
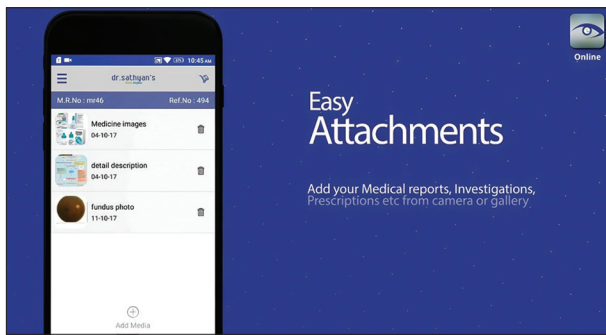

Figure 1: Snapshot of the "My Attachments" section of the Eye Drop Reminder Lite App. Patients can upload medical records, prescription images, and other vital documents directly from their camera or gallery, enhancing comprehensive glaucoma care
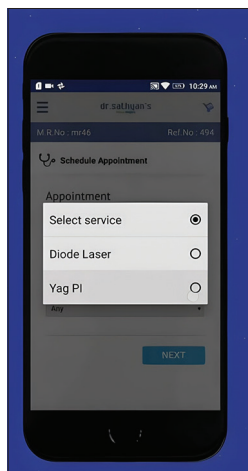

Figure 2: Snapshot of the "Schedule Appointments" feature in the Eye Drop Reminder Lite app. Users can conveniently fix appointments, consult with specific doctors, and even schedule glaucoma procedures, fostering seamless communication between patients and healthcare providers

With the "My charts" feature users can meticulously document multiple medications employed for glaucoma management. This includes the initiation date, application times, and cessation date of eye drops. Notably, the application of each drop is graphically visualized over varying periods – ranging from days to years – offering valuable insights into the patient's medication adherence over the long term.
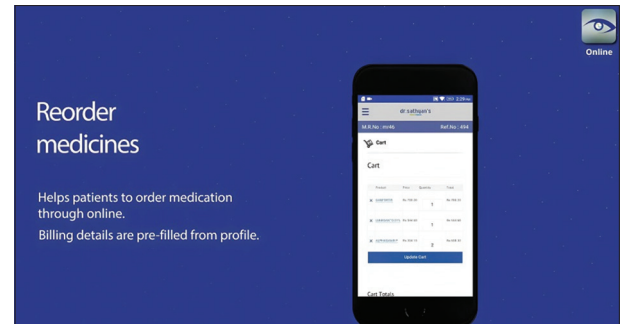
Figure 3: Snapshot of the "Reorder Medicines" feature, demonstrating the convenience of online medicine orders through the Eye Drop Reminder Lite App. Billing details are effortlessly pre-filled from the patient's profile, ensuring a hassle-free medication replenishment process
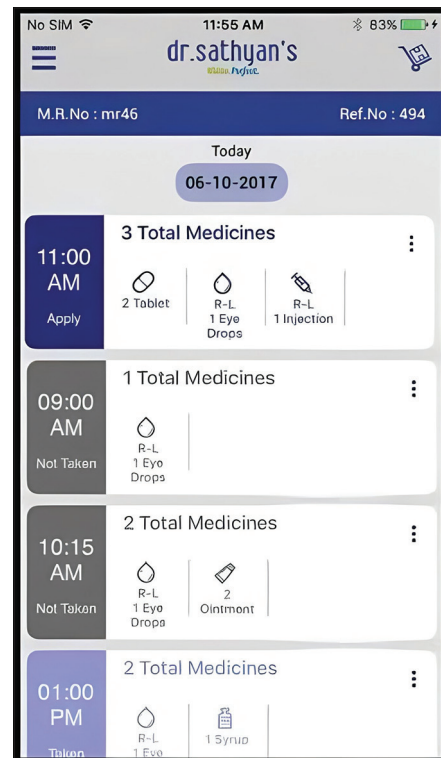
Figure 4: Snapshot of the "Reminders" feature, highlighting the eye-drop reminder in the Eye Drop Reminder Lite App. This crucial tool aids in timely medication adherence, preventing missed doses and contributing to the overall improvement in patient compliance with glaucoma management strategies

The "Medication reports" feature aids in generating insightful reports on drug usage. For example, this feature provides information on whether eye drops were applied, the time of application, and whether the reminder alarm was snoozed, offering a nuanced understanding of the patient's medication habits.

The "Schedule appointments" feature aids users in effortlessly scheduling consultations with specific doctors at preferred dates and times, from any location. Similarly, appointments can be efficiently scheduled for any glaucoma procedures such as YAG PI, for any specific date and time, based on the availability of the relevant doctor.

