Development and Usability Evaluation of an Application for Patients With Glaucoma

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Research Article

Abstract

Introduction

Glaucoma is a progressive optic neuropathy that requires continuous monitoring. The purpose of the study was to develop and evaluate the usability of a mobile application, for iOS and Android platforms, containing functionalities to improve patients' knowledge about glaucoma and facilitate their treatment.

Methods

The application was developed by a multidisciplinary team using an adapted version of a co-design methodology. Thirty-six volunteers were selected, among patients and patients' relatives, from the Instituto Cearense de Oftalmologia, chosen by rational choice sampling, to answer the System Usability Scale after having prior orientation. The results extracted from the questionnaire were analyzed quantitatively. After grouping by age, a proportions test (z-test) was performed.

Results

It was possible to develop an application for mobile devices named "*GlaucoCheck*". Of the 36 interviewees, the average age was 51 (22-69) years old, 56% were women, and 64% had a university degree. The average APP score for usability in the SUS questionnaire was 75.6 (95% CI 74.1-77.2).

Discussion

There was an appropriate acceptance of patients to the "*GlaucoCheck*", as it was considered easy to handle, exhibiting interactive and uncomplicated layout. It was possible to develop an application and to register a positive acceptance by the users, encompassing functions that permits better adherence to treatments and additional knowledge about glaucoma.

Introduction

Glaucoma is a progressive optic neuropathy, in which the main recognized and modifiable risk factor is high intraocular pressure (IOP). The disease is associated with a progressive loss of visual field as the optic nerve lesion progresses, leading to irreversible vision loss [1]. It is estimated that 60.5 million people were affected by chronic open-angle glaucoma (COAG) and closed-angle glaucoma (CAG) worldwide in 2010, making it the leading cause of irreversible global blindness, with an estimated number of affected people aged 40-80 years worldwide of 111.8 million in 2040 [2]. Because it is a chronic condition, glaucoma requires continuous treatment in order to delay its damage [3]. The incorrect use of eye drops leads to mistreatment and increases therapeutic costs. Such factors are usually obstacles in the patient's adherence to the treatment, leading to therapeutic failure [4, 5].

The technological revolution has brought countless benefits and facilities to humanity, thus mobile phones can configure important allies for patient's awareness and information. In this context, the

creation of health-oriented applications to help patients and doctors has been growing, as they can help managing and treating chronic diseases [6].

The present study aims to develop and evaluated the usability of a mobile application available on iOS and Android platforms, containing functionalities to improve patients' knowledge about glaucoma and facilitate their treatment.

Materials And Methods

Study design

This was a transversal and quantitative study divided into two stages. The first stage consisted of creating and developing the application for iOS and Android platforms. The final stage consisted of testing the application, verifying its operation, usability, and acceptance. All the participants signed the informed consent form.

Application development

The "*GlaucoCheck*"'s entire layout and interface were designed and manufactured to be intuitive, and easy to visualize, as many patients with glaucoma already experience some vision loss, enabling telemedicine functions. Thus, when accessing the application, the patient will be faced with an initial screen, with six options to trigger: "About Glaucoma", "My Eye Drops", "Treatment", "My Exams", "My Pressure" and "Questions".

The topic "About Glaucoma" consists in recording some quick videos, with themes according to the major doubts and complaints of patients affect by glaucoma and the general population.

In the "My eye drops" section, there is an option to select the medications that the patient currently uses and set the time to use it, including notifications at the exact chosen time. Furthermore, by selecting the "Treatment" option there is the possibility to store information about patients' surgical treatments (Figure 1).

. "My Exams" enables the registration of performed exams, such as Gonioscopy, Pachymetry, Visual Field, Retinography, and OCT of nerves and fibers (Figure 2).

In the section "My Pressure", the patient can store the values of measured Intraocular Pressure (IOP), enabling the monitoring of the variation during time and automatically generating follow-up graphs.

In "Questions" menu, there are available frequently asked questions (FAQ) among patients with glaucoma, with the respective answers. Beyond that, there is also a telecare option to send e-mails with new questions for the developers, facilitating the communication between patients and professionals.

Mobile application customer feedback

The inclusion criteria were patients suffering from glaucoma who were registered in the Instituto Cearense de Oftalmologia or relatives responsible for those patients who were familiar with iOS ar Android platforms. Participants who did not suffer from glaucoma or did not have a relative with glaucoma, illiterate volunteers, and participants unfamiliar with smartphones and iOS or Android platforms

The volunteers of this research were chosen using a rational choice sample that is justified or not in a non-random way. The choice was intentional or by convenience, considering the study group's characteristics or the researcher's knowledge of what they were investigating [7].

