ORIGINAL

Mobile application for nursing on drug therapy in adults and elderly: methodological study

Aplicativo móvel para a enfermagem sobre terapia medicamentosa em adultos e idosos: estudo metodológico

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Submission: 07/05/2024
Approved: 01/14/2025

ABSTRACT

Objective: To build and validate a mobile application for nursing aimed at preventing errors in drug therapy in clinical practice with adults and elderly. **Method:** methodological study of quantitative approach conducted between May and November 2023, in five stages: Literature review, content organization, application construction (designer and development), application validation by experts and adequacy of educational technology. The evaluation of content, appearance and usability was carried out through an online form with 13 *experts.* In the data collection, the instrument of Validation of Educational Content in Health was used, the instrument to validate the appearance of Educational Technology in Health and the *System Usability Scale.* **Results:** among the experts, the overall average score of the Content Validation Instrument was 0.98 (98%) and the Appearance Validation Instrument was 0.87 (87%), values considered excellent in the parameters of content validity and appearance. In the *System Usability Scale,* the final score of 91.2 points was obtained, a value considered best imaginable in the usability validity parameter. **Conclusion**: the mobile application was considered valid through the methodology applied to the experts. This application is an innovative resource based on scientific evidence.

Descriptors: Adult; Elderly; Medication Errors; Patient Safety; Mobile Apps; Educational Technology.

RESUMO

Objetivo: construir e validar um aplicativo móvel para a enfermagem voltado à prevenção de erros na terapia medicamentosa para a prática clínica com adultos e idosos. Método: estudo metodológico de abordagem quantitativa realizado entre maio e novembro de 2023, em cinco etapas: revisão da literatura, organização do conteúdo, construção do aplicativo (designer e desenvolvimento), validação do aplicativo por especialistas e adequação da tecnologia educacional. A avaliação de conteúdo, aparência e usabilidade foi realizada por meio de um formulário online com 13(treze) *experts*. Na coleta de dados foi utilizado o Instrumento de Validação de Conteúdo Educativo em Saúde, o Instrumento para Validar Aparência de Tecnologia Educacional em Saúde e a *System Usability Scale*. **Resultados:** entre os experts, a pontuação média global do Instrumento de Validação de Conteúdo foi de 0,98 (98%) e do Instrumento de Validação de Aparência de 0,87 (87%), valores considerados excelentes nos parâmetros de validade de conteúdo e de aparência. Na escala *System Usability Scale* obteve-se o escore final de 91,2 pontos, valor considerado melhor imaginável no parâmetro de validade de usabilidade. **Conclusão:** o aplicativo móvel foi considerado válido mediante a metodologia aplicada junto aos experts. Esse aplicativo é um recurso inovador, fundamentado em evidências científicas.

Descritores: Adulto; Idoso; Erros de Medicação; Segurança do Paciente; Aplicativos Móveis; Tecnologia Educacional.

INTRODUCTION

The error of administration of drugs is defined as an avoidable phenomenon that can lead to the improper use of a drug or drug, involving health professionals, patients or users. Such an error may result from deficiencies in the work processes involving medical prescription, drug descriptions and their formulation, organization, administration or monitoring[1].

Incorrect procedures in drug therapy represent the fourth leading cause of global death[2]. Although the preparation and administration of medicines are daily tasks and common to nursing, constituting approximately 40% of the work[3], every year, 134 million adverse events are reported in hospitals in low- and middle-income countries, contributing to 2.6 million deaths[4]. Patient safety, including adults and the elderly, is therefore a constant concern, covering management and care functions of nursing, with the aim of applying the best practices[5].

Several methods have been studied to reduce the risks to patients, especially in the prevention of errors at all stages of drug therapy[6], especially those using Information and Communication Technologies (ICTs)[7]. In this directive, permanent health education with the use of digital technologies has the purpose of modifying the behavior of the professional, derived from the critical analysis of what occurs in practice and seeking solutions with the teams to the difficulties encountered[8].

The educational technologies (TE) in health can be facilitating tools for permanent education, with greater engagement of nursing in the subject in question, promoting better access to information and, consequently, greater commitment to the patient. This type of technology has been favorable in the area of health, contributing to the modification of professional conduct[9].

Mobile apps are innovative digital technologies that can promote permanent health education. They offer visual, tactile and auditory features, making it easy to access information. These applications enhance the delivery of health services by enabling the rapid search for reliable and relevant information for care[10].

Digital Health uses ICT resources to produce and share reliable health-related information, meeting individual needs at the appropriate time[11]. Thus, a tool that assists in the prevention of errors in drug therapy, improves nursing care and promotes patient safety, providing agility and ease in consulting reliable information, tends to be an efficient and effective TE in preventing preventable events, this extends the application of digital health principles.

