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Design Thinking for mHealth Application Co-Design to Support Heart Failure Self-Management

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Abstract. Heart failure is a prevalent, progressive chronic disease costing in excess of $1billion per year in Australia alone. Disease self-management has positive implications for the patient and decreases healthcare usage. However, adherence to recommended guidelines is challenging and existing literature reports sub-optimal adherence. mHealth applications in chronic disease education have the potential to facilitate patient enablement for disease self-management. To the best of our knowledge no heart failure self-management application is available for safe use by our patients. In this paper, we present the process established to co-design a mHealth application in support of heart-failure self-management. For this development, an interdisciplinary team systematically proceeds through the phases of Stanford University's Design Thinking process; empathise, define, ideate, prototype and test with a user-centred philosophy. Using this clinician-led heart failure app research as a case study, we describe a sequence of procedures to engage with local patients, carers, software developers, eHealth experts and clinical colleagues to foster rigorously developed and locally relevant patient-facing mHealth solutions. Importantly, patients are engaged in each stage with ethnographic interviews, a series of workshops and multiple re-design iterations.

Keywords. Co-design, Design Thinking, mHealth, application, heart failure, self-management

Introduction

Heart failure is a highly prevalent chronic condition and major burden to the Australian healthcare system [1, 2] costing in excess of one billion dollars a year [3]. In Australia, up to half of all patients initially hospitalised with heart failure will be re-hospitalised within 3-6 months [3]. While heart failure often shows an adverse trajectory towards morbidity and mortality, out-patient self-management is an important practice to improve symptoms and quality of life. Self-management involves the person monitoring their own health supported by their clinicians, with the aim to limit the worsening of symptoms by daily symptom monitoring and addressing deterioration promptly and effectively [4]. Recommended self-care regimes, such as those set by the Australian Heart Foundation [4, 5] are perceivably complex and often challenging to maintain [6].

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Our primary aim is to co-design a mHealth application to improve heart failure self-management in the out-patient population at St Vincent's Private Hospital Sydney. A secondary aim is to evaluate the user-experience of the application by patients themselves. The overall objective of this research is to improve patient symptom self-management and assist with specific evidenced-based guideline requirements improving clinical outcomes, enhancing patient self-efficacy and subsequent satisfaction with their disease management. This paper describes the proposed development methodology for the mHealth application.

1. Methodology

A structured framework, the Design Science Research Cycles outlined by Hevner [7] will be followed to ensure a high quality product. Comprising three cycles, the framework applies design science to IT systems. We have modified the framework to fit with our healthcare context as demonstrated in Figure 1;

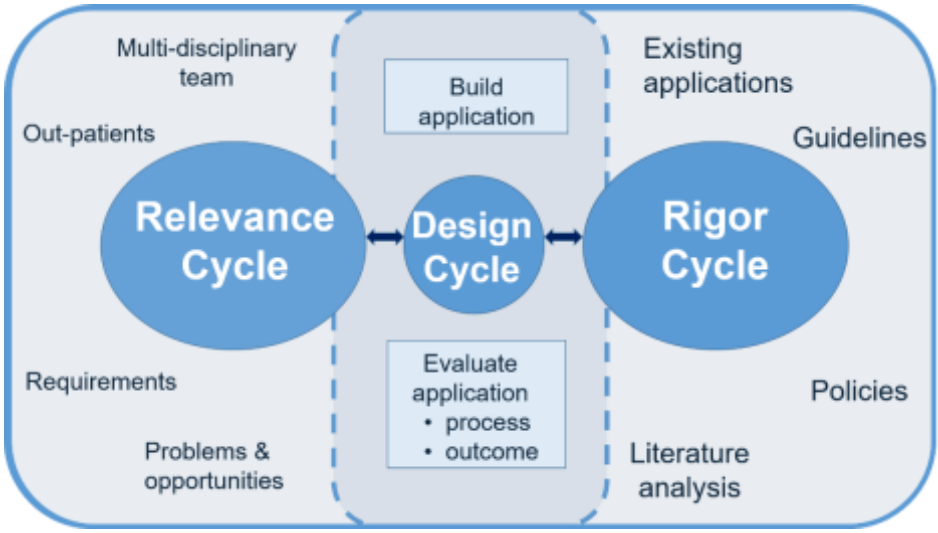

Figure 1. Modified Design Science Research Cycles [7]. (Used and adapted with kind permission from the original author)

1.1. Relevance Cycle

The relevance cycle relates to the context; specifically, the requirements of out-patients with heart failure, their carers, and the perspectives of interdisciplinary team members who regularly care for this patient population. This empathetic process uncovers what is important in the context of everyday life [8] both as a healthcare consumer and healthcare provider to ensure app content is user-centred and clinically relevant. The relevance cycle not only encompasses the current perspectives ('problems'), but also captures the possibilities of what the future of heart failure care may look like ('opportunities') from a variety of opposing perspectives.

1.2. Rigor Cycle

The rigor cycle relates to knowledge. It focuses on acknowledging the contribution of the existing knowledge base regarding mHealth application design, health literacy, behaviour change theory and the local and national heart failure policies and guidelines. Conducting ongoing literature analyses through academic literature, grey literature and local (internal) publications is the basis of these rigor exercises, ensuring the app content is consistent with the current healthcare delivery of heart failure services to our patient population.

1.3. Design Cycle

Application development is informed by both the relevance and rigor cycles in an iterative, cyclical fashion. Continuous evaluation of the design maintains relevance to end-users and consistency with the knowledge base.

2. Design process

A series of rigor and relevance exercises initially and continually inform the design of the mHealth application using Stanford University's Design Thinking Process [9]. The Design Thinking Process was used with the aim to produce a well-designed product meeting the requirements of the end-user from the outset, supporting a patient-centred healthcare philosophy. It is a systematic innovation process that prioritises deep empathy for end-user needs and challenges to fully understand a problem in order to then develop a comprehensive, effective and technically viable solution [8].