Initially, an informal conversation about the research occurred, clarifying doubts and inviting volunteer's formal invitation to participate and sign the consent form.

After that, the "User Guide" was delivered to the volunteer, which was an explanatory document that clearly shows all the functionality of the application and its tools. Then the volunteer's first contact with the "*GlaucoCheck*" application occurred through a smartphone base unit with the iOS or Android operating system.

Under the evaluator's supervision, the volunteer was encouraged to explore all the functionalities contained in the application. This whole process occurred with the evaluator's minimum intervention.

Volunteers were finally instructed to fill up a questionnaire containing questions related to their disease and the System Usability Scale, a scale that is characterized as an easy-to-apply method to investigate the system's usability, where each question contains five answer options that follow the 5-point Likert scale (completely disagree, disagree, neutral, agree, and completely agree) [8].

Statistical analysis

The data extracted from the SUS questionnaire answered by the physicians were exported to the Statistical Package for the Social Sciences (SPSS) software version 20.0 for Windows, in which the averages of each item of the SUS questionnaire and the total score of this questionnaire (0-100) were disposed.

Results

36 volunteers were included after following the inclusion and exclusion criteria. There were 20 women (55.5%) and 16 men (44.4%). The average age was 51 years old (22-69). Regarding the educational level, 23 (63.8%) volunteers finished high school, 11 (30.5%) had a university degree, and two (5.5%) were post-graduated.

When asked about the classification of their disease, the majority of the participants were not entirely sure. In addition, 12 (33.3%) volunteers were diagnosed with chronic open-angle glaucoma and five

(13.8%) with closed-angle glaucoma. No participant reported suffering from congenital or secondary glaucoma. (Table 1)

Regarding the time of diagnosis, the majority of the volunteers had between six and ten years of illness, 6 (16.6%) had up to five years of illness.. Patients older than 55 years old were diagnosed 6-10 years ago more frequently than patients younger than 55 years old (p=0.026).

When asked about the name of the eye drops, most patients knew the name of the medications. Regarding participants older than 55 years, 34 (94.4%) knew the name of their eye drops, while among patients younger than 55 years 21 (58.3%) knew the name of the eye drops and 15 (41.6%) did not. 16 (44.4%) of the volunteers affirmed that they always use the medications properly, while 20 (55.5%) do not use the eye drops correctly.

21 (58.3%) patients believe they do not have sufficient knowledge about the disease. However, 31 (86.1%) patients stated that they have adequate comprehension about their exams and treatments.

Concerning the SUS questionnaire, there was a separation into groups by age, with no difference in usability between patients under 55 years old or over 55 years old (Table 2).

The application received a fair usability assessment, obtaining an average SUS score of 75.6 (95% CI 74.1-77.2) (Table 3). The "*GlaucoCheck*" was pointed to arouse the interest in using it frequently among 22 (61.1%) volunteers, while eight (22.2%) were quite interested, demonstrating a level of acceptance of the application of 83.3%. 35 (97.2%)participants considered the application easy to use.

All the volunteers stated that they did not need the support of any technical assistance to use the application. Regarding the integrality of this application's functions, 100% of the participants considered the functions well integrated and the application very consistent, offering no obstacles to use. (Table 4)

Discussion

According to a survey by the State University of Campinas (Unicamp) and the Thomas Jefferson School of American Medicine in Philadelphia, about half of glaucoma patients have little knowledge about the disease. The results were alarming in both countries: in the United States, 44% of glaucoma patients did not give satisfactory answers about glaucoma, and in Brazil, that number increased to 54% [3,9]. Our results corroborates with the literature, as 58.3% of the patients did not have sufficient knowledge about the disease and 52.7% were not able to classify their glaucoma, highlighting the need and relevance of the "*GlaucoCheck*" application, as there is great misinformation, which can lead to ineffective treatment. Poor adherence to glaucoma treatment, which varies from 30 to 80%, is related to several factors, such as an incorrect technique when applying eye drops, inadequate dosage, side effects of medications, lack of organization with exams, low confidence in the doctor, ignorance about the severity of the disease and about its treatment [3,4,9,10,11].