Therefore, it was aimed to build and validate a mobile application for nursing aimed at preventing errors in drug therapy in clinical practice with adults and elderly.

METHOD

Type of study

Methodological study[12] for the construction and validation of the content, appearance and usability of a mobile application carried out in five steps: literature review, content organization, application construction, validation by experts and adequacy of TE[13].

The first stage involved the search for scientific articles through an integrative literature review, identifying topics related to drug therapy to compose the theoretical content of the mobile application. For the searches, the research question was elaborated using the PICO strategy (P – Population; I – Interest; Co – Context), namely: "What has been produced in the literature about patient safety and errors in drug therapy in adults and the elderly?"

The information resources accessed were: Latin American and Caribbean Literature in Health Sciences (LILACS); Medical Literature Analysis and Retrieval System Online (MEDLINE); Scientific Electronic Library Online (SciELO); Nursing Database (BDENF); Cumulative Index to Nursing and Allied Health Literature (CINAHL); and Web of Science. The descriptors were: "Medication errors", "Drug Treatment Conduct", "intravenous administration", "Medication Systems at Hospital" and "Nursing Care", respecting the particularities of each informational resource.

The content organization was based on the analysis of the identified literature. A matrix containing the main data of the selected articles was elaborated, from which the thematic axes of the mobile application were built. Then, the contents were elaborated, with texts, images, links and tables. The theoretical basis used included COFEN Resolutions, scientific articles, laws, standard operating procedures, books, documents of the National Health Surveillance Agency and manuals of the Ministry of Health related to the subject, made available in the application.

The third step consisted of the construction of the mobile app, developed for Android and *iOS*

systems. The interface was built using the *Java Script language* by system programmers. *The React Native Framework was used,* creating the rendered application for different operating systems in conjunction with *the Compact* Expo, with application development tools *for* smartphones, in addition to the *Visual Studio Code text editor*.

At this stage, the team held meetings to ensure that the application interface met the research objectives. The design was developed to be attractive and enjoyable, integrating all the contents. The interface is designed to offer easy reading, with clear and objective information, in a visually appealing format.

The fourth step was the validation of the application by *experts,* the content was evaluated, ensuring the appropriate approach[14], the appearance, ensuring the aesthetics[15], and the usability, ensuring ease and efficiency in using the mobile app[16].

The adequacy of TE was performed according to the suggestions of *experts*, by agreement of 80%.

Scenario
The study took place in a virtual environment, *through* link to a *Google forms form.*

Period
The study was conducted from March to November 2023, with literature review in March-April, content organization in May-July, application construction in August-October, and data collection with experts and adjustments in TE in November.

Population
The study population consisted of nurses who had an approach to the theme.

Selection criteria
The experts were selected for convenience using the snowball technique[17] and analysis of the Lattes curriculum, with a minimum score of five points according to the Fehring model[18-19] : doctoral degree (4 points), master's degree (3 points), article published in specialized journal on the subject (2 points), proficiency in the subject (2 points), minimum assistance experience of 5 years in the area (2 points), and participation in scientific event on the subject in 2022 and 2021 (1 point).

The inclusion criteria were: having a master's or doctor's degree in nursing or the like; working with adult patients or having experience in educational practices; having publications on drug therapy, TE or application construction and validation. The following exclusion criterion was used: Incomplete or inconsistent forms.

Definition of the sample
As for the quantitative *of experts*, the recommendation most used in the scientific literature was adopted, that the number is greater than six[20] .

Study variables
The variables collected on the profile of *the* experts were: age, gender, professional training, professional qualification and time of professional experience. The second part of the form was composed of the instruments of validation of content, appearance and usability.

Instruments used for data collection
The data collection took place through an online form, which contained two parts, the first with questions for the characterization of *the profile of the experts* and the second with the evaluative instruments.

The following validated instruments were used: Instrument of Validation of Educational Content in Health (IVCES) for Content Evaluation, Instrument of Appearance Validation of Educational Technology in Health (IVATES) for Evaluation of Appearance and System Usability Scale — Brazilian Version - to evaluate usability.

The IVCES consists of 18 items divided into three domains (objectives, structure/presentation and relevance). The answers are given on a *Likert scale*, being 0=disagree, 1=partially agree and 2=fully agree[14].

IVATES consists of 12 items on the appearance of the application, distributed in five evaluative aspects of a *Likert scale* (I totally disagree, disagree, partially disagree, agree and fully agree) [15].