The "History" feature offers a comprehensive repository of critical information, encompassing drug order history, doctor appointment records, and discharge summaries. The discharge summary is seamlessly transmitted from the hospital server to the mobile interface.

The "Reorder Medicines" feature allows users to conveniently order medications online, with the added convenience of doorstep delivery. Billing details are intelligently pre-filled from the user's profile, ensuring a seamless and efficient ordering process.

Eye drop reminder lite

In addition to the integrated app, an offline app Eye Drop Reminder Lite was also created. This user-friendly reminder app is available to everyone at no cost, requiring no data connectivity. In addition to serving as a reminder tool, it also enables users to efficiently manage prescription details and medication reports.

Overall report

Both the reminder app incorporates an embedded feature that facilitates an overarching assessment of patient compliance with anti-glaucoma medications. Individual reports of each patient and overall reports of all patients will be generated and can be viewed both by the patient and at the hospital server with the Eye Drop Reminder App. Individual reports will be generated and can be viewed only by the individual with the Eye Drop Reminder Lite.

Contact us

The patients can reach out to us at any point in time through the "Contact Us" feature in the app. Their queries will be answered as soon as possible.

Results

The apps were recently launched in smartphone app stores. To date, the Sathyan Eye Care and Coimbatore Glaucoma Foundation app has 100+ downloads, and Eye Drop Reminder Lite has 500+ downloads. So far, users who downloaded the apps have utilized all features corresponding to the downloaded app version. There have been no crashes or bugs identified to date and the app is now being rolled out to a larger audience.

Discussion

Popular compliance apps that are available include MangoHealth and Pillboxie, Memotext, Medisafe Pill Reminder and Medication Tracker, AlarMeds, MyEyeDrops, MyMedSchedule, MyMeds, and RxmindMe. When comparing the above-mentioned medication reminder apps for eye care, each offers distinct features catering to diverse user preferences and needs. MangoHealth stands out with its gamification approach, rewarding users for adherence. Pillboxie, designed exclusively for iPhone users, provides straightforward medication reminders with images. Memotext demonstrates effectiveness in behavior alteration, utilizing text or voice reminders on smartphones. Medisafe, available on both iOS and Android, excels in functionality, involving family members in the reminder process. AlarMeds, exclusive to Android, offers extensive customization options in both free and advanced versions. The Wills Eye Glaucoma App combines eye drop reminders with educational content, appointment alerts, and data storage. MyEyeDrops, developed by the Singapore National Eye Centre, integrates reminder alarms, instructional videos, and caregiver alerts. Users may consider platform compatibility, gamification elements, customization, family involvement, and cost when selecting an app that best suits their preferences and enhances medication adherence for eye care. These apps are predominantly straightforward medication reminder systems with or without gaming principles.[10] These applications predominantly serve as straightforward medication reminder systems, some incorporating gamification principles to enhance user engagement. However, the Eye Drop Reminder App stands out prominently with its groundbreaking approach as an integrated hospital-based platform exclusively designed for registered patients. Diverging from the typical functionalities of other apps, the Eye Drop Reminder App empowers hospitals to actively monitor patient activities and conduct follow-ups by leveraging a connected server intricately linked to the patient database. Intriguingly, to date, no ophthalmologist has directly utilized this system to influence patient behavior, highlighting the uniqueness of this hospital-centric approach. The Eye Drop Reminder App's distinctive model represents a paradigm shift in patient care and compliance, departing from the conventional methods employed by its counterparts. By providing a novel perspective on healthcare, it introduces an innovative approach to the management of glaucoma services. This visionary approach is not only patient-centric but also extends its reach by harnessing the power of mobile technology. In conjunction with the Eye Drop Reminder Lite, the Eye Drop Reminder App endeavors to offer comprehensive glaucoma services, contributing significantly to the enhancement of overall health outcomes. A particularly noteworthy feature is the two-way communication facilitated by smartphones, allowing seamless interaction with patients at their convenience. Smartphones, with their user-friendly interfaces, transcend geographical and temporal constraints, making them an ideal medium for fostering patient engagement. Their ease of use further ensures widespread accessibility, offering a versatile solution that accommodates various patient needs. In essence, the Eye Drop

