Application prototype for patient education before coronary artery bypass graft surgery

Protótipo de aplicativo para a educação do paciente antes da revascularização miocárdica

Prototipo de aplicación para la educación de pacientes antes de la revascularización miocárdica

Alcides Viana de Lima Neto[1] https://orcid.org/0000-0001-6191-9465
Isabelle Pereira da Silva[1] https://orcid.org/0000-0002-9865-2618
Simone Karine da Costa Mesquita[1] https://orcid.org/0000-0002-4537-2014
Pétala Tuani Candido de Oliveira Salvador[1] https://orcid.org/0000-0002-3208-6270
Taciana da Costa Farias Almeida[2] https://orcid.org/0000-0002-9390-9656
Patrícia Peres de Oliveira[3] https://orcid.org/0000-0002-3025-5034
Isabelle Katherinne Fernandes Costa[1] https://orcid.org/0000-0002-1476-8702

How to cite:
Lima Neto AV, Silva IP, Mesquita SK, Salvador PT, Almeida TC, Oliveira PP, et al. Application prototype for patient education before coronary artery bypass graft surgery. Acta Paul Enferm. 2023;36:eAPE010731.

DOI
http://dx.doi.org/10.37689/acta-ape/2023A00107331

Keywords
Patient education; Educational technology; Mobile applications; Myocardial revascularization; Postoperative period

Descritores
Educação do paciente; Tecnologia educacional; Aplicativos móveis; Revascularização miocárdica; Período pré-operatório

Descriptores
Educación del paciente; Tecnología educacional; Aplicaciones móviles; Revascularización miocárdica; Periodo posoperatorio

Submitted
June 7, 2022

Accepted
December 19, 2022

Corresponding author
Alcides Viana de Lima Neto
E-mail: alcides.vln@gmail.com

Associate Editor (Peer review process):
Camila Takao Lopes
(https://orcid.org/0000-0002-6243-6497)
Escola Paulista de Enfermagem, Universidade Federal de São Paulo, São Paulo, SP, Brazil

Abstract

Objective: To analyze the content and usability of a mobile application prototype to support patient education in the preoperative period of myocardial revascularization.

Methods: This is a quantitative methodological study based on the contextualized instructional design framework. In the analysis stage, a scoping review and a qualitative study were carried out with 13 patients to identify the content to compose the application. In the design and development stage, content was structured. In the implementation stage, resources were configured. In the assessment stage, the Delphi technique was used, with content assessment from the Pasquali criteria and application usability through the ERGOLIST by 20 judges in the first round and 16 in the second. For analysis, the Content Validity Coefficient was used, considered valid above 0.8 and the percentage of agreement equal to or greater than 80%. The binomial test was performed on each item to determine the significance level ($p<0.05$).

Results: Content analysis resulted in a Content Validity Coefficient greater than 0.8 and a percentage of agreement greater than 80% in all analyzed criteria. Usability, on the other hand, presented a percentage greater than 90% in all items. All items analyzed were statistically significant. The OrientaRVM application was composed of 90 screens that form the initial menu and nine sections: understand more about the heart; understand your illness; understand coronary artery bypass graft surgery or breast bypass surgery; care before surgery; care after surgery; rehabilitation and lifestyle changes; patient records; schedule; quiz.

Conclusion: OrientaRVM presents reliable content, adequate functionality and was recommended to be used as an auxiliary resource in patient education before myocardial revascularization.

Resumo

Objetivo: Analisar o conteúdo e usabilidade de um protótipo de aplicativo móvel para apoiar a educação do paciente no pré-operatório de revascularização miocárdica.

Métodos: Estudo metodológico, quantitativo, baseado no referencial design instrucional contextualizado. Na etapa de análise realizou-se revisão de escopo e um estudo qualitativo com 13 pacientes com a finalidade de identificar o conteúdo para compor o aplicativo. Na etapa de design e desenvolvimento estruturou-se o conteúdo. Durante a implementação, procedeu-se a configuração dos recursos e, na avaliação, utilizou-se a técnica Delphi, com a avaliação do conteúdo a partir dos critérios de Pasquali e a usabilidade do aplicativo por meio do ERGOLIST por 20 juízes na primeira rodada e 16 na segunda. Usou-se, para análise, o coeficiente de validade de conteúdo, considerado válido acima de 0,8 e o percentual de concordância igual ou superior a 80%. Realizou-se o teste binomial em cada item para determinar o nível de significância ($p<0,05$).

[1]Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil.
[2]Universidade Federal de Campina Grande, Campina Grande, PB, Brazil.
[3]Universidade Federal de São João del-Rei, São João del-Rei, MG, Brazil.
Conflicts of interest: nothing to declare.

Resultados: A análise do conteúdo resultou em um coeficiente de validade de conteúdo superior a 0,8 e percentual de concordância superior a 80% em todos os critérios analisados. Já a usabilidade, apresentou percentual superior a 90% em todos os itens. Todos os itens analisados apresentaram significância estatística. O aplicativo OrientaRVM foi composto por 90 telas que formam o menu inicial e nove seções: entenda mais sobre o coração; entenda a sua doença; entenda a cirurgia de ponte de safena ou ponte mamária; cuidados antes da cirurgia; cuidados após a cirurgia; reabilitação e mudanças no estilo de vida; registros do paciente; agenda; *quiz*.