The System Usability Scale presents interspersed items of positive and negative evaluations, with the options of answers given in *Likert scale*, being 1 = strongly disagree, 2 = disagree, 3 = do not agree or disagree, 4 = agree, 5 = strongly agree[16].

Data collection
Experts were selected based on eligibility criteria by consulting the Lattes curriculum. Invitations were sent by email or *WhatsApp* for participation, starting with close contacts of

the team and expanding through a reference chain[17]. Participants accessed a *Google Forms form* via *a* link sent, which included study information and the Free and Informed Consent Registration for download. After consenting, the experts filled out the instruments. Those who met the eligibility criteria in the first part of the form comprised the study sample. The deadline of 10 days for response was set; the non-respondents within this period were excluded.

Data processing and analysis

To characterize the profile of experts, the analysis was performed using descriptive statistics, which included simple frequency, central tendency measures (mean and median) and dispersion measures (standard deviation).

The item-by-item content was analyzed using the total score of the IVCES, which brings together the domains of objectives, structure/presentation and relevance. The Content Validity Index (IVC) was calculated by adding the "partially agree" and "fully agree" tags and dividing by the total number of responses. Items with agreement of at least 80% were considered valid, preferably above 90%, according to the literature [14]. Items with low validation would be deleted or reviewed.

To analyze the appearance of the application, it is recommended to use the Appearance Validity Index (VAT), calculated from the IVC. VAT is obtained by dividing the number of experts who answered "I agree" or "totally agree" by the total number of respondents. The total VAT is the average of the IVAs of the items. It was considered VAT > 0.78 as excellent, 0.60 < IVA < 0.77 as adjustments are necessary, and IVA < 0.60 as poor, requiring reformulation of the application[15].

To analyze the usability of the application, the final score of the System Usability Scale (SUS), Brazilian version was used. For odd items, 1 was subtracted from the evaluator's score; for even items, 5 was subtracted. The final score was the sum of these values multiplied by 2.5. The scores were classified as: Up to 20.5 (worst imaginable), 21 to 38.5 (poor), 39 to 52.5 (at the average), 53 to 73.5 (good), 74 to 85.5 (excellent) and 86 to 100 (best imaginable)[16]. The analysis of the SUS scale by domains included the "ease of knowledge (items 3, 4, 7 and 10), efficiency (items 5, 6 and 8), inconsistencies (item 6), ease of memorization (item 2) and user satisfaction (items 1, 4 and 9)"[21]. The overall average per domain was calculated

by adding the points of each item per participant, multiplying by 25 to obtain a scale from 0 to 100, and dividing the sum of the averages of the items by the number of items in the domain[21].

The scores for each domain's items were multiplied by 25 to obtain a variation of 0 to 100[21]. Then, both in the validation phase and in the evaluation phase, the overall mean of the scores for each question was calculated, adding the points and dividing by the number of participants. Then, the average of the items for each domain was obtained by adding the points of the domain items and dividing by the total of domain items[22].

Ethical aspects

The research was approved by the Research Ethics Committee of the Universidade Federal Fluminense (Opinion 5.725.119; CAAE: 60748122.8.0000.8160), following Resolution No. 466/2012 of the National Health Council (CNS), participants registered their consent online by marking the "I have read and agree" option in the ETS.

RESULTS

From the integrative literature review, nine themes were listed for the composition of the content of this technology, namely: 1) Professional Safety, 2) Prevention of Infections, 3) Error Prevention, 4) Calculation of Medicines, 5) Ways of Administration, 6) Diluents, 7) Deferral and Check, 8) Preparation of Medications and 9) Training of the Nursing Team. A theme about the goals of the application and the idealizing team, called "Who we are", was also included.

For the construction of each thematic content, a script was created *in word* with texts, schemes and illustrations based on the theoretical framework. We opted for practical language, which would hold the reader's attention and facilitate communication quickly. The illustrations were used from the *Canva image bank,* education version.

The mobile application on drug therapy in adults and elderly was evaluated by 13 (100.0%) experts, 11 (84.6%) women and 2 (15.4%) men. The average age of the experts was 39 years, with standard deviation (SD) of ± 10.38 25, ranging from 57 to years. As for the time of professional experience, the specialists had an average of 15 years (± SD 10.24 61.5), eight (23.1%) have a PhD degree, three (15.4%) master and two (%) have a specialty in nursing.

Of the total number of experts, six (46.2%) working with adult patients, 10 (76.9%) have experience in educational practices, nine (69.2%) have publications on TE, seven (53.8%) have publication on application construction and validation, and three (23.1%) have publications on drug therapy.