Design Thinking prioritises:

- Developing empathy through comprehensive understanding of a problem,
- Radical collaboration incorporating opposing mindsets, and
- Rapid prototyping engaging users in the iterations [8]

The Design Thinking Process is a five phase innovation process which may be fluid or linear depending on the progression of the design; empathise with the end-user, define the problem, ideate a solution, prototype by building a solution and test with the end-user [9].

The project is a hospital-university collaboration conducted on site at St Vincent's Private Hospital Sydney inclusive of the following team members;

Table 1. Co-design team from the hospital/university campus

Patients	Carers	Clinicians	App developer	Research team
Adults with heart failure	Provide supportive care for an adult with heart failure	Nurse Practitioners Cardiologist Cardiac Clinical Nurse Consultant Dietitian Physiotherapist Pharmacist	University affiliate	Doctoral candidate Supervision team

2.1.1. Empathise

Ethnographic interviews, conducted with self-selecting patients and their carers recruited from the hospital, allow for a deep understanding of their daily life living with, and self-managing, heart failure. It uncovers insights and elicits the requirements of the end-user. Previous work conducted by this research team in the same healthcare context investigated fluid restriction self-management specifically, discovering patients found self-management complex, tiring and challenging [10]. These previous study participants demonstrated limited skills to self-manage symptoms in their homes, many misunderstood the treatment rationale and were often confused about the benefits of adherence [10]. Posters containing personas and a patient journey map will be developed to visually represent the findings of this phase; the unique needs and insights of end-users which can be leveraged into the application design.

2.1.2. Define

Based on these needs and insights from phase 1, the healthcare problem needs clarity. Specifically, the design team define a list of opportunities regarding maintenance and improvements in the self-management of heart failure in the out-patient setting relative to our patients needs and based on the local guidelines and policies. For example, the design criteria may include facilitating knowledge [11], improving cognition [12, 13], and developing problem solving skills [14] in this patient population.

2.1.3. Ideate

A two-hour collaborative design workshop with all members of the co-design team is to be conducted on the hospital campus for the purpose of idea generation. Using a collection of creative thinking activities (for example, Idea Matrix, Rose Thorn Bud, Visual Vote), a multitude of perceivably effective strategies are generated based on team members' experiences and exposures from a range of perspectives. Field notes, matrix content and photographed images of the generated ideas on posters will be the basis of the data collected.

2.1.4. Prototype

The second workshop uses convergent thinking approaches to select the best ideas in order to make a visual prototype. Using an Impact/Effort Matrix when considering possible solutions, the design team actively draw a storyboard of how an end-user would interact with the solution, always referring to the user's needs and knowledge base as a cross-reference. The team *proceed* with low effort/high impact solutions in the first instance, *consider* low impact/high effort solutions, *investigate* high effort/high impact solutions and *disregard* high effort/low impact solutions.

Storyboard content (and sequence) is finalised during the workshop and then transferred to wireframe format to allow for prototype refinement based on feedback from end-users. Importantly, this stage engages patients themselves facilitating multiple feedback/ re-design iterations to ensure an appropriately tailored product.

Once the design team achieves consensus regarding the features and functions of the wireframes, a software prototype is promptly synthesised by the application developer. Based on a collective summary of individual feedback from the design team

members and importantly patients themselves, two further iteration cycles of the mHealth application result in the completion of this phase.

2.1.5. Test

Finally, the prototype is tested with a new subset of 12 patients using a validated tool to assess usability. Participants interact with the mHealth application prototype for 14 days in the home setting and thereafter report their experience of using the application. The Mobile Application Rating Scale (MARS) [15], together with app analytics provided by the IT partner and qualitative interviews conducted by the student researcher will be used to evaluate the application from the perspective of the end-user.

3. Discussion

Innovative, patient-centred interventions which improve heart failure self-management benefit patients and healthcare providers alike. In the Australian state where our hospital is located, the most likely location of discharge after a hospital admission for heart failure is home (73%) [16]. But nearly half of these patients are re-hospitalised with heart failure within 3 to 6 months [3], with suboptimal self-care a contributing factor. This is true even when over half of these patients are referred to a multidisciplinary heart failure service (59%) [16]. Therefore, the importance of supporting our patients in self-management in the home setting is overwhelmingly necessary. Encouraging and facilitating patient engagement and empowerment could decrease hospitalisations by teaching self-care skills specific to the healthcare context, patient socio-demographic population and the existing evidence-based guidelines already in place. The resultant app is for out-patients to use in addition to regular heart failure care provided by our hospital's interdisciplinary team.

Design Thinking is one possible process to truly uncover the needs of the end-user in context and develop a unique product necessary to complement existing complex, chronic contemporary healthcare services. In a recursive, dynamic manner design team members involved in each design process activity re-familiarise and discuss relevance and rigor content from the Design Science Research Cycles, expediting a fit-for-purpose solution. Indirectly, the application could benefit healthcare providers by decreasing the frequency and duration of health professional interactions. With an increasing emphasis on co-design with end-users, it is necessary to engage with patients, health care professionals and technologies to foster sustainable, viable healthcare solutions in a contemporary, ageing healthcare environment.

4. Conclusion

Interdisciplinary healthcare research in mHealth leads to quality systems benefiting the end-user. The potential for improvements in sustainable and efficient healthcare are endless with mHealth systems but only if they are tailored to the end-user and supported by rigorous research. We must evaluate systematic design processes like Stanford University's Design Thinking Process used by this research team, to provide a

robust evidence-base for our speciality in our pursuit of context-sensitive health technology design for the advancement of patient-centred care.

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