*Connecting the System to Enhance the Practitioner and Consumer Experience in Healthcare*
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# Conceptual Design and Iterative Development of a mHealth App by Clinicians, Patients and Their Families

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**Abstract.** Heart failure self-management can be challenging but appropriately designed, user-centred mobile health (mHealth) innovations may help. We have built a consumer mHealth application which we plan to implement as an adjunct to existing specialist multidisciplinary heart failure care at our health service. We have the double aim to meet the needs of patients and ensure clinical relevance in order to be recommended by clinicians. This paper reports the participatory, user-centred co-design process of the conceptual design and iterative development of the application. Two nurse-led participatory design workshops were conducted with six clinicians and a patient, which determined user-experience opinions, key features and priority functions. The iterative development phase encompassed two application wireframe feedback cycles with seven clinicians, three patients and a family member. Workshops and wireframe feedback activities took place on the hospital campus predominantly using resources available to clinicians. Software build was outsourced and was followed by the design team reaching consensus with features and functions of the app. Further development and evaluation of flexible participatory, user-centred methods for use by clinicians to facilitate co-design with consumers will advance consumer digital health strategies.

**Keywords.** mHealth; participatory design; co-design; consumer application; user-centred design

## Introduction

Leveraging the advancement of technologies, novel ways to provide patient-centred healthcare have emerged to address the burden of chronic conditions and the financial sustainability of health services. Currently in our health service, no consumer mobile health (mHealth) application (app) is recommended for safe use in the self-management of heart failure. This chronic, highly symptomatic syndrome of the heart muscle requires symptom self-monitoring, lifestyle changes and concordance to treatment pathways; alongside support from a multidisciplinary team of healthcare professionals [1]. The experience of self-management in this patient population is reported as being complex, challenging and tiring [2].

This research involves the in-hospital development of a novel mHealth application which could be implemented as an adjunct to existing care for optimised patient

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empowerment and wellbeing. It is based on the premise that validated consumer apps should have the potential to improve consumers' self-management [3]. Our methodology focusses on the double aim to meet user requirements and ensure relevance to local clinicians. Prior work conducted by this research team [4] discovered patients and providers could benefit from a solution that addresses medication and symptom management challenges, involves a self-care plan and manages all stakeholders in care effectively. The brief was to design a consumer application to support people with heart failure to live well at home.

This paper reports the processes, personnel and resources involved in the nurse-led conceptual design and iterative development of the patient-facing mHealth application by clinicians, patients and their families.

## 1. Process

The design and development processes followed a deep understanding of the patient and family experience and a needs assessment conducted with clinicians. Conceptual design activities occurred during two participatory design workshops where user-experience opinions, key features and priority functions were determined. Iterative development commenced with the creation of wireframes - a visual, interactive representation of app screens on a laptop computer. Feedback and improvement cycles with individual co-design team members were conducted until there was consensus that the features and functions of the application were accurately represented. The final development phase describes the improvements following the application build by the software partner. The workshops and subsequent app development activities were lead by a registered nurse (lead author) who had extensive clinical experience but limited design experience. The output from each activity was the input into the next activity; see figure 1. Detail of the conceptual design and the iterative development processes are described in the following sections.

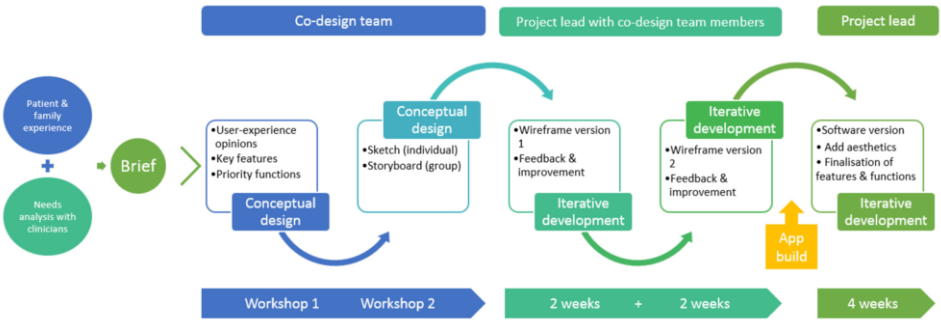


**Figure 1.** Design and development process, personnel and timeline.

### *1.1. Conceptual Design*

Seven volunteer co-design team members (six clinicians and one patient) were recruited from our health service to attend two 2-hour participatory design workshops conducted on the hospital campus. Clinicians represented nursing, pharmacy, physiotherapy and dietetics backgrounds.