The experts' evaluation of the content of the mobile application obtained an average IVC of 0.98, indicating the validity of the application content (Table 1). The values of the items varied between 0.76 and 1.00. Item 15, referring to the size of the text, was the only one that did not reach the minimum IVC of 80%, requiring revision.

Table 1 – Distribution of answers from *experts* according to items from IVCES, =n 13, Rio das Ostras, RJ, Brazil, 2023

CONTENT OF THE APPLICATION				
Items	**Disagree**	**Agree partially**	**Totally agree**	**IVC**
OBJECTIVES				
1. It includes a proposed theme	0	0	13	1,00
2. Suitable for the teaching-learning process	0	4	9	1,00
3. It clarifies doubts about the topic addressed	0	0	13	1,00
4. Proporciona reflexão sobre o tema	0	4	9	1,00
5. It encourages change of behavior	0	6	7	1,00
STRUCTURE/PRESENTATION				
6. Language suitable for the target audience	0	1	12	1,00
7. Language appropriate to educational material	0	2	11	1,00
8.Interactive language, allowing active involvement in the educational process	1	4	8	0,92
9. Correct information	0	2	11	1,00
10. Objective information	0	4	9	1,00
11. Enlightening information	0	1	12	1,00
12. Information required	0	0	13	1,00
13. Logical sequence of ideas	0	1	12	1,00
14. Current theme	0	0	13	1,00
15. Appropriate text size	3	5	5	0,76
RELEVANCE				
16. It stimulates learning	0	4	9	1,00
17. It contributes to knowledge in the area	0	1	12	1,00
18. It arouses interest in the theme	0	3	10	1,00
AVERAGE IVC 0.98				

The experts' evaluation of the content of the mobile application obtained an average IVA of 0.87, considered excellent in the appearance validity (Table 2). The index of the items varied between 0.61 and 0.92. Items 2 and 11, referring to the clarity and size of the illustrations, were classified as necessary for adjustments and improvement of the appearance of the application.

Table 2 – Distribution of answers from *experts* according to items of IVCES, =n 13, Rio das Ostras, RJ, Brazil, 2023

APPEARANCE						
Items	**DT**	**D**	**DP**	**C**	**CT**	**IVA**
1. The illustrations are suitable for the target audience.	0	0	1	7	5	0.92
2. The illustrations are clear and convey ease of understanding.	0	0	3	6	4	0.76
3. The illustrations are relevant to understanding the content by the target audience.	0	0	1	6	6	0.92
4. The colors of the illustrations are suitable for the type of material.	0	0	1	7	5	0.92
5. The shapes of the illustrations are suitable for the type of material.	0	0	1	6	6	0.92
6. The illustrations depict the daily life of the target audience of the intervention.	0	0	1	7	5	0.92
7. The layout of the figures is in harmony with the text.	0	0	1	5	7	0.92
8. The figures used elucidate the content of the educational material.	0	0	1	7	5	0.92
9. The illustrations help in the exhibition of the theme and are in a logical sequence.	0	0	1	5	7	0.92
10. The illustrations are in adequate quantity in the educational material.	0	1	1	6	5	0.84
11. The illustrations are in adequate size in the educational material.	0	0	5	5	3	0.61
12. The illustrations help in changing the behaviors and attitudes of the target audience.	0	0	1	6	6	0.92
AVERAGE IVA 0.87						

Legend: DT – I totally disagree; D – I disagree; DP – I partially disagree; C – I agree; CT – I totally agree

The evaluation of *the* experts regarding the usability of the mobile application obtained the final score of 91.2 points in the SUS scale, a value considered best imaginable, indicating that the application is valid for its usability (Table 3).

Table 3 – Distribution of answers from *experts* according to items of SUS Scale, =n 13, Rio das Ostras, RJ, Brazil, 2023

USABILITY OF THE APPLICATION

Items	DF	D	NCND	C	CF
1. I think I would like to use this system often.	0	0	0	3	10
2. I found this system unnecessarily complex.	7	5	0	1	0
3. I found this system easy to use.	0	0	1	2	10
4. I thought I would need help from a technical person to be able to use this system.	13	0	0	0	0
5. I found the various functions of this system were well integrated.	0	0	1	3	9
6. I think the system has a lot of inconsistency.	11	2	0	0	0
7. I suppose that most people can learn how to use this system quickly.	0	1	0	3	9
8. I found this very heavy to use.	11	1	1	0	0
9. I felt very safe using the system.	2	0	1	3	7
10. I had to learn many things before I could use this system	11	2	0	0	0

FINAL SCORE 91.15

Legend: DF – I strongly disagree; D – I disagree; NCND – I do not agree nor disagree; C – I agree; CF – I strongly agree

All items of the SUS scale obtained an average greater than 86 among the experts in its first version. All domains of the scale had a general average greater than 86 indicating that the application contemplates the usability characteristics regarding the ease of knowledge and memorization of the system, high satisfaction and efficiency (Table 4).