Reminder App not only redefines the landscape of medication reminders but also pioneers a holistic and technologically advanced approach to patient care in the realm of glaucoma services. Smartphones are easy to use with few limitations in terms of geography or time.[10] Smartphones are increasingly popular even in developing countries like India. For a population of 1.3 billion, there are 1.8 billion mobile phones with 92.03 connections per 100 citizens in India.[11] However, a major barrier to the use of smartphones or mobile apps is the cost. Even if the app is priced relatively low like USD 3.00, people are not willing to pay it for a health app.[12] Although there are now more than 1,65,000 mobile health apps, only 272 health apps are medication reminder apps. [13] Out of this limited pool of 272 apps, only 109 apps are offered free of charge and a mere 33 apps are available on both the Google Play and iTunes app stores.[14] Our decision to provide these apps at no cost to patients aims to encourage widespread usage, driven by the recognition that reminder technologies have demonstrated a substantial enhancement in medication adherence, with improvements reaching up to 40 percent.[10] These two glaucoma apps are readily accessible on the Google Play and iTunes App stores, contributing to their accessibility and potential impact on improving medication adherence in individuals dealing with this condition. The assessment of the relative desirability or utility of features within these applications is to be conducted using a three-point system established by Dayer *et al.* [Table 1], where ratings range are 1 (modest), 2 (moderate), and 3 (high). This particular rating system serves as a valuable tool for ultimately ranking the applications based on the features claimed by their respective manufacturers.[15] This study asserts that both apps encompass

various attributes identified by Dayer *et al*. These include features such as online data entry, intricate medication instructions, cloud data storage, synchronization, export, and printing of medication databases, monitoring of both missed and taken doses, capability for provider data input, compatibility across multiple platforms, availability in free-only versions, generation of reminders even without connectivity (exclusive to Eye Drop Reminder Lite), capacity for multiple profiles, and multilingual support.

Monitoring overlooked medication doses and exporting relevant data are crucial functionalities for evaluating adherence. Remarkably, a mere 29.4% of applications encompassed the former, while an even smaller fraction, standing at 24.4%, offered the latter.[13] The Eye Drop Reminder Lite and Eye Drop Reminder App stand out for their dynamic execution of these pivotal features, ensuring an enhanced and efficient user experience. The support provided by platforms, such as the Google Play Store for Android and the Apple App Store for iOS, ensures the functionality, accessibility, and user satisfaction of healthcare applications. This support facilitates regular updates, bug fixes, and compatibility adjustments, ensuring that the applications remain technologically up-to-date and aligned with evolving smartphone ecosystems. The "contact us" feature provided within both applications allows users to reach out to us, enabling us to provide technical assistance, security measures, and adherence to evolving industry standards based on customer feedback. Regular updates are instrumental not only in enhancing the overall user experience but also in addressing potential security vulnerabilities, thereby fostering a sense of reliability among users. This includes addressing user feedback and streamlining the apps' performance on diverse devices.

Table 1: Ranking system for attributes of the app features in points scale[13]

Attribute	Points	Description
Online data entry	3	App had companion website(s) that allow data and medication regimen entry from a computer.
Complex medication instructions	3	App had the capability to schedule medication instructions (including medication dose administrations that occurred daily, monthly, or medications with stop dates) that were considered complex.
Cloud data storage	3	App had the capability to back up and retrieve a medication regimen from a cloud storage system.
Database of medications	3	A medication database was available that allowed the user to enter, search, and select medications.
Sync/export/print data	3	App had the capability to transmit, print, or export medication regimens and/or medication-taking behaviors for use by the patient or healthcare providers.
Tracks missed and taken doses	3	App had the capability to remind the patients to take their medication and record taken and missed doses that could potentially be used to calculate adherence rates.
Provider data input capable	3	App allows providers to input and maintain the patient's medication regimen and "push" the regimen to the patient's device.
Multiple platform app	3	App was available on more than one platform. (No apps were identified that were available on all two operating systems [iOS and Android).
Free-only apps	2	App was completely free (that is, no fees for pro upgrades or charges to unlock additional features).
Generates reminders with no connectivity	2	App had the capability to generate medication reminders without the use of cellular (3G/4G/LTE) or wireless (Wi-Fi) connectivity.
Multiple profiles capable	2	App had the capability to generate medication reminders for multiple individuals on different medications (that is, enabled family use).
Multilingual	1	App was available in English plus any other language.

Conclusion

Smartphone applications show great promise as valuable tools within the realm of glaucoma management, as indicated by existing research.[16-18] As the landscape of mobile technology continues to evolve, these healthcare applications become increasingly vital in ensuring the sustained effectiveness of digital health solutions. It is crucial to recognize, however, that these applications are intended to augment adherence to established therapeutic regimens. Their precise contribution to glaucoma management requires thorough exploration in future investigations. Currently, we are in the process of designing additional studies to assess the user-friendliness of these apps among individuals with glaucoma, while also identifying any potential limitations and avenues for improvement in the application's functionality.

Declaration of Patient Consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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