Conclusão: O OrientaRVM apresenta conteúdo confiável, funcionalidade adequada e foi recomendado para ser utilizado como recurso auxiliar na educação do paciente antes da revascularização miocárdica.

Resumen

Objetivo: Analizar el contenido y la usabilidad de un prototipo de aplicación móvil para apoyar la educación de pacientes en el preoperatorio de revascularización miocárdica.

Métodos: Estudio metodológico, cuantitativo, basado en el marco referencial de diseño instruccional contextualizado. En la etapa de análisis se realizó la revisión de alcance y un estudio cualitativo con 13 pacientes con la finalidad de identificar el contenido para componer la aplicación. En la etapa de diseño y desarrollo se estructuró el contenido. Durante la implementación se realizó la configuración de los recursos y, en la evaluación, se utilizó el método Delphi, con la evaluación del contenido a partir de los criterios de Pasquali y la usabilidad de la aplicación por medio de ERGOLIST por 20 jueces en la primera ronda y 16 en la segunda. Para el análisis se usó el coeficiente de validez de contenido, considerado válido superior a 0,8 y el porcentaje de concordancia igual o superior al 80 %. Se realizó la prueba binominal en cada ítem para determinar el nivel de significación ($p<0,05$).

Resultados: El análisis del contenido dio como resultado un coeficiente de validez de contenido superior a 0,8 y porcentaje de concordancia superior al 80 % en todos los criterios analizados. Por otro lado, la usabilidad presentó un porcentaje superior al 90 % en todos los ítems. Todos los ítems analizados presentaron significación estadística. La aplicación OrientaRVM estuvo compuesta por 90 pantallas que forman el menú inicial y nueve secciones: entienda más sobre el corazón; entienda su enfermedad; entienda la cirugía de bypass coronario o puente mamario; cuidados antes de la cirugía; cuidados después de la cirugía; rehabilitación y cambios en el estilo de vida; registros del paciente; agenda; *quiz*.

Conclusión: OrientaRVM presenta contenido confiable, funcionalidad adecuada y fue recomendado para su uso como recurso auxiliar en la educación del paciente antes de la revascularización miocárdica.

Introduction

Cardiovascular diseases are considered a public health problem because they are the main causes of morbidity and mortality in the world. This group includes coronary artery disease (CAD), caused by a decrease in blood supply to the heart muscle due to reduced blood flow in the vessels that irrigate the heart.[1]

CAD treatment includes non-invasive measures such as drug therapy and changes in lifestyle, maintaining or adopting healthy habits and, in certain situations, invasive interventions. Among these, the coronary artery bypass graft surgery (CABG) stands out, which consists of a complex and large heart surgery, with the aim of reducing morbidity and mortality and improving individuals' quality of life.[2]

Patients undergoing CABG are subject to complications in the postoperative period, which can lead to an increase in hospital stay and delay in recovery.[3] In this context, it is essential to implement care, with a view to favoring a postoperative period with fewer complications and adverse events. For this, it is necessary to provide valid and reliable information about the treatment process to patients to promote health education and thus provide effective learning in the preoperative period. This may contribute to an active involvement of individuals in the care process.[4]

Thus, health education should be carried out by the entire multidisciplinary team in the perioperative period. In this team, the nurse stands out, who has a fundamental role in contributing in a direct and planned way in the preoperative routine, which includes educational interventions.[5] These interventions were influenced, in recent decades, by technological evolution and began to incorporate several technologies, which can be defined as resources used to improve education efficiency, achieved from the functionality provided by the materials.[6] As an example of these technologies, we mention videos, leaflets, guidance manuals and applications (apps) for mobile devices.

A systematic review aimed at assessing the effect of mobile apps on improving adherence to cardiac rehabilitation verified different types of approaches focused on patient autonomy, including monitoring parameters and daily activities, feedback from professionals, encouraging and providing information

about exercise, medication and health care. This study concluded that such apps have great potential to improve adherence and minimize health problems. However, the implementation and assessment of these resources are still incipient, especially in the preoperative period of patients with heart disease, with the need for the development of smarter devices and additional research to verify their effectiveness.[7]

In the educational context, an example is the development of a prototype of an educational and nursing follow-up app for patients diagnosed with peripheral arterial disease by Brazilian researchers. This resource listed key points to provide an effective and safe health education tool for patients with this disease.[8]

Thus, the following question arose: are the content and usability of a mobile app prototype to support patient education in the preoperative period of CABG valid? In this context, the objective was to analyze the content and usability of a mobile app prototype to support patient education in the preoperative period of myocardial revascularization.

Methods

This is a quantitative methodological carried out from January to September 2021. The framework for structuring educational resources contextualized instructional design (CID) was adopted, which proposes the following stages: analysis, design, development, implementation and assessment.[9]

In the analysis stage, a scoping review was carried out in the data sources: PubMed; CINAHL; Web of Science; Scopus; Latin American and Caribbean Literature in Health Sciences (LILACS); The Cochrane Library; Base; Theses and Dissertations Catalog of the Coordination for the Improvement of Higher Education Personnel; DART-Europe E-Theses; Electronic Theses Online Service; Open Access Scientific Repository of Portugal; National Library of Australia (Trove); National ETD Portal; Education Resources Information Center; and Theses Canada.

