GeriatricHelper: Iterative Development of a Mobile Application to Support Geriatric Assessment

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Abstract. Clinical assessment scales for specific medical subareas include domain knowledge that may not be of general awareness among practitioners, hindering the adoption of best practices. In this context, we propose a pocket guide for comprehensive geriatric assessment as a mobile application. The GeriatricHelper is an Android mHealth application developed under an iterative, User-Centered Design approach. Feedback from a broad set of users including domain experts has been obtained throughout and a functional prototype is currently being tested in a Portuguese hospital, allowing for any clinician to apply the otherwise experts-limited geriatric assessment.

Keywords: mHealth · Geriatrics · Comprehensive geriatric assessment
Android · Patient follow-up · Pocket guide · User Centered Design

1 Introduction

The Comprehensive Geriatric Assessment (CGA) [1, 2] is a multidimensional and interdisciplinary evaluation of the elderly. It is composed of mental, functional, nutritional and social areas of assessment, each one containing several related scales. Its main objectives are to reach a precise and full diagnose and facilitate prevention and follow up. CGA is applied to people over 75 years old, or over 65 if in risk situations, such as lack of social support, multiple pathologies, chronic disease or institutionalization. Being a multidisciplinary evaluation, it would ideally be applied by physicians, nurses, social services technicians, gerontology doctors and physiotherapists. It should be performed on a regular basis to better adjust to the decaying health conditions of some patients.

The inexistence of a formal medical specialty in Geriatrics, in Portugal, makes it difficult to widely apply CGA in routine, due to the lack of awareness and training to this kind of evaluation. There are only three medical centers in Portugal in which CGA is performed by a multidisciplinary team (nutritionist, doctor and pharmaceutical). For the remaining locations, CGA is applied by a single person, mainly an internal medicine doctors or general practitioner, filing a paper form. In the current practice, doctors need to calculate the result for each scale by hand.

After performing the scales relevant to the appointment, a health professional may need to prescribe medicine. The Start/Stopp [3] and Beers [4] criteria make up a

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valuable tool, since they advise on drugs that should or should not be prescribed to the elderly. However, these encompass large lists that would profit from easier access.

In this paper, we describe the development of a mobile application to act as a pocket guide to assist any practitioner to apply the CGA scales, applying a User-Centered Design approach.

2 Related Work

Currently, there are some mobile solutions focused on assessing the elderly. PT-Measures [5] includes one scale from the mental area and five from the functional area, which are grouped by their respective area; each scale includes some associated textual info; scales can't be performed for a patient, instead, after performing each scale individually, the doctor inserts the patient's personal information; this application doesn't include any clinical criteria.

Indicators of dependence [6] contains eleven scales, from mental, functional and social areas, but scales aren't grouped into areas; there is detailed information on how to perform each scale, their scoring outcomes and associated bibliography; scales can't be associated to a patient, only saved with a keyword.

iGeriatrics [7] was developed by the American Geriatrics Society, doesn't include information on how to perform CGA, but instead covers a wide range of topics related to older adults, such as vaccinations and prevention of falls. It doesn't allow to perform scales, but contains the Beers criteria.

OncoScale [8] includes mental, functional and nutritive scales, grouped into areas; there is info about a scale's bibliography and how to perform it. As a side-note, none of these apps allows tracking patient's medication.

As we can see, some of them implement only part of the required functionalities. It is important to stress out that CGA is performed i.e., it can assess multiple areas and contain multiple scales or tests, while these apps only allow to perform one test at a time.

3 GeriatricHelper

Motivated by the abundance of smartphone devices, mainly Android, and the convenience for a technology-oriented CGA, we propose GeriatricHelper, an Android mobile application that implements a mobile-oriented CGA, act as a guide on how to perform CGA, and includes the clinical criteria that may aid health professional prescribing drugs for the elderly.

3.1 Methods

To implement this solution, we opted for User Centred Design (UCD) [9], based on the end-user characterization, example workflows and requirements, so the objective was to obtain a final product with high usability standards.

For requirements elicitation, in a first instance, Personas were built and scenarios defined for the context of interest. Personas provide examples of representative users, for better capturing not only the roles, but also the motivations of users in using the technology in their daily activities. Personas include a description of tasks, expectations, and user profiling information, to "humanize" actors.

Being an iterative process, we opted for short cycles of prototyping followed by evaluation adjusted to the current stage of development.

