Using ICDMI Model to Guide the Design of Mobile Tool to Support the Care and Treatment of Type-2 Diabetes and Discordant Chronic Conditions

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Abstract

Patients with type-2 diabetes and Discordant Chronic Comorbidities (DCCs) have multiple, often unrelated, chronic illnesses with opposing treatment instructions that need to be addressed. These conditions can make it difficult for patients and healthcare providers to prioritize and manage the treatment of each individual disease. Some difficulties that arise from having DCCs include conflicting medication plans, managing multiple treatments simultaneously, and difficulty in visualizing the patient's information. Designing tools to empower patients, as well as their multiple providers to visualize the complex, multifaceted data captured across a long and complex process is still challenging problems. With an attempt to address this issue, we draw from our prior ICDMI conceptual model to guide the interface design process for a tool to help patients and their providers reflect on their conditions and symptoms at every stage of the care and treatment. We describe the early stages of how we mapped the features of the popular tools onto ICDMI model and how we iterated them on the paper prototypes using a series of design sessions.

Author Keywords

DCCs management, Information Visualization, and Communication

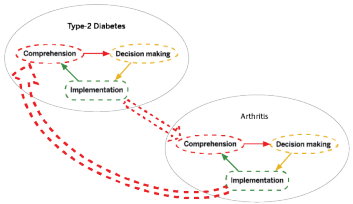

Figure 1: IDMI model: Showing the stages of DCCs care and management

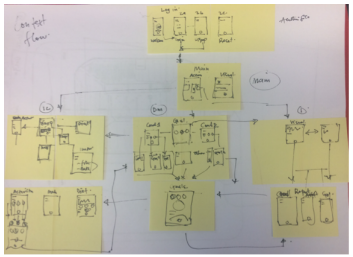

Figure 2: Contextual flow model of the first paper prototype

ACM Classification Keywords

H.5.m [Visualization, Mobile device]: HCI

Introduction

Patients with type-2 and Discordant Chronic Comorbidities (DCCs) have multiple, often unrelated chronic illnesses with opposing treatment instructions that need to be addressed. These conditions can make it difficult for patients and their healthcare providers to prioritize and manage the treatment of each individual disease, consequently increasing their risk of developing severe health outcomes and poor quality of life [11].

The works by Zulman et al.[11] and Sinnott et al.[7] separately explored barriers, strategies, and guidelines used to support patients with multiple conditions. Their findings show that these guidelines do not address issues specifically faced by patients with type-2 diabetes and DCCs. Also, despite the fact that challenges of managing multiple chronic diseases are well explored in the recent literature, the plethora of available tools, apps, wearable and sensing devices only support the care and treatment of single chronic diseases. With an exception of work on the elimination diet, no other tools have been designed to address issues specific to care and treatment of type-2 diabetes concurrently with other diseases.

In our prior work [6], we developed information conceptualization, decision making, and Implementation (ICDMI) of a conceptual model to help HCI designers make use of simple and yet sustained reflection by patients on their conditions, symptoms, capabilities, and concerns at every stage of care and treatment in the process of designing tools for DCCs. The model is grounded in three components: i) information comprehension, ii) decision making, and iii) goal implementation. Patients' data visualization and communication across multiple providers are the integral aspects of these components.

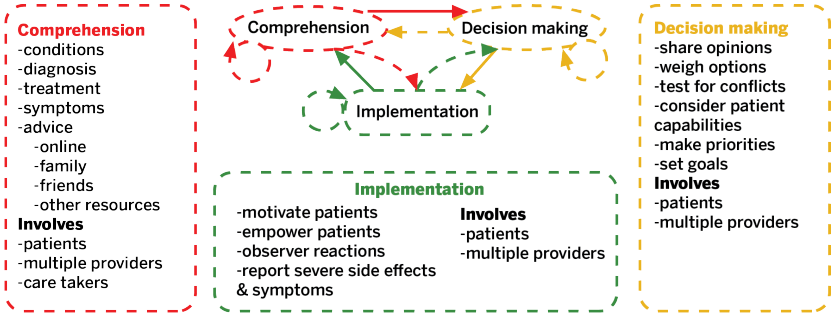

Figure 3: ICDMI model

In this paper, we discuss the outline of the early stages of our iterative design process, during which we used the features extracted from popular models, tools, and technologies, such as ATM machines, Uber, Kanban, Matrix, and others mapped onto the ICDMI conceptual model. We iterated mobile app paper prototypes through a series of design sessions as they evolved. The paper prototype was created with the goal of helping patients and providers visualize different aspects of their health and better prioritize their care and treatment plans.