The search strategy was used: "patient" OR "client" AND "patient education" OR "health education" OR "learning needs" OR "learning" OR "active learning" OR "educational needs assessment" AND "preoperative period" OR "perioperative care" AND "myocardial revascularization" OR "internal mammary artery implantation" OR "coronary artery bypass graft surgery" OR "coronary artery surgery" AND "hospital" OR "intensive care unit" OR "coronary care units" OR "inpatients" OR "hospitalization". The review protocol was registered on the Open Science Framework platform, Digital Object Identifier System (DOI): 10.17605/OSF.IO/2PBEM.

Still in the analysis stage, a qualitative study was carried out with 13 patients diagnosed with CAD and indication for CABG surgery, admitted to a university hospital, with the purpose of identifying the content to compose the app. Data collection was performed through a semi-structured interview, based on the question: What content/topics should a mobile app with guidance on your surgery present? Data were tabulated, entered into the *R Interface pour les Analyzes Multidimensionnelles de Textes et de Questionnaires* (Iramuteq) and analyzed according to Descending Hierarchical Classification (DHC).

In the design and development stage, adapted for this study in simultaneous stages, content was structured in topics, short texts, images, and other didactic resources to form the interface (layout). This was based on patients' learning needs identified in the scoping review and in the qualitative study, which were related to knowledge about the heart, care and routines involving patients' context in the preoperative period, the surgical procedure itself and important aspects related to the postoperative period. Furthermore, the prototype was produced without the need for prior registration, allowing free navigation by users.

There was also the selection of resources that represented the app navigation structure, with screen planning and configuration. Education and information technology experts helped to develop low- and high-fidelity prototypes of the software in the Figma® tool. The illustrations and icons used in the app originated from the Freepik® vector image repository and were edited or created by the development team in Illustrator® software.

In the implementation stage, the educational resources used in the high-fidelity prototype in the Figma® tool were configured, for later development of the final version for download in the app stores. In the assessment stage, app content and usability were verified. In this stage, nurses with experience and/or experts in cardiology, selected by intentional sampling, participated. For this group, a sample of 20 professionals was estimated, as recommended by other studies, which cite a sample of six to 20 participants as sufficient for content assessment.[10,11]

To select these professionals, at least 4 points were considered in the Fehring criteria model[12] adapted for this study: master's degree in nursing (1); master's degree in nursing with dissertation in cardiology (1); research (2) or articles published in the field of cardiology or development of apps (2); doctoral degree in nursing, with a thesis in the area of cardiology or app development (2); experience in assistance of at least one year in cardiology (4); and specialization and/or uni- or multi-professional residency in cardiology (3), with a maximum score of 15 points.

A search was carried out on the *Plataforma Lattes* of the Brazilian National Council for Scientific and Technological Development (CNPq - *Conselho Nacional de Desenvolvimento Científico e Tecnológico*), by filling in the fields: subject – nursing in cardiology AND myocardial revascularization. The bases of doctors and other researchers were kept selected, according to specific fields of the portal. A total of 44 nurses were located, who were invited to participate in the validity stage, from July to September 2021, by e-mail, identified in publications available in databases. An invitation was sent to a number higher than recommended due to the possibility of refusals to participate in the research. Also participating were nurses from the qualitative study scenario who met the same criteria described above, whose invitation was made directly by the researchers or by email.

Still in the assessment stage, the Delphi technique was used, which consists of work carried out jointly, but anonymously, by experts in a given area, to obtain consensus.[13] Thus, as recommended, the data collection instrument was sent more than once to the same experts, until consensus was reached on content and usability assessment, which in this research took place in two assessment rounds.

A structured instrument sent via Google Forms was used, consisting of open- and closed-ended questions to outline judges' sociodemographic, academic and professional profile and questions regarding the degree of ap content adequacy as a whole, composed of 12 criteria adapted to the developed technology, namely: behavioral, objectivity, simplicity, clarity, relevance, accuracy, variety, modality, typicality, credibility, breadth and balance.[14] The questions had the following response options on a Likert scale: 1. Inadequate; 2. Partially adequate; 3. Neutral; 4. Adequate; 5. Totally adequate and a space for comments and suggestions.

For usability analysis, 18 ERGOLIST items were used. These items were adapted by a Brazilian researcher and adjusted for this research.[15] Furthermore, each item presented the following response options using a Likert scale: 1. Strongly disagree; 2. Disagree; 3. Do not know; 4. Agree; 5. Strongly agree.

In both rounds, a link was sent along with the instrument to access the high-fidelity prototype on the Figma® platform, to enable judges to navigate it as well as screens of each section. In the second round, a link was also provided to access a folder on Google Drive with all comments/suggestions made by judges in the first assessment.