Table 4 – Validation of experts regarding usability characteristics by SUS scale domains, Rio das Ostras, RJ, Brazil, 2023.

Features of usability	Average of items	Average domains	Meaning
Ease of knowledge of the system	I3 (92.3) I4 (100.0) I7 (90.3) I10 (96.1)	94.7	Easy to use system when used for the first time
System efficiency	I5 (90.3) I6 (96.1) I8 (94.2)	93.5	Speed in the execution of the established tasks
Inconsistencies	I6 (96.1)	96.1	Absence or low error rate
Easy to store	I2 (86.5)	86.5	Easy to run system even after a long period without using it
User satisfaction	I1 (94.2) I4 (100.0) I9 (75.0)	89.7	*Nice* design

The evaluation of the mobile application was considered satisfactory, however, it was decided to adapt some aspects, especially related to the content and appearance of the application according to *the suggestions of the* experts. The second version of the mobile application titled "Enf at the right dose" (Figure 1) consists of 10 tabs, 16 subtabs and a dilution table for injectable products. The app will be available in the *Google* Play app stores and *App Store* for free.
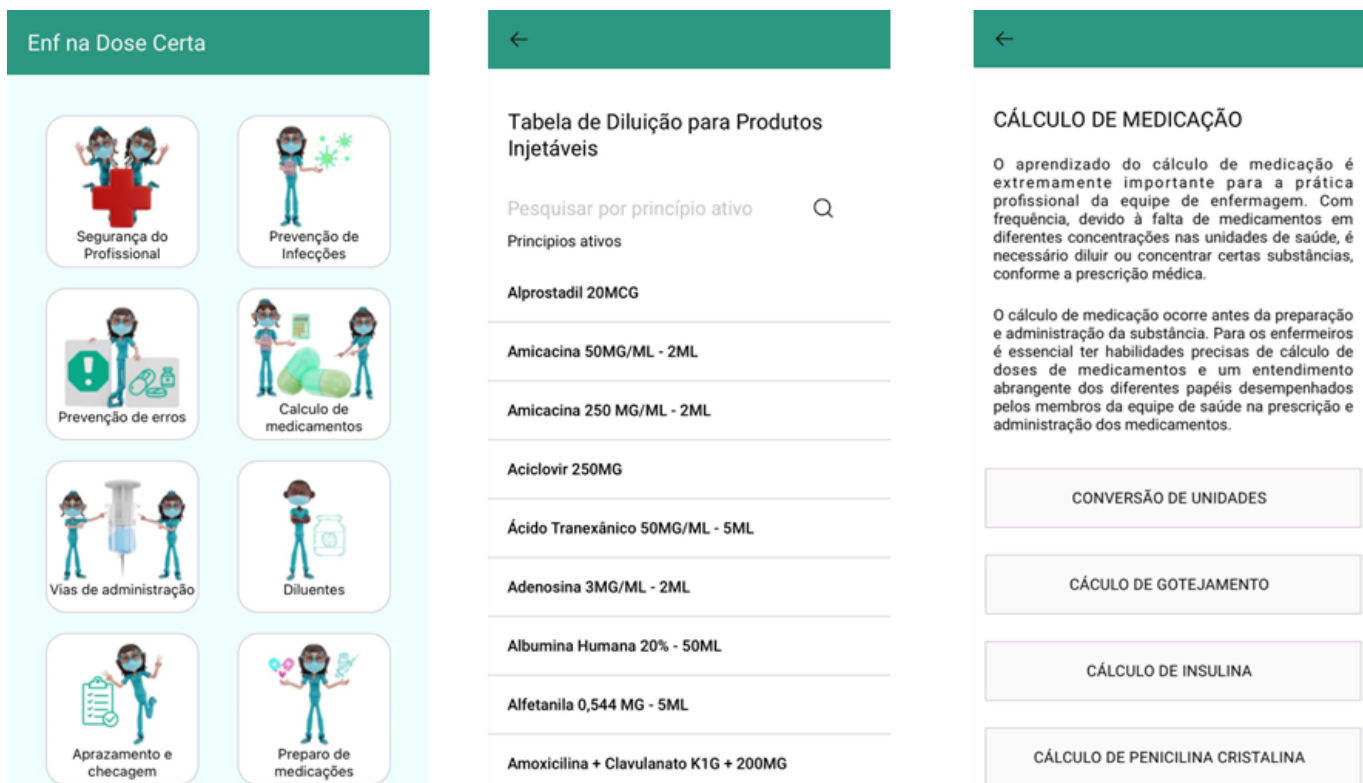
Figure 1 – Home screen, sub-tab screen and dilution table screen for injection products of the ENF mobile application at the right dose, Rio das Ostras, RJ, Brazil, 2023