Background

Models and Frameworks

Interesting work has been done on integrating the use of the conceptual models and frameworks to influence designs of social-technical systems.

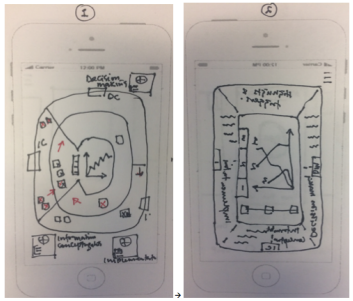

Figure 4: Paper prototype of the first and second design iteration

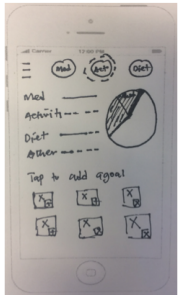

Figure 5: Paper prototype of the third design iteration

Table 1: Table showing exemplar applications and features extracted.

		Exemplar tools	
Tools	*Name*	*Domain*	*Features*
Planing	Advicent	Retirement	Collaboration
Persuasive	Wish	e-commerce	Anticipation
Activity	MODD	Health care	Patterns
Process	Kanban	Corporate	Task allocation
Journals	OmniTrack	Health care	Visualization
Navigators	Uber	Commercial	Simplicity

For example, studies by Silje Wangberg used the social cognitive theory (SCT) constructs to guide the design of an Internet-based diabetes platform to improved self-care behavior [10]. There are also tools being built to evaluate various constructs of these models [9]. There is also substantial work done in utilizing i) online health communities to seek support and disease management strategies [13], ii) knowledge-based systems to aid diagnosis, assist and provide preventive care reminders[5], and iii) the application of personal(patient) and professional(doctor) experience to comprehend a patient's symptoms and treatment strategies[9]

Cancer management model
Some studies have created models and frameworks meant to address issues specific to the care and treatment of individual conditions.

For example, a study conducted by Hayes et al.[3] discussed four phases of cancer care: i) screening and diagnosis, ii) initial information seeking, iii) acute care and treatment, and iv) either absence of evidence of disease or chronic disease management. Hayes et al's work has informed the design of frameworks and interventions, including the "cancer journey framework" and the "my journey campus" now being used to help patients with breast cancer to navigate through their healthcare needs right from the moment of diagnosis "screening" up to the end of life or survivorship.[4]

Diabete care model
While the care and treatment of cancer have a predefined end goal, chronic disease such as type-2 diabetes requires continuous management iterations. Patients with chronic conditions engage with healthcare system potentially for the rest of their life. This process usually goes through cycles of stable and unstable disease trajectories. For this reason, patients and their healthcare providers have to tweak treatment and care strategies as conditions change. Some patients usually never get their diabetes under control, hence shortening their life and quality of life.

In personal health Informatics, HCI, pervasive health work is being done in exploring the design and implementation of tools that i) support patient tracking and collect relevant information [2], ii) facilitate reflection and problem-solving, and iii) make healthy dietary and exercise choices [1]. Mamykina et al.[5], for example, used their self-reflection and problem-solving tool (MODD) to develop a diabetes self-management model with steps that include i) identifying problematic glycemic control patterns, ii) exploring behavioral triggers, iii) selecting alternative behaviors, and iv) implementing these behaviors while at the same time monitoring a patient for general healthcare improvement.

Patients with type-2 diabetes and DCCs can also benefit from both Hayes's cancer journey work and Mamykina's diabetes management models, however, patients with DCCs

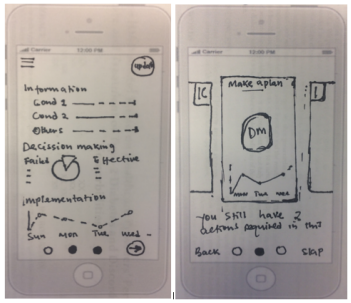

Figure 6: Final design showing floating and action main pages

also experience complex disease interactions and episodes that are not fully