The data from the instrument were tabulated in Microsoft Excel®, and then a descriptive analysis was carried out. Content was considered valid when it presented a Content Validity Coefficient (CVC) greater than 0.8 and a percentage of agreement (PA) equal to or greater than 80%. The CVC was identified through the following operation: dividing the average of judges' response values ($\sum xj$) - variable from 1 to 5, by the maximum value of the last response option on the Likert scale (V_{max}) – 5.[16]

To calculate the PA, we adopted the division of the number of participants who agreed (nc) - sum of participants who answered options 4 and 5 (adequate and totally adequate, respectively) by the total number of participants (n), multiplied by 100.[17]

As for usability, the app was considered valid when there was a percentage of agreement equal to

or greater than 80% after applying the 18 items of adapted ERGOLIST.[15] This calculation was obtained using the formula previously described, in which the number of participants who agreed (nc) - sum of participants who responded to options 4 and 5 (agree and strongly agree, respectively) was divided by the total number of participants (n), multiplied by 100.

Additionally, data underwent statistical analysis based on probability through the binomial test, with p-value calculation (significant when p <0.05) in the R-4.2.1 software. For this calculation, both in the assessment of content and usability, items that received answers 1, 2 and 3 were considered inadequate and items with answers 4 or 5 adequate.

All stages of the research considered the ethical precepts established for research with human beings. The assessment was given by the Research Ethics Committee of the *Universidade Federal do Rio Grande do Norte* (UFRN), through CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 39198020.0.0000.5537 and approval by Opinion 4,437,457.

Results

Based on the content identified in the scoping review and in the qualitative study, OrientaRVM sections were structured. The low-fidelity prototype's initial screen was primarily composed of nine sections, called: 1. The heart; 2. Understand your illness; 3. Coronary artery bypass graft surgery; 4. Pre-surgical care; 5. Care during and after surgery; 6. Post-surgical care; 7. Rehabilitation; 8. Schedule; 9. Quiz; and Credits. After developing the low-fidelity prototype, adjustments were made according to the needs identified by the researchers, in order to improve content and structure for the high-fidelity version. This process resulted in some changes in sections' titles, namely: sections 1 to 4 remained unchanged and sections 5 and 6 were unified, named "care during and after surgery" (new section 5). Moreover, sections 6 to 9 became, respectively, "rehabilitation and lifestyle changes", "new record", "schedule" and "quiz". The "schedule" tab allows users to record important dates and times for their follow-up, such as surgery, exams, appointments and medications. The "quiz" tab consists of a knowledge test, with true or false options, which provides feedback on user responses. Figure 1 shows the initial menu screens of the low- and high-fidelity prototypes.

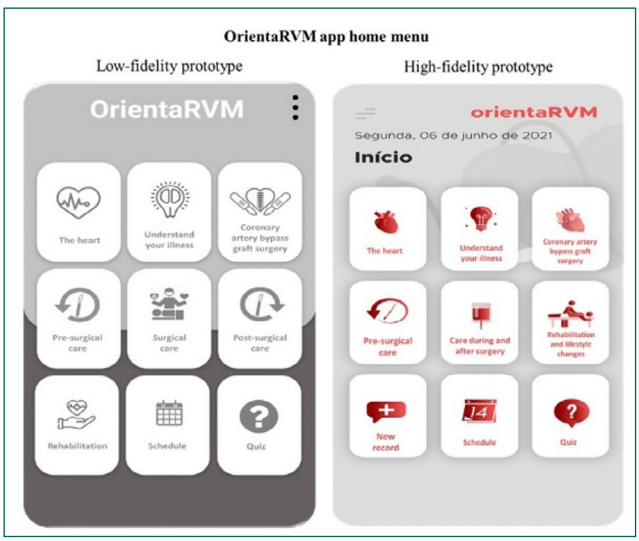

Figure 1. Initial menu of OrientaRVM low- and high-fidelity prototypes

In content assessment, 20 judges participated in the first round, and in the second round, four professionals did not respond, which resulted in 16 participants. In the first, most were female (15; 75.00%), with a mean age of 37.35 years (SD±8.54), with a master's degree (9; 45.00%), with experience in the care area (9; 45.00%). In the second round, judges' characteristics were similar to the first, with a predominance of females (11; 68.75%), mean age of 37.81 years (SD±9.32), holding a master's degree (9; 56.25 %), with experience in the care area (7; 43.75%). Table 1 describes the CVC, the percentage of agreement and the p-value (obtained by the binomial test) for the high-fidelity prototype's initial menu and nine sections. In round 01 of the Delphi technique, the lowest CVC value was 0.81 for section 2 - Understand your illness and the lowest PA was 85% for section 1 - The heart. From participants' comments and suggestions in the first assessment, adjustments were made for submission

Table 1. Content Validity Coefficient values, percentage of agreement (%) and p value (obtained by the binomial test) assessed by judges in Delphi rounds 1 (n=20) and 2 (n=16) for the initial menu and sections 1 to 9 of the app