DISCUSSION

The main finding of this study was the conception and positive validation of an application, demonstrating its potential as TE for the prevention of drug errors and the promotion of patient safety. This type of mobile technology innovates nursing, changing the practice of nurses and interaction with other health professionals, promoting health[23]. Health applications (m-healths) are attractive, dynamic, affordable and low-cost, simplifying learning and providing educational support in health at any time and place, highlighting the importance of mobile technology in health education[24].

The application "ENF at the right dose" was created to simplify access to information about drug preparation and administration, aiming at the safety of adult and elderly patients, helping to mitigate doubts and reduce errors in drug therapy.

Health applications are fundamental to face challenges in health care and administration[25], connecting the daily practice of nurses to the virtual environment, expanding the dissemination of guidelines and promoting knowledge, benefiting both nurses and patients with technological innovations[26].

Nursing applications have become important for access to information, so it is essential that they are based on scientific evidence to ensure the safety of professionals and constitute viable tools for planning care, expanding digital health[27]. Experts considered the application as a VALID TE in content, appropriate for teaching-learning, clarifying doubts and promoting reflections and behavior changes[28].

Overall, the judges' reviews of appearance were positive. As indicated in the literature, the design and structure of mobile applications have the potential to positively impact the user, facilitating reading, optimizing time and improving the overall experience[29] . All the suggestions of *the experts* related to the appearance were contemplated for the second version of the application, in particular include a "click to enlarge" sign in the images and, also, to increase the font size of the texts to improve readability. A research on the elaboration and validation of a breastfeeding application, with 20 nurses, revealed an average CVI of 0.96, slightly lower than that of the application "Enf at the right dose". Despite the complex theme, the content is valid for the target audience. Regarding appearance, the font size (IVC=0.95) and the understanding

of the images (IVC=0.90) were well evaluated. Although the results were not the same as the study cited, the VAT of the application was considered excellent, and all suggestions were incorporated in the second version [13].

Usability is fundamental in the development of technological innovations in health to ensure clear language, proper instructions and understandable information in navigation [30]. The application "ENF at the right dose" obtained a usability score considered best imaginable, aligning itself with the results of a previous study that validated the usability of an application for primary care in diabetes mellitus[22]. The use of mobile applications in clinical practice can reduce adverse events and the length of hospital stay, however, information on their effectiveness is still limited. It is noteworthy that, even in the face of evidence suggesting a positive impact, mobile applications in the health area should serve as support for clinical decision-making, not as substitutes[31].

Thus, a necessary strategy is to combine the use of accessible and scientific evidence-based mobile applications with personal interactions in the permanent education of nursing professionals[32]. The technology used in this strand can promote the increase of knowledge in an interactive and attractive way, besides bringing relevant outcomes to clinical practice, which enhance patient safety, minimize harm and adverse events and promote innovation in nursing care[32].

A study of technological prospecting that sought in virtual stores and search tools, mobile applications aimed at the guidance of professionals, patients and companions on patient safety and analyzed 25 applications. Of the total applications analyzed, only three are specifically related to drug safety and, of these, two are available in the English language and one, whose purpose is a drug safety game, is available in the Portuguese language[32]. Also, the absence of information on the validation of content and usability of the applications was a highlight in the study findings, reiterating the need to provide this information accessible to the consumer of mobile applications. This finding demonstrates the scarcity of applications focused on the theme and the character of novelty of the application "Enf in the right dose" in the Brazilian context, considering the specificities of nursing.

The application "ENF at the right dose" has great potential to promote safe nursing care in drug therapy, standing out as an innovative strategy that contributes to the construction of knowledge, aiming to reduce medication errors, thus enhancing patient safety. This study has limitation in relation to validation done only by specialists. However, it is essential that the app is also evaluated by the target audience.

CONCLUSION

The application "Enf at the right dose" was built and validated satisfactorily by nursing experts, standing out as a valuable educational tool for professionals. This initiative represents a significant advance in the application of technology in nursing, focusing on the prevention of medication errors and patient safety. Based on scientific evidence, the application offers quick and easy access, promoting security during procedures. This study is expected to motivate other nurses to develop technologies that improve the quality of care provided.

CONFLICT OF INTERESTS

The authors have declared that there is no conflict of interests.