3.2 Users and Scenarios

The first stage of the development process consisted of a brainstorming session with a doctor from the Geriatric Studies Center (*Núcleo de Estudos de Geriatria* -GERMI) [10], of the Portuguese Society of Internal Medicine (*Sociedade Portuguesa de Medicina Interna*). During this session, some use cases were established, for the application, who would use it and in which context, as well as which high-level features should be implemented.

Then, we created four Personas, corresponding to two doctors and two patients (not provided here in full for compactness). One of the Personas is a doctor profile, Albert, a 55 years old Family Doctor. He performs the CGA daily. To view a patient's progress, he must consult the previous paper records and that can be quite cumbersome. Sometimes he uses his tablet to store notes about his patients.

One of the "patient" Personas is 82 years old Laura. She had a brain vascular accident which led to problems in locomotion and right side dexterity. Very often she experiences some level of depression. She has already taken some drugs to help her, but very frequently she finds herself questioning her daily life and feeling alone. She would like to feel more well fit into society.

Based on the Personas and on the information collected during the initial brainstorming session, scenarios were proposed. As an example, we have "Laura's monthly appointment". To reevaluate her, Albert decides it is better to redo every CGA test. He opens her patient profile in the app and creates a new evaluation for her. The doctor thinks that Laura has been sadder recently, so conducts a test for tracking depression. He checks her temporal evolution for that test and sees that the results got worse, so he should prescribe some medicine for that.

Albert consults the app and inserts the name of the medicine he has in mind. The app informs him that this medicine should be avoided for a health issue Laura already has. He searches another drug by using the Start criteria that inform which drugs are best for certain conditions.

3.3 User Requirements

The system requirements dictated the features included on each prototype. As expected, these changed along with the development of the application, since, after each evaluation, the overall performance results and participant feedback were discussed leading to ideas for new and refined requirements. Table 1 contains a list of the requirements considered for each of the prototypes (P1, P2 and P3).

Table 1. Requirements for each of the prototypes. New requirements that were added to each list appear in bold, strikethrough requirements weren't implemented on the prototype.

Prototype version	Subset of the original requirements list implemented
P1	1. Possibility to create new patients 2. View a patient's profile 3. Must allow to track the patient's progress 4. Create new evaluations 5. Act as a guide for choosing the best medicine for a given patient ~~6. Patients data must remain confidential always~~ 7. Store information relative to patients and evaluations
P2	**8. Act as a guide on how to conduct a CGA evaluation**
P3	**9. Export a session's result into a PDF file** **10. Save drugs prescribed to a patient**

3.4 Evolving Prototypes

Three prototypes were developed, beginning with a requirements elicitation and the outcomes of each iteration were subject of user assessment (Fig. 1).

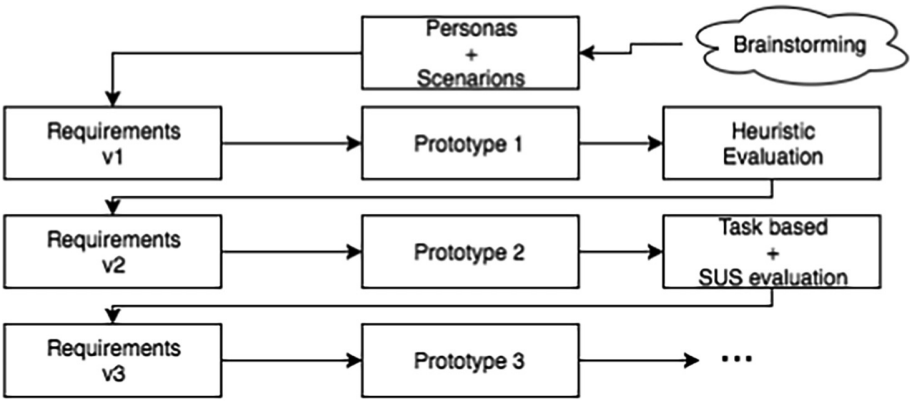

Fig. 1. Iterative design and development approach, integrating User-Centered Design, and multiple cycles of requirement elicitation, prototype development and evaluation.

3.4.1 First Iteration

The first prototype was based on the initial system requirements (Table 1). This prototype (P1) allowed to conduct public and private CGA sessions (Fig. 2a), consult medical criteria (Fig. 2d), and manage patient's profiles (Fig. 2c), along with their respective sessions.