Delphi 1				Delphi 2			
Initial menu and Sections	CVC	%	p-value	Initial menu and Sections	CVC	%	p-value
Initial menu	0.84	95	<0.001	*Initial menu*	0.94	100	<0.001
1 – *The heart*	0.84	85	0.0026	1 – *Understand more about the heart*	0.98	100	<0.001
2 – *Understand your illness*	0.81	90	0.0004	2 – *Understand your illness*	0.96	100	<0.001
3 – 3 – *Coronary artery bypass graft surgery*	0.82	90	0.0004	3 – *Coronary artery bypass graft surgery or breast bypass*	0.95	100	<0.001
4 – *Pre-surgical care*	0.90	95	<0.001	4 – *Pre-surgical care*	0.95	100	<0.001
5 – 5 – *Care during and after surgery*	0.87	95	<0.001	5 – *Post-surgical care*	0.96	100	<0.001
6 – *Rehabilitation and lifestyle changes*	0.85	90	0.0004	6 – *Rehabilitation and lifestyle changes*	0.95	100	<0.001
7 – *New record*	0.92	100	<0.001	7 – *Patient records*	0.94	100	<0.001
8 – *Schedule*	0.92	100	<0.001	8 – *Schedule*	0.98	100	<0.001
9 – *Quiz*	0.88	95	<0.001	9 – *Quiz*	0.96	100	<0.001
Total	0.87	-			0.96	-	

to the second assessment stage. After that, it was observed that there was an improvement in CVC for all items assessed. As for the percentage of agreement, an increase was also noticed, in which all items obtained a result of 100% in the last assessment. All items were considered significant, since p was always less than 0.05.

Table 2 presents the app's assessment results as a whole, for the 12 criteria.[13] Thus, it was possible to identify that there were improvements from the comments and suggestions of the first assessment stage, since all the criteria obtained an increase in CVC and reached, in the end, a percentage of 100, with the exception of the simplicity criterion, which resulted in 93.75%, however higher than initial analysis. All items were also considered significant, since p was less than 0.05 in all criteria.

As for OrientaRVM usability, performed through the 18 items of the ERGOLIST, there is Table 3.

Usability assessment, as shown in Table 3, was considered satisfactory, since the sum of the answer options agree and strongly agree was equal to or greater than 90% in most requirements, with the exception of items 6, 10 and 15 in round 1. Of these, the first two are related to navigation functions, which can only be fully analyzed after the final version is implemented in the app store. As for item 15, it is related to the color scheme, which did not receive agreement by three (15%) of the evaluators. All 18 usability analysis items were considered significant, since p was less than 0.05. Also, usability adjustments were also made according to research participants' comments in the specific spaces for this action in the data collection instrument, still in the first round. After that, the second round of assessments took place according to the Delphi technique, in which 16 judges participated. At the end of this secondary assessment, some adjustments were made to the prototype, according to judges' comments/suggestions. With that, the final version of the prototype was elaborated, composed by the initial menu and nine sections, formed by 90 screens: understand more about the heart (01 screen); understand your illness (5 screens); understand coronary artery bypass graft surgery or breast bypass surgery (21 screens); care before surgery (10 screens); care after surgery (17 screens); rehabilitation and lifestyle changes (10 screens); patient records (2 screens); schedule (3 screens); quiz (19 screens).

Table 2. Content Validity Coefficient values, percentage of agreement (total %) and p-value (obtained by the binomial test) of the app assessed by judges in Delphi rounds 1 (n=20) and 2 (n=16)

Criteria	CVC		%		p-value	
	Delphi 1	Delphi 2	Delphi 1	Delphi 2	Delphi 1	Delphi 2
Behavior	0.85	0.95	85.00	100.00	0.0026	<0.001
Objectivity	0.91	0.98	95.00	100.00	<0.001	<0.001
Simplicity	0.88	0.91	90.00	93.75	0.0004	<0.001
Clarity	0.81	0.96	75.00	100.00	0.0414	<0.001
Relevance	0.95	0.99	100.00	100.00	<0.001	<0.001
Accuracy	0.89	0.96	95.00	100.00	<0.001	<0.001
Variety	0.80	0.99	80.00	100.00	0.0118	<0.001
Modality	0.86	0.95	90.00	100.00	0.0004	<0.001
Typicality	0.92	0.96	95.00	100.00	<0.001	<0.001
Credibility	0.93	0.99	95.00	100.00	<0.001	<0.001
Amplitude	0.90	0.96	95.00	100.00	<0.001	<0.001
Balance	0.89	0.93	90.00	100.00	0.0004	<0.001
Total	0.90	0.96	-	-		

Table 3. Results of usability validity by judges in Delphi rounds 1 (n=20) and 2 (n=16) according to 18 ERGOLIST items