REFERENCES

1. Paulino GME, Matsuda LM, Matta ACG, Ferreira AMD, Dias AO, Silva LF. Custos e causas-raízes de erros de medicação e quedas em hospital de ensino: estudo transversal. Texto & contexto enferm. 2021;30:e20200045. https://doi.org/10.1590/1980-265X-TCE-2020-0045

2. Izadpanah F, Moradi M, Amini M, Rahimpour A. Evaluating the effects of medication reconciliation by pharmacists on patient safety in hospitalized patients. [Internet] RJMM. 2021 [cited 10 Apr 2024].;124(3):393-7. Available from: http://www.revistamedicinamilitara.ro/wp-content/uploads/2021/07/Evaluating-the-effects-of-medication-reconciliation-by-pharmacists-on-patient-safety-in-hospitalized-patients.pdf

3. Kim K, Lee I. Medication error encouragement training: A quasi-experimental study. Nurse Educ Today. 2020;84:e104250. https://doi.org/10.1016/j.nedt.2019.104250

4. Samico CSB, Henriques A, Lucas P. Occurrence of medication administration errors - integrative review. NTQR. 2021;8:496-504. https://doi.org/10.36367/ntqr.8.2021.496-504

5. Hamdan M, Jaaffar AH, Khraisat O, Issa MR, Jarrar M. The association of trans-

formational leadership on safety pratices among nurses: the mediating role of patient safety culture. Risk Management and Healthcare Policy. 2024;17: 1687-700. https://doi.org/10.2147/RMHP.S458505

6. Benedik FN, Andrade MC, Silva LL, Júnior AMF, Lima AB. Development and validation of a mobile application for calculating pediatric doses in the pediatric intensive care unit and urgency and emergency. REAS. 2021;13(3):1-10. https://doi.org/10.25248/REAS.e6498.2021

7. Costa CRB, Santos SS, Godoy S, Alves LMM, Silva IR, Mendes IAC. Strategies for reducing medication errors during hospitalization: integrative review. Cogitare Enferm. 2021;26:e79446. https://doi.org/10.5380/ce.v26i0.79446

8. Ferreira L, Barbosa JSA, Esposti CDD, Cruz MM. Permanent health education in primary care: an integrative review of literature. Saúde debate. 2019;43(120):223-39. https://doi.org/10.1590/0103-1104201912017

9. Portal LC, Souza TRM, Carlos ALNS, Vaz DWN, Ribeiro MES, Souza GF, et al. Educating to empower: the use of educational technologies for hospital infection control and prevention. Braz J of Develop. 2020;6(7):50658-73. https://doi.org/10.34117/bjdv6n7-643

10. Ferreira DP, Junior SCSG. Mobile applications developed for children and adolescentes experiencing chronic health conditions: na integrative review. Interface (Botucatu). 2021;25:e200648. https://doi.org/10.1590/interface.200648

11. Muniz VO, Mota TN, Sousa AR. Saúde digital à brasileira e a prática clínica em enfermagem: do que estamos falando? Enferm Foco. 2023;14:e-202336. https://doi.org/10.21675/2357-707X.2023.v14.e-202336

12. Gigante VCG, Oliveira RC, Ferreira DS, Teixeira E, Monteiro WF, Martins ALO, et al. Construction and validation of educational technology about alcohol consumption among university students. Cogitare Enferm. 2021;26:e71208. http://dx.doi.org/10.5380/ce.v26i0.71208

13. Souza AN, Góes FGB, Mello NC, Silva LF, Silva ACSS, Barcellos TMT. Educational technolo-gy about breastfeeding for mobile devices. Cogitare Enferm. 2021;26:e78118. http://dx.doi.org/10.5380/ce.v26i0.78118.

14. Leite SS, Áfio ACE, Carvalho LV, Silva JM, Almeida PC, Pagliuca LMF. Construction and validation of an educational content validation instrument in health. Rev bras enferm. 2018;71(suppl 4):1732-8. https://doi.org/10.1590/0034-7167-2017-0648

15. Souza ACC, Moreira TMM, Borges JWP. Development of an appearance validity instrument for educational technology in health. Rev bras enferm. 2020;73(Suppl 6):e20190559. http://dx.doi.org/10.1590/0034-7167-2019-0559

16. Lourenço DF, Valentim EC, Lopes MHBM. Translation and cross-cultural adaptation of the System Usability Scale to Brazilian Portuguese. Aquichan. 2022;22(2):e2228. https://doi.org/10.5294/aqui.2022.22.2.8

17. Vinuto J. A amostragem em bola de neve na pesquisa qualitativa: um debate em aberto. Temat. 2014;22(44):203-20. https://doi.org/10.20396/tematicas.v22i44.10977