### *1.1.1. Workshop 1*

In the *Lightning Demos* activity [5] individuals reviewed personal smartphone applications they considered enjoyable, useful and user-friendly. Working in two groups, team members were asked to decide on a summary of favourable app features and functions. Secondly, team members were encouraged to brainstorm multiple, varied potential solutions to health challenges associated with four previously-developed personas [4]. Solutions considered by the group for possible inclusion in the app were clustered among similar solutions and the cluster was given a label. Based on field notes, photographs and individual summaries, data was further summarised by the project-lead at the completion of the first workshop. This resulted in three groups of concepts; user-experience opinions, key features and priority functions. Three posters (labelled A, B and C) containing these findings were developed using the accessible language statements; *we'd like the app to be…*, *we'd like the app to contain* and *our ideas so far are…* See table 1.

**Table 1.** Representing the initial design concepts generated in workshop 1.

| Poster | Group of concepts | Accessible language |
|---|---|---|
| A | User-experience opinions | We'd like the app to be… |
| B | Key features | We'd like the app to contain… |
| C | Priority functions | Our ideas so far are… |

Detail specific to our healthcare context and therefore relevant to our patient population was represented by infographics within each poster in preparation for the next workshop.

### *1.1.2. Workshop 2*

In the second workshop co-design team members reviewed and discussed the poster content, adding three more design concepts. The aim of the second workshop was to progress the initial design concepts to a refined design from which wireframes could be built. Using pens and paper, co-design team members individually produced a *Solution Sketch* [5] representing how a user would interact with the mHealth application. Sketches were shared and through a facilitated group discussion, favourable components were shortlisted. In the final activity, a comic-like *Storyboard* [5] of the main features and functions of the application was collaboratively created on a whiteboard. The team attached six individual paper sketches, 12 'main feature' comments and 10 'design consideration' comments to their work. The storyboard was developed in 45 minutes using a variety of materials such as markers, paper, different coloured post-it notes and voting stickers. A total of 14 frames of sketches, labels and descriptions were developed accurately representing the team members' priorities for user interaction with the mHealth application to address perceived self-management challenges. Frame content and sequence was considered as input to the first cycle of development.

### *1.2. Iterative Development*

Two patients, a family member and a another clinician joined the team to participate in the development (totalling 11 team members including seven clinicians, three patients and one family member). Two wireframe versions were produced during a series of iterative development activities which resulted in a defined, clickable representation of

the app with enough detail for the initial software build. This was then revised to produce a final product.

### *1.2.1. Wireframe Versions*

Wireframes were produced by the project lead within Microsoft® PowerPoint using the low-cost PowerMockup software add-on (Wolfsoft, Germany, ©2018). This software provided generic app templates, icons and directional options and was easily navigated by the project-lead who has no experience in computer programming. Each wireframe screen, as well as the functionality provided between screens through clickable hyperlinks, demonstrated the user-experience for review by the team. Individual team members assessed the summarisation by the project lead was accurate. To do this and for design improvement, feedback data containing what worked, what could be improved, questions to be answered and further ideas, was collected using a feedback template; see figure 2.

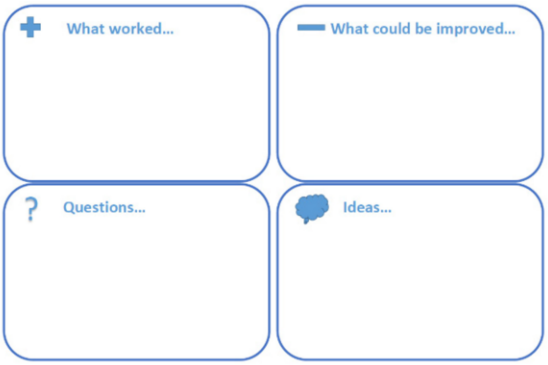


**Figure 2.** Wireframe feedback template.

Where possible each team member's feedback was incorporated prior to the next feedback session resulting in five updates of each version. Seventy-five wireframes were produced by the completion of version 1 which increased to 89 in version 2 due to user-interface specification. The nurse-led feedback process occurred on the hospital campus either in the cafeteria or clinicians' office, each session lasting 50-60 minutes. Due to geographic and time restrictions some team members provided feedback via email or phone by viewing the wireframes electronically. The approximate length of time it took the project-lead to update each version was 48 and 32 hours respectively.