Criteria	Delphi 1 (n=20)		Delphi 2 (n=16)	
	n(%)	p-value	n(%)	p-value
1. The app is easy to navigate.	19(95.00)	<0.001	16(100.00)	<0.001
2. The app screens are designed in a clear and understandable way.	20(100.00)	<0.001	16(100.00)	<0.001
3. App section and subsection pages have proper titles/headers.	19(95.00)	<0.001	16(100.00)	<0.001
4. Users always command navigation in the app.	19(95.00)	<0.001	16(100.00)	<0.001
5. The app screens show only the necessary and indispensable data and information for users.	19(95.00)	<0.001	16(100.00)	<0.001
6. The app has a continuation indicator for items on other pages.	15(75.00)	0.0414	16(100.00)	<0.001
7. Content layout on the app's screens is organized according to logical criteria and encourages memory.	19(95.00)	<0.001	16(100.00)	<0.001
8. The app's information is properly distributed on the screens from a space point of view.	20(100.00)	<0.001	16(100.00)	<0.001
9. App icons are screen space efficient and legible.	18(90.00)	0.0004	16(100.00)	<0.001
10. The app's icons, action buttons, menu, and presentation formats remain consistently maintained from screen to screen when required for that function.	17(85.00)	0.0026	16(100.00)	<0.001
11. The actions that can be controlled in the app are visually different from those only shown on the screens.	18(90.00)	0.0004	16(100.00)	<0.001
12. The app user can stop and resume a screen of content at any time.	18(90.00)	0.0004	16(100.00)	<0.001
13. The fonts used in the app are of proper size and style.	18(90.00)	0.0004	16(100.00)	<0.001
14. The text of app sections, subsections, and contents highlights important words or notions.	19(95.00)	<0.001	16(100.00)	<0.001
15. The use of colors in the app is adequate and does not overload information.	17(85.00)	0.0026	16(100.00)	<0.001
16. The quiz available in the app allows users to analyze the knowledge acquired with content.	20(100.00)	<0.001	16(100.00)	<0.001
17. The app's quiz feedback responses in cases of errors and correctness of the questions are clear.	19(95.00)	<0.001	16(100.00)	<0.001
18. Acceptable app page loading speed.	18(90.00)	0.0004	15(93.75)	0.0005

Discussion

It is noticed, in the midst of technological advances, the increasing adoption of software that promote self-care/health education for smartphones. Among these, apps stand out that enable self-management of various conditions and provide information at any time and place where individuals are in possession of a cell phone, in addition to contributing to strengthen patient education actions.[18] As an example, an app developed in Brazil to support shared decision-making in thromboembolic prophylaxis in atrial fibrillation can be cited, which contributed to improving patients' knowledge about the disease and the best treatment option.[19]

OrientaRVM was developed based on systematic, structured and careful planning, which took into account the stages proposed by the CID.[9] This method can be used for planning and elaborating mobile health apps' content, as evidenced in a literature review.[20] In other studies with the development of similar apps, the CID method made it possible to identify the needs of patients in clinical practice and in the literature, in addition to guiding software development in order to produce content and functionalities that are applied to the target audience, for later implementation and assessment.[8,21]

In this context, it was essential to build content based on scientific evidence to strengthen educational strategies. As highlighted in another study, it is essential that there is evidence that the proposed appeal is applicable according to its purpose. Therefore, it needs to be assessed in order to become an important tool for the construction and application of knowledge and contribute to patient education.[22]

In the process of assessing educational technologies, the importance of judges' contribution with expertise, mainly experts or with experience, is highlighted, which strengthens the quality of the element developed.[23] Thus, in order for there to be consistency in the verification stages, they must have great knowledge about the subject of interest.[24]

In this sense, previously described aspects were valued in this technological production, since all participants in the analysis stage were nurses with training and working in the field of cardiology, with emphasis on masters with experience in direct patient care.

OrientaRVM content assessment obtained good results in the two stages of verification carried out by judges. Despite this, it should be noted that in the second round of analyzes there was an

important improvement in all the analyzed criteria. At this stage, an agreement greater than 90 was obtained, according to what is recommended by the framework used in this research,[14] as well as with other validity studies that used the Delphi technique, which also obtained better scores in the second round.[10,25]

This aspect of improvements made from the comments and suggestions provided by judges and experts in the related area demonstrates developers' and researchers' commitment to the improvement and quality of the technology developed. Moreover, it is noteworthy that most of judges' suggestions were accepted by the researchers.

Usability assessment aimed to identify the degree of ease of use and may also represent user satisfaction with resource use.[26] Some evidence suggests that well-designed, user-friendly software can lead to more active user engagement and reduce the risk of failures as well as the need for future fixes.[26,27]

Studies on the development of resources to promote education, such as virtual learning objects and apps, carried out by nurses also assessed usability.[28,29] As an example, an investigation carried out in the United States of America (USA) aimed to explore the use and acceptance of an app designed to provide access to preventive information and promote adherence to clinical exams in women. As a result, it was highlighted by participants that the technology was useful and easy to use and could contribute to the empowerment, especially of the less economically favored.[30]

With this, OrientaRVM usability was verified based on criteria selected and adapted from ERGOLIST.[15] It was noticed, in the first round of assessment, that only the aspect related to the continuation indicator had a lower value than expected, but, in the second round, there was an increase in the percentage of agreement of the items of this indicator, due to adjustments made in general, based on judges' suggestions. This fact demonstrates an improvement in the technological resource before its final availability, which is necessary to guarantee better navigation by users, free of failures and errors, in order to become attractive and pleasant.[26,31]

Regarding the app screen colors, a value higher than the cut-off point was obtained for usability. In this regard, the importance of using colors in a limited and appropriate way is highlighted, so as not to overload users.[32] It is understood that this is relevant for visual communication when it comes to an educational app.

It was found, therefore, that OrientaRVM had its usability verified from the results obtained in the two rounds of assessment by judges, with emphasis on the last one, in which 17 of the 18 items obtained the maximum assessment value. This is similar to other healthcare app usability studies that scored high on participant ratings.[33,34]

It should be noted that many apps are being produced to meet the needs of patients with heart disease, in the context of prevention, monitoring and rehabilitation, but there is an incipient assessment of these software. Furthermore, few are aimed at preparing patients for major surgeries. Such resources, if produced and used properly, can provide greater autonomy and confidence to patients.[35] OrientaRVM brings a new perspective on the use of apps in the field of cardiology, because it covers educational aspects in the preoperative period and can be used in continuity of treatment and rehabilitation, based on the function of diary and recording of daily activities.