Concerning ophthalmology, there are more than 120 mobile applications dedicated to ophthalmological surgery, configuring smartphones as medical tools [12,13]. In this context, applications must be tested and evaluated for a better chance of success in its acceptance [14]. Thus, when patients were asked about their interest in the application's daily use, 61.1% expressed interest in using it frequently, and 22.2% were very interested. These numbers show an application acceptance level of 83.3%, which is a significant level.

When asked about the application's complexity, 83% of patients had a favorable perception of this aspect, showing that "*GlaucoCheck*" achieved one of its objectives: to be an easy and intuitive application. Moreover, regarding usability, 97% of patients found the app easy to use.

Mobile applications are practical and low-cost tools to help promote the population's health, especially for risk groups, as the target population of this study. In this perspective, some studies have demonstrated the acceptability and the availability of other health applications on a global scale [15,16,17,18]. However, some of these available applications did not assess the users' subsequent usability and their positive health effects, which corroborated with the design and study of "*GlaucoCheck*". In addition, one of the main benefits of this type of application is its large-scale reach, which translates into a positive impact on access to health information through the acceptability of using portable technology [19,20,21].

Conclusion

It was possible to develop and confirm the usability of an user-friendly interface application for mobile devices named "*GlaucoCheck*", containing functions directed to raise patients' awareness of glaucoma, improve patient's knowledge about their condition, facilitate the use of eye drops, favor adherence to treatment and enable archiving of exams.

Declarations

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Tables

Table 1. Volunteers' knowledge about the disease.

Question					
1. Do you know the classification of your glaucoma?	I'm not sure (53%)	Chronic open-angle glaucoma (33%)	Narrow/closed-angle glaucoma (14%)	Congenital glaucoma (0%)	Secondary glaucoma (0%)
2. How long has it been since you discovered that you have glaucoma?	0-5 years (33%)	6-10 years (47%)	11-20 years (17%)	21-25 years (3%)	>25 years (0%)
3. Do you know all the eye drops you use?	Yes (78%)	No (22%)			
4. Do you believe that you know enough about your disease?	Yes (42%)	No (58%)			
5. Do you have all your exam results stored?	Yes (33%)	No (67%)			
6. Do you drip your eye drops correctly?	Always (44%)	Often (42%)	Sometimes (14%)	Rarely (0%)	
7. Have you ever had any treatment without really understanding what it was about?	Yes (14%)	No (86%)			

Table 2. Summary of the SUS analysis of groups A and B.

Variable	Group A	Group B
Sample Size	17	19
Mean SUS Score	74.9	76.3
Confidence Interval (95%)	72.8-76.9	73.8-78.8
Margin of Error	2.0	2.5
Standard Deviation	3.9	5.2

SUS: System Usability Scale

Table 3. Application usability review summary (N = 36).

SUS Score	Standard Deviation	Margin of Error	Confidence Interval (95%)
75.6	4.6	1.6	74.1-77.2

N: number of volunteers; SUS: System Usability Scale

Table 4. System Usability Scale.

I think that I would like to use this system frequently.	Strongly disagree (0%)	Disagree (0%)	Indifferent (17%)	Agree (61%)	Strongly agree (22%)
I found the system unnecessarily complex.	Strongly disagree (14%)	Disagree (83%)	Indifferent (3%)	Agree (0%)	Strongly agree (0%)
I thought the system was easy to use.	Strongly disagree	Disagree	Indifferent (3%)	Agree (39%)	Strongly agree (58%)
I think that I would need the support of a technical person to be able to use this system.	Strongly disagree (92%)	Disagree (8%)	Indifferent (0%)	Agree (0%)	Strongly agree (0%)
I found the various functions in this system were well integrated.	Strongly disagree (0%)	Disagree (0%)	Indifferent (0%)	Agree (11%)	Strongly agree (89%)
I thought there was too much inconsistency in this system.	Strongly disagree (75%)	Disagree (25%)	Indifferent (0%)	Agree (0%)	Strongly agree (0%)
I would imagine that most people would learn to use this system very quickly.	Strongly disagree (0%)	Disagree (0%)	Indifferent (3%)	Agree (33%)	Strongly agree (64%)
I found the system very cumbersome to use.	Strongly disagree (22%)	Disagree (53%)	Indifferent (25%)	Agree (0%)	Strongly agree (0%)
I felt very confident using the system.	Strongly disagree (50%)	Disagree (31%)	Indifferent (19%)	Agree (0%)	Strongly agree (0%)
I needed to learn a lot of things before I could get going with this system.	Strongly disagree (0%)	Disagree (29%)	Indifferent (14%)	Agree (57%)	Strongly agree (0%)