A Smartphone Application for Monitoring Postoperative Symptoms and Signs with an Instant Bi-Direction Feedback System in Patients after Cataract Surgery

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Abstract

Purpose: Outpatient postoperative periodic visits still lack information for the early detection of patients with initial infection or other serious conditions after cataract surgeries. We developed and accessed a postoperative care smartphone application (PC app) for patients to self-record and report postoperative symptoms/signs with an instant bidirectional feedback system.

Methods: The PC app alerted the patient to report and grade six ocular symptoms/signs associated with endophthalmitis or retinal detachment. Patients used the PC app for 7 days postoperatively to assess their symptoms/signs 4 times a day after receiving an alert. The data automatically collected using a cloud computer system judged the grade and sent messages to medical staff for further medical assistance. User information and satisfaction were collected from the questionnaire on the 7th day.

Results: 50 patients participated. There were two reports of symptom grade deterioration (increased photopsia and fever) in two patients. 81% of patients were satisfied or very satisfied to communicate their symptoms instantly with the app, 86% reported the app to be helpful, and 81% opined to use it again. While, 79% of patients considered the PC app to improve the quality of postoperative care, 86% found it helpful for seeking medical assistance. Critical themes included less willingness to look at smartphones after eye surgery, lack of a footnote area, and the need for more medical education.

Conclusion:

This novel PC app for self-reporting of postoperative symptoms and instant bidirectional feedback system could be useful for cataract patients. It was perceived to be satisfactory and user-friendly.

Introduction

Cataract is an eye disease that occurs with aging, and a leading cause of blindness worldwide.¹ As per a World Health Organization report, 64% of countries have set targets for the cataract surgical rate in their plan.²

Vision impairment due to cataract is treatable. When cataract affects visual function, or when it causes secondary ocular complications such as glaucoma or uveitis, surgery is the major treatment option. A combination of new and improved technologies, have established cataract surgery as the most successful clinical treatment in medicine, which directly improves vision, thereby facilitating daily activities, as well as reducing mortality.^{3, 4}

Though 95% of patients who undergo cataract surgery are likely to have improved vision, complications after surgery are possible. Rare but serious postoperative complications include endophthalmitis and retinal detachment; the incidence of which are approximately 0.05–0.24% and 0.36–2.9% respectively.^{5, 6} These two conditions are associated with certain ocular signs and symptoms that include redness, tenderness, blurred vision, floaters, photopsia, or visual field defects. Because most patients receive

cataract surgery in the outpatient setting, the interval during the follow-up visits might delay the golden time for treatment. Therefore, the development of early detection and reference systems is important.

The current COVID-19 pandemic has largely accelerated the demand for telehealth solutions to reduce the risk of infection.^{7,8} When office visits are not feasible or practical, remote patient monitoring may help facilitate access to professional and cost-effective medical health care. This feature has contributed to the rise of telemedicine.⁹ It would be desirable that the solutions for monitoring patients remotely be user friendly.¹⁰

In this study, we assessed the usability and feasibility of a Postoperative Care smartphone application (PC app, HornChang Culture & Technology Co., Kaohsiung, Taiwan) for assisting patients who underwent cataract surgery. The application periodically prompted patients self-record/report postoperative symptoms/signs and was equipped to send responses through a cloud-based feedback system to medical staff for bi-directional feedback.

Methods

This prospective cohort study was conducted at the Kaohsiung Chang-Gung Memorial Hospital, Taiwan. The study adhered to the Declaration of Helsinki and was approved by the Institutional Review Board (IRB)/Ethics committee of Chang-Gung Memorial Hospital. The informed consent was obtained from all subjects.

The prototype application named as the Postoperative Care application (PC app) was developed for the Android and iOS operating systems. The patients could avail the application free of charge on their smartphones. During the study, the application was securely connected to the data server of the cloud computer server according to the standards of privacy protection mandated by the Taiwan Personal Data Protection Law.

Participants and recruitment

Patients undergoing outpatient cataract surgery and possessing a smartphone with an Android or iOS operating system were considered as eligible participants. Individuals who were unable to read or understand Mandarin were excluded from this study. Patients were asked to participate in this study during their visit to the outpatient pre-surgery clinic and a written informed consent was obtained from all participants. In addition, the researcher helped the participants download the application on their smartphone and provided instructions on its usage and the course of the study. A sample size of approximately 50 participants was estimated to be sufficient for collecting end-user feedback. Patients were recruited in consecutive order of cataract surgeries.

Study procedure

During postoperative assessment, patients willing to participate received verbal and “hands on” instructions on how to use the application. After downloading the application from Google Play or App store, the patients were asked to allow the application to permit storage, message, and contact upon opening the application. Thereafter, the patients had to register an account by filling in their name and the last four digits of their mobile number. Once logged in, they were required to fill in the date of cataract surgery and download an alarm application that worked with PC app. The account created was connected to the research database following authorization by a researcher. Furthermore, the patients completed a questionnaire on the application after 7 days to obtain feedback on whether any future improvements to the application need to be made.

After surgery, once the patients left the postoperative care unit, they could start using the application to self-report on any postoperative symptoms and signs (Figure 1). In addition, all patients were notified four times daily at 8:00, 12:00, 16:00, and 20:00 by the application to report their condition. They could answer the questions by themselves or with the help of their co-resident family members. Six of the following questions were required to be answered: 1. How is your eye pain? 2. How is the blurriness of your vision? 3. Do you have headache? 4. Are you experiencing nausea or vomiting? 5. Degree of comfort level 6. Are you seeing black shadows, floating dots, or flashlights? For each question, there were four options: 1. Better 2. Same or none 3. Not good. 4. Worse. If the patient had chosen the “Worse” option, the application would send notification to the medical facility, so that a doctor could contact the patient and decide whether any further treatment was needed. Afterward, a survey was conducted that collected the patients’ feedback. There were seven questions in the survey, with three options for patients to choose: 1. Satisfied 2. No comment 3. Unsatisfied.