Although OrientaRVM content and usability analysis demonstrates content relevance and reliability, as well as functions of the resource for the target audience, some limitations need to be mentioned. Among them, usability non-assessment by professionals in the area of information and communication technology, which could have contributed to a better app function adequacy. Additionally, an analysis of such aspects was not carried out by the target audience, which could also indicate the need for adjustments for better understanding and use by patients.

Therefore, it is emphasized that the app contributes to advancement of knowledge in cardiology nursing, and can help in the educational process of patients who will undergo CABG. It should be noted that the app is in the implementation phase for subsequent free availability on Android and iOS platforms.

Conclusion

OrientaRVM is an app with reliable content and recommended to be used as an auxiliary resource in patient education before CABG surgery. As for usability, CVI and PA values demonstrated that the app is easy to handle as well as functionality and resources adequate for the purpose. It is inferred that such a tool can provide knowledge acquisition to patients through information about the heart, the disease, the surgery, care before and after surgery and rehabilitation and changes in lifestyle. In addition to this, it allows users to register important information about their treatment as well as dates of consultations, exams, among others. As a way of assessing knowledge, a quiz about the content was made available. Therefore, the app can be used by health professionals, especially nurses who work in the preoperative care units for CABG surgery as well as in technical and undergraduate training scenarios in health. As recommendations, we suggest OrientaRVM assessment and satisfaction with using the resource by the target audience.

Acknowledgments

The *Universidade Federal do Rio Grande do Norte* for granting a Scientific Initiation scholarship for the research project entitled "*Desenvolvimento e validação de aplicativo móvel para educação do paciente no pré-operatório de revascularização do miocárdio*", linked to Notice 01/2021.

Collaborations

Lima Neto AV, Silva IP, Mesquita SKC, Salvador PTCO, Almeida TCF, Oliveira PP and Costa IKF collaborated with the conception and project, data analysis and interpretation, writing of article or relevant critical review of intellectual content and final approval of the version to be published.

References

1. Campos HO, Rodrigues QT, Drummond LR, Lima PM, Monteiro MC, Wanner SP, et al. Exercise-based cardiac rehabilitation after myocardial revascularization: a systematic review and meta-analysis. Rev Cardiovasc Med. 2022;23(2):74.
2. Beckmann A, Bitzer EM, Lederle M, Ihle P, Walker J, Marshall U, et al. Health care analysis on myocardial revascularization in patients with chronic coronary artery disease: the multicenter REVASK study: design and protocol. Thorac Cardiovasc Surg. 2021;69(07):599-606.
3. Lopes RO, Castro J, Nogueira CS, Braga DV, Gomes JR, Silva RC, et al. Complicações do pós-operatório imediato de cirurgia cardíaca eletiva: estudo transverds. Referência. 2019;4(22):23-32.
4. Gomes ET, Silva JI, Bezerra SM. Elaboração da escala de avaliação do conhecimento de pacientes acerca da cirurgia cardíaca. Rev SOBECC. 2020;25(4):227-33.
5. Lucena JS, Silva AB, Marques MJ, Gomes BM, Sousa TD, Pereira EB. Ansiedade na cirurgia vascular e ações de educação em saúde no pré operatório Rev Enferm Digit Cuid Promoção Saúde. 2020;5(1):47-51.
6. An T, Oliver M. What in the world is educational technology? Rethinking the field from the perspective of the philosophy of technology. Learn Med Technol. 2021;46(1):6-19.
7. Xu L, Li F, Zhou C, Li J, Hong C, Tong Q. The effect of mobile applications for improving adherence in cardiac rehabilitation: a systematic review and meta-analysis. BMC Cardiovasc Disord. 2019;19(1):166.
8. Mendez CB, Salum NC, Junkes C, Amante LN, Mendez CM. Aplicativo móvel educativo e de follow up para pacientes com doença arterial periférica. Rev Lat Am Enfermagem. 2019;27(1):21-9.
9. Filatro A. Design instrucional contextualizado. São Paulo: SENAC; 2019. 215 p.
10. Salvador PT, Mariz CM, Vítor AF, Ferreira Júnior MA, Fernandes MI, Martins JC, et al. Validação de objeto virtual de aprendizagem para apoio ao ensino da sistematização da assistência de enfermagem. Rev Bras Enferm. 2018;71(1):16-24.
11. Moura TN, Moreira TM, Sousa AD, Santos Neto AC, Sousa RX, Lima LH. Elaboração e validação de jogo educativo para smartphone sobre hábitos de vida saudáveis para adolescentes. Texto Contexto Enferm. 2019;28:e20180252.
12. Fehring R. Methods to validate nursing diagnoses. Heart Lung. 1987;16(6):625-9.
13. Reguant-Álvarez M, Torrado-Fonseca M. El método Delphi. Rev d'innovació i recerca en educació. 2016;9(1):87-102.
14. Pasquali L. Instrumentação psicológica: fundamentos e práticas. Porto Alegre: Artmed; 2010. 568 p.
15. Goes FS. Desenvolvimento e avaliação de objeto virtual de aprendizagem sobre raciocínio diagnóstico em enfermagem aplicado ao recém-nascido pré-termo [tese]. Ribeirão Preto: Escola de Enfermagem de Ribeirão Preto, Universidade de São Paulo; 2010.
16. Filgueiras A, Galvão BO, Pires P, Fioravanti-Bastos AC, Hora GP, Santana CM, et al. Tradução e adaptação semântica do Questionário de Controle Atencional para o Contexto Brasileiro. Estud Psicol. 2015;32(2):173-85.
17. Alexandre NM, Coluci MZ. Validade de conteúdo nos processos de construção e adaptação de instrumentos de medidas. Cien Saude Colet. 2011;16(7):3061-8.
18. Meedya S, Win K, Yeatman H, Fahy K, Walton K, Burgess L, et al. Developing and testing a mobile application for breastfeeding support: the Milky Way application. Women Birth. 2021;34(2):e196-203.