### *1.2.2. Software Version*

The application was built in January 2018, ready for debugging and prototype finalisation. The project-lead worked closely with the software development partner using a freely-available online collaborative project management website Trello.com (Trello®, Atlassian, ©2018). Importantly, the software version needed to accurately represent the information and functionality decided by the co-design team in the final wireframe version. Additional aesthetic elements such as the colour palette, logo graphic and icon design were confirmed, adding to the quality of the app. To achieve a stable product for use, this process took nine software builds (Android and iOS), multiple

bidirectional communication threads and in excess of 80 hours of time for the project-lead.

## 2. Discussion

In the design and development process, we report the workshop, wireframe and software development activities conducted by our team. Patients, family members and clinicians were included in our pursuit of a well-designed product which would be supported, in principle, by the multidisciplinary healthcare professionals providing care to this patient group. Ongoing and regular engagement with multiple stakeholders had many benefits.

Firstly, use of participatory, user-centred procedures leveraged the different strengths and perspectives in an active and continuing negotiation between the needs of both stakeholders. Recommendations from research findings and theoretical perspectives reported in a recent scoping review [6] support a user-centred, interdisciplinary and collaborative approach to mHealth design to enhance feasibility, acceptability and usability.

Secondly, providing a variety of environments and materials supported inclusion of team members regardless of personality type, technology familiarisation and scheduling availability. For example, volunteer team members who participated in group activities within workshops were introduced to health technology design and were facilitated through collaborative brainstorming and decision-making activities while defining tangible solutions. For those preferring individual interactions, and to refine the wireframes, individual feedback sessions with the project-lead ensured diverse perspectives and preferences were accurately represented as the research progressed.

Finally, we benefited from having a project-lead who is a clinician familiar with the healthcare context and was involved in each research phase. During the software feedback cycle conducted independently with the software developer, the project-lead acted as an advocate for patients, family members and clinicians involved in the previous phases to ensure that the user- and clinician- requirements were addressed as the application was built.

Digital health designers need to document case studies and experiences to advance the knowledge base for in-hospital co-design of mHealth solutions. In our example, the participatory co-design practices conducted by a clinician aimed to limit the burden on the volunteer team members but capitalise on their skills and perspectives. The process was engaging and dynamic yet complex in recognition of designing a new innovation which needs to acknowledge the current reality of health service delivery, variations in patient experience and limited awareness of the possibilities of technology. Being located within a single health service allowed us to engage with our community of patients and providers as we hope to produce a useful product fit-for-purpose to current clinical practice. Well-defined, efficient co-design processes which take place within a health service add value to patient-centred healthcare delivery and needs further investigation.

The authors acknowledge the absence of user-experience experts as a limitation of this study and we plan to engage with these experts as we refine, test and plan for its implementation. The possibility of replicating these development processes through patient-facing mHealth technologies for other chronic conditions requiring self-management could be assessed for suitability.

## 3. Conclusion

We report the conceptual design and iterative development processes of a consumer mHealth application conducted on our hospital campus by clinicians, patients and family members. The context-specific app will complement our service by adding a new heart failure self-management tool for optional use by local patients.

Using participatory design processes to develop our mHealth application allowed for the inclusion of diverse perspectives from different stakeholders into the product's features and functions. Whilst end-users of consumer applications are patients themselves, healthcare teams need to lead design and development procedures in order to endorse such digital health technologies alongside current healthcare delivery. Accurate, evidence-based and validated mHealth apps, if designed with a balance of consumer and provider input, can be safely used where most of the care for people living with chronic conditions takes place; the home. A variety of flexible and inclusive participatory, user-centred methods should be used and evaluated by clinicians when designing with consumers to ensure the quality and suitability of consumer health technologies.

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