Results

A total of 50 patients used the PC application after cataract surgery. The study included 33 women and 17 men. The mean age was 68.14 ± 8.99 years. Among the patients, 22 (44%) answered the app questions by themselves, 20 (40%) had their children respond, and for 9 of them (17%), answers were given by others.

Two patients had recorded “Worse” once during the 7 day follow-up; they reported deterioration of the symptom grade—one being increased photopsia, and the other was fever. The message was sent to the medical staff; following which, the patients were contacted by phone. The surgical doctor gave the initial diagnosis and gave an appointment time for further OPD/ER visits. The final diagnoses for the two patients were myodesopsia and urinary tract infection, respectively.

The results of the survey after using the application for 7 days are as follows: 81% of the patients were satisfied or very satisfied with the use of postoperative care application to communicate their symptoms instantly; 86% reported that application is helpful and useful; 81% were willing to use the application again; 79% believed that this application can improve the quality of postoperative care for cataract surgeries; 86% of the patients indicated that the application helps to seek medical assistance promptly

(Figure 2). Suggestions for improvements included adding a remark column and more health education related content to the application, and the poor willingness to use an eye-watching smartphone postoperatively.

Discussion

This study evaluated the usability and feasibility of a novel smartphone application (PC app) for postoperative symptom/sign monitoring and bi-directional cloud-based feedback in patients operated for cataract. The app system emerged as a reliable method for monitoring postoperative conditions in home settings because of the automatic judgment of symptom/sign severity and real-time feedback, and excellent usability support.

Based on the results, it can be said that smartphone-based remote patient symptom/sign reporting and monitoring has the potential to improve overall patient care. Postoperative endophthalmitis and retinal detachment are serious complications of cataract surgery. Acute postoperative endophthalmitis frequently occurs 1 week post-surgery. Detection of any early changes in associated ocular symptoms and signs correlates with better outcomes as it can facilitate clinical attention and ensure earlier return to office by ensuring prompt treatment.^{11,12} Conversely, a delay in early treatment may lead to irreversible loss in vision and other worse outcomes. Besides, the bidirectional feedback through the PC app system, a postoperative periodically symptom/sign questionnaire may also ensure that the patient is alert for any change in the symptom/sign and seek early medical assistance.

The PC app system could thus supplement current telehealth options by providing reliable postoperative care from ophthalmologists to help monitor patients remotely. With assistance through computer based artificial intelligence and instant feedback without time delay, enables physicians to have better individualize contact with patients, suggest treatment, and minimize visits to the clinic thereby decreasing patient discomfort as well as expenses. It can also serve as an important tool to improve patient care and reduce costs after cataract surgery, especially for those who live in rural areas that are far away from ophthalmologist centers. It can also be a potential solution in situations where fewer visits are possible such as during the COVID-19 pandemic to minimize potential exposure to virus. In addition, the bi-directional feedback system of the app has the potential to be applied in any kind of surgery to offer a holistic quality of care to patients. It could also contribute in improving the doctor-patient relationship.

This study does have some limitations. First, the age of patient included in the study (>68 years), and female predominance might have led to a potential selection bias. In addition, more than half of the patients could not use smartphones by themselves. They needed to depend on their family members to complete app questionnaires. On the other hand, additional care by family members through reminders by the PC app possibly had a positive effect on postoperative care. Furthermore, the use of app may not be feasible for patients who live alone. Artificial intelligence speech recognition and answer systems may be developed in the future. Second, as there were no serious postoperative complications, this study could not evaluate the possibility of any earlier intervention using this system.

In summary, the study demonstrated the reliability and feasibility of the PC app system to monitor postoperative symptoms/signs with bidirectional feedback. The patient survey demonstrated that the PC app was easy to use, and the patients opined that it improved quality of care. The findings suggest that this app is a reliable approach for monitoring patients after cataract surgery in home settings. Nevertheless, further large-scale studies should be undertaken using the PC app to determine if postoperative complication outcomes could be improved with smartphone-based monitoring and early detection systems.

Declarations

(a) Ethical Approval and Consent to Participate

The authors confirmed that the study adhered to the Declaration of Helsinki and was approved by the Institutional Review Board (IRB)/Ethics committee of Chang-Gung Memorial Hospital. The informed consent was obtained from all subjects.

(b) Consent for publication

The manuscript did not include information or images that could lead to identification of a study participant.

(c) Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

(d) Competing interests

None

(e) Funding

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(f) Acknowledgment

PC app was developed, patented and sponsored by HornChang Culture & Technology Co., Ltd, Kaohsiung, Taiwan. However, the sponsor had no role in the design and conduct of the study.

(g) Author's Contribution

MH Wu and PC Wu wrote the main manuscript text, CL Tsai prepared figures 1-2, LB Hsieh prepared the material, and LM Lin contributed the protocol. All authors reviewed the manuscript.

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Figures

Figure 1

Patients used the PC app for 7 days postoperatively to assess their symptoms/signs 4 times a day after receiving an alert. The satisfaction questionnaires were collected on the 7th day.

Figure 2

The results of the satisfaction questionnaires after using the application for 7 days.