19. Stephan LS, Almeida ED, Guimarães RB, Ley AG, Mathias RG, Assis MV, et al. Anticoagulação oral na fibrilação atrial: desenvolvimento e avaliação de um aplicativo de saúde móvel para suporte à decisão compartilhada. Arq Bras Cardiol. 2018;110(1):7-15.

20. Barra DC, Paim SM, Sasso GT, Colla GW. Métodos para desenvolvimento de aplicativos móveis em saúde: revisão integrativa da literatura. Texto Contexto Enferm. 2017;26(4):e2260017.

21. Almeida TC, Sousa MM, Gouveia BL, Almeida AA, Oliveira SH. Prototype of a motivational mobile application for people with hypertension. Acta Paul Enferm. 2021;34:eAPE001055.

22. Sousa EK, Morais EJ, Amorim FC, Oliveira AD, Sousa KH, Almeida CA. Elaboração e validação de uma tecnologia educacional acerca da violência contra a mulher. Esc Anna Nery. 2020;24(4):e20190314.

23. Vasconcelos SS, Gomes IL, Barbalho EV, Gouveia SS, Gouveia GP. Validação de uma cartilha sobre a detecção precoce do transtorno do espectro autista. Rev Bras Promoção Saúde. 2018;31(4):1-7.

24. Boateng GO, Neilands TB, Frongillo EA, Melgar-Quiñonez HR, Young SL. Best practices for developing and validating scales for health, social, and behavioral research: a primer. Front Public Health. 2018;6(1):1-18.

25. Chaves PR, Silva MC, Mendonça TS, Baldoni AO, Sérgio Silva ES, Belo VS, et al. Desenvolvimento e validação de cartilhas para cuidado farmacêutico de pacientes com diabetes mellitus em uso de insulinas. J Health Biol Sci. 2021;9(1):1-5.

26. Beauchemin M, Gradilla M, Baik D, Cho H, Schnall R. A multi-step usability evaluation of a self-management app to support medication adherence in persons living with HIV. Int J Med Inf. 2019;122(1):37-44.

27. Chumkasian W, Fernandez R, Win KT, Petsoglou C, Lord H. Adaptation of the MAUQ and usability evaluation of a mobile phone–based system to promote eye donation. Int J Med Inf. 2021;151(1):1-8.

28. Girão AL, Sampaio RL, Aires SF, Oliveira IC, Oliveira SK, Carvalho RE. MedSafe: protótipo de um jogo virtual sobre preparo e administração de medicamentos. Rev Min Enferm. 2019;23:e1239.

29. Sousa CS, Turrini RN. Desenvolvimento de aplicativo de celular educativo para pacientes submetidos à cirurgia ortognática. Rev Lat Am Enfermagem. 2019;27:e3143.

30. Reyes J, Washio Y, Stringer M, Teitelman AM. Usability and acceptability of everhealthier women, a mobile application to enhance informed health choices. JOGN Nurs. 2018;47(6):853-61.

31. Constantinescu G, Kuffel K, King B, Hodgetts W, Rieger J. Usability testing of an mHealth device for swallowing therapy in head and neck cancer survivors. Health Informatics J. 2019;25(4):1373-82.

32. Solecki IS, Justen KA, Porto JV, Wangenheim CA, Hauck JC, Borgatto AF. Estado da prática do design visual de aplicativos móveis desenvolvidos com App Inventor. Rev Bras Inf Educ. 2020;28(1):30-47.

33. Marques AD, Moreira TM, Jorge TV, Rabelo SM, Carvalho RE, Felipe GF. Usabilidade de um aplicativo móvel sobre o autocuidado com o pé diabético. Rev Bras Enferm. 2020;73(4):e20180862.

34. Clebone A, Kim MS, Gina W, Michael RA, Jeffrey H, James F, et al. Development and usability testing of the society for pediatric anesthesia pedi crisis mobile application. Anesth Analg. 2019;129(6):1635-44.

35. Villarreal V, Berbey-Alvarez A. Evaluation of mHealth Applications Related to Cardiovascular Diseases: a Systematic Review. Acta Inform Med. 2020;28(2):130-7.