The iterative method followed considers that the evaluation type should be adapted to the current stage of development. The objective for P1 evaluation was mainly to

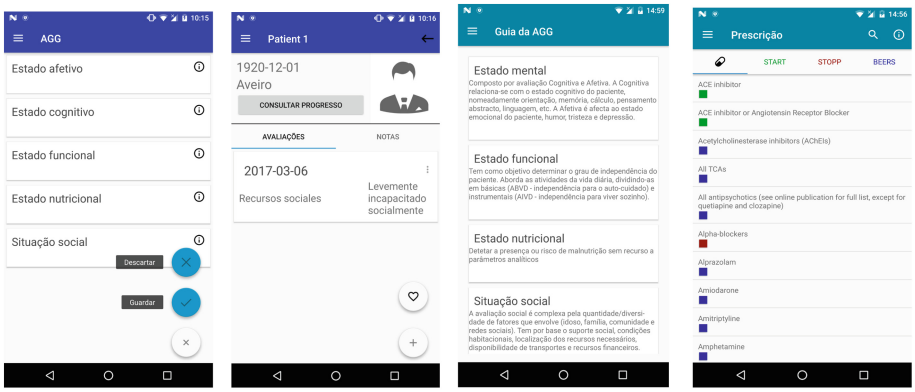

Fig. 2. Screenshots of the first (a), (b) and second (c), (d) prototype running on a smartphone. (a) displays an ongoing CGA session, (b) is a patient's profile, (c) the CGA guide and (d) a list of drugs.

expose issues concerning general usability guidelines, focusing on platform and context specific methods in later stages of the usability evaluation process. Being a broader evaluation, Nielsen's heuristics [11] were chosen as the evaluation method. Considering the general purpose of this first stage of evaluation, the users who participated in the evaluation were not yet domain experts, but five students from a Computer Science degree (at University of Aveiro) who had previous knowledge about Nielsen's heuristics. Besides those heuristics, we also considered as important the *Competency* concept from Health-ITUEM [12] and *Pleasurable and respectful interaction* and *Privacy* heuristics from the heuristics proposed for mobile interfaces [13].

Most of the usability problems found were not severe to the point to make it impossible for a user to use the application. The heuristic that had more flaws was Aesthetic and minimalist design, in both versions of the app (smartphone and tablet), with comments such as "There is too much text" or "Text is too small".

3.4.2 Second Iteration

The second prototype (P2) added the possibility to register in the app, contained improvements to patients and sessions management, allowed adding textual notes to a patient, the application could run on more devices, sessions appeared in a dedicated menu entry, made it easier to quickly check which type of requirements were associated to a drug, and allowed to consult tests information as a pocket guide (Fig. 2c).

P2's evaluation aimed to detect additional usability issues that become apparent when trying to reach concrete goals. Think aloud was the chosen evaluation method, since it is based in tasks and goals. Goals consisted of 15 tasks which the user will perform based on the workflows identified for the app from the devised scenarios such as "Check patient's progress relative to Clock Drawing scale" or "Consult Start criteria associated with Metformin". The participants in this evaluation were eleven individuals

with knowledges of Human Computer Interaction (HCI) and/or mobile applications development.

Besides measuring the time taken to complete a task and the success rate, we deemed as necessary to have concrete values about usability and easiness while handling the application. Popular questionnaires include Software Usability Measurement Inventory (SUMI), Post-Study System Usability Questionnaire (PSSUQ), and the System Usability Scale (SUS) [14]. The first one requires purchasing a license so it was dismissed from the start. PSSUQ should be used carefully as it is susceptible to the "acquiesce bias" (people are more likely to agree with a statement than to disagree with it). Since all questions in the PSSUQ are positively worded this may occur.

SUS avoids this acquiesce bias, so it was chosen. The original version is in English, but, when applying it to Portuguese users, some of them may not be as capable of understanding the language as others. Therefore, since there is already a validated translation of this scale to Portuguese, we chose to use it [14].

Overall, the participants were able to complete the tasks (average success rate of 89%) although a few required more time to get acquainted with the application and exceeded the initial time given (see Fig. 3). Regarding SUS results (Fig. 4), the average was 78.4, the lowest 57.5 and the highest 97.5. SUS scores present an average of 68 [15], so, with an average score of 78.4, GeriatricHelper can already be considered as providing a good usability.