18. Fehring RJ. Symposium on validation models: the Fehring model. ln: Carrol-Johnson RM, Paquette M. Classification of Nursing Diagnoses - Proceedings of the Tenth Conference. North American Nursing Diagnosis Association. Philadelphia, PA: Lippincott; 1994. p. 55-62

19. Dantas DC, Góes FGB, Santos AST, Silva ACSS, Silva MA, Silva LF. Produção e validação de vídeo educativo para o incentivo ao aleitamento materno. Rev gaúcha enferm. 2022;43:e20210247. https://doi.org/10.1590/1983-1447.2022.20210247.pt

20. Silva ACSS, Góes FGB, Ávila FMVP, Goulart MCL, Pinto LF, Stipp MAC. Construção e validação de aplicativo móvel para educação em saúde acerca da COVID-19. Rev gaúcha enferm. 2022;43:e20210289. https://doi.org/10.1590/1983-1447.2022.20210289.pt

21. Cavalcanti HGO, Bushatsky M, Barros MBSC, Melo CMCS, Filho AJFD. Avaliação da usabilidade de um aplicativo móvel para detecção precoce do câncer pediátrico. Rev gaúcha enferm. 2021;42:e20190384. https://doi.org/10.1590/1983-1447.2021.20190384

22. Melo CMCS, Filho AJFD, Oliveira ER, Araújo AA, Cavalcanti HGO, Melo CMCS, et al. De-

velopment and assessment of an application for primary care for users with diabetes mellitus. Aquichan. 2020;20(2):e2026. https://doi.org/10.5294/aqui.2020.20.2.6

23. Mello NC, Góes FGB, Pereira-Ávila FMV, Moraes JRMMM, Silva LF, Silva MA. Construction and validation of an educational booklet for mobile devices on breastfeeding. Texto & Contexto enferm. 2020;29:e20180492. https://doi.org/10.1590/1980-265X-TCE-2018-0492

24. Neto NMG, Sá GGM, Barbosa LU, Pereira JCN, Henriques AHB, Barros LM. Covid-19 and digital technology: mobile applications available for download in smartphones. Texto & contexto enferm. 2020;29:e20200150. https://doi.org/10.1590/1980-265X-TCE-2020-0150

25. Salomé GM, Rosa GCM, Rosa JI. Validação do aplicativo móvel asptraqueal para aspiração. Rev enferm contemp. 2022;11:e3982. https://doi.org/10.17267/2317-3378rec.2022.e3982

26. Maciel NS, Ferreira DS, Oliveira AWN, Santos MP, Costa CC, Sousa LB. Aplicación móvil sobre sífilis para adolescentes: validación de apariencia y contenido. Enferm global. 2023;22(1):499-534. https://doi.org/10.6018/eglobal.529961

27. Leigh S, Ashall-Payne L, Andrews T. Barriers and facilitators to the adoption of mobile health among health care professionals from the United Kingdom: discrete choice experiment. [Internet] JMIR Mhealth Uhealth; 2020 [cited 10 Apr 2024];8(7):e17704. Available from: https://pubmed.ncbi.nlm.nih.gov/32628118/

28. Júnior CJS, Júnior SNS, Costa PJMS. Construção e validação de tecnologia educativa no formato de história em quadrinhos na área de imunizações: instrumento de autocuidado e de estímulo à vacinação infantil. Ciênc educ (Bauru). 2021;27:e21036. https://doi.org/10.1590/1516-731320210036

29. Paes VM, Polimeno C, Souza CS, Costa JPS, Andrade RM, Gaspar R. Experiência do usuário e design de interação: uma análise bibliométrica de publicações acadêmicas. InfoDesign. 2022;19(1):1-18. https://doi.org/10.51358/id.v19i1.906

30. Barboza HN, Lima MC, Ferreira RJS, Rosa MRD, Araújo ALLS, Acioly ASG. Avazum app usability testing. [Internet] Codas; 2023 [cited 10 Apr 2024];35(5):e20220103. Available from: https://pubmed.ncbi.nlm.nih.gov/37820196/

31. Andrade LS, Silva RFA, Tonini T. Nursing Alert® mobile app to support nurses in identifying patient clinical deterioration. Rev enferm UERJ. 2022;30:e65600. https://doi.org/10.12957/reuerj.2022.65600

32. Mendes LA, Antunes CC, Alves TF, Manzo BF. Aplicativos de apoio à educação sobre a segurança do paciente hospitalizado: prospecção tecnológica. Online Braz J Nurs. 2024;23:e20246671. https://doi.org/10.17665/1676-4285.20246671

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