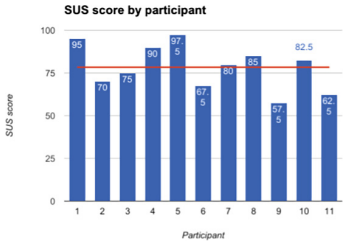

Fig. 3. SUS scores for P2's evaluation

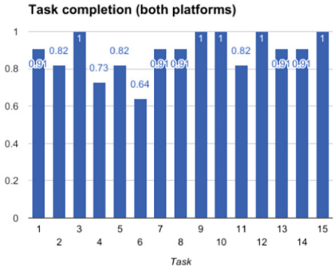

Fig. 4. Task completion for P2's evaluation

After the evaluation, and after solving some of the usability problems reported during the think aloud, a brainstorming session was conducted with a clinician, presenting the current state of the application and collecting suggestions that further informed the creation of the third prototype.

3.4.3 Third Iteration

The third prototype (P3) is currently in development. The main corrections and improvements to be included were: displaying a summary of each CGA area when conducting a CGA session; an increase in font size for some screens; the user was warned when trying to leave a scale without having answered every question; added feedback to actions that were lacking it and increased feedback time for key actions; added more contextualization for the user; and made more use of the bigger screen on the tablet. The added functionalities were the possibility to generate a PDF for a CGA

session, which later could be archived on the patient's physical profile, and the ability to keep a list of drugs prescribed for each patient.

Its evaluation is underway, by clinicians, the end-users (pilot user group), and is mainly being focused on the functionalities themselves, since the most prominent usability issues were solved in the first two prototypes.

3.5 Security Issues

GeriatricHelper deals with personal clinical data, which must remain confidential and inaccessible to third parties. Implementing this may not be straight-forward, which may explain why most the apps mentioned do not make it available. The security enforcement for this system is based on the separation of demographic and clinical data, i.e., data which may lead to identifying a person, such as name, address and birthdate, is ciphered before being stored on a backend, while the other data, such as sessions and scales, are not ciphered on the backend, since they point out to the ID of a patient, not its personal data.

4 Conclusion

GeriatricHelper development followed a User Centered Design approach and aims at providing a valuable "pocket" application for the Portuguese geriatric community. Its functionalities were designed considering the Portuguese reality, with the active participation of domain professionals. The application is an improvement to the paper-only existing support, making it more practical to calculate scales and browse clinical recommendations.

As future work, the application that is already multilingual, needs to obtain the clinical validation for other health care context, to be used by an international community of practitioners.

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References

1. Bassem Elsawy, M.D., Higgins, K.E.: The geriatric assessment. Am. Fam. Physician **83**, 48–56 (2011)
2. Tsaousides, T., Gordon, W.A.: Geriatric assessment tools. Mt. Sinai J. Med. **76**, 173–181 (2009)
3. Gallagher, P., Ryan, C., Byrne, S., Kennedy, J., Mahony, O.D.: STOPP START toolkit supporting medication review. Eur. J. Clin. Pharmacol. **46**, 1–12 (2008)
4. American Geriatrics Society (AGS), Geriatrics Society Beers Criteria for Potentially Inappropriate Medication Use in Older Adults: AGS Beers Criteria. Most, 2–5 (2012)

5. PT-Measures - Android Apps on Google Play. https://play.google.com/store/apps/details?id=com.sensingfuture.ptmeasures
6. Indicators of dependence - Android Apps on Google Play. https://play.google.com/store/apps/details?id=gt.app.dep
7. iGeriatrics - Android Apps on Google Play. https://play.google.com/store/apps/details?id=com.usbmis.reader.dwtf1
8. OncoScale - Android Apps on Google Play. https://play.google.com/store/apps/details?id=com.agmmultimedia.oncoscale
9. Wilkinson, C.R., De Angeli, A.: Applying user centred and participatory design approaches to commercial product development. Des. Stud. **35**, 614–631 (2014)
10. Sociedade Portuguesa de medicina interna. http://www.spmi.pt/nucleos_estudo_conteudos.php?id_nucleo=17
11. Alertbox: current issues in Web usability. Nielsen Norman Group
12. Brown, W., Yen, P.-Y., Rojas, M., Schnall, R.: Assessment of the health IT usability evaluation model (Health-ITUEM) for evaluating mobile health (mHealth) technology. J. Biomed. Inform. **46**, 1080–1087 (2013)
13. Yáñez Gómez, R., Cascado Caballero, D., Sevillano, J.-L.: Heuristic evaluation on mobile interfaces: a new checklist. Sci. World J. **2014**, 434326 (2014)
14. Martins, A.I., Rosa, A.F., Queirós, A., Silva, A., Rocha, N.P.: European Portuguese validation of the system usability scale (SUS). Procedia Comput. Sci. **67**, 293–300 (2015)
15. MeasuringU: Measuring Usability with the System Usability Scale (SUS). https://measuringu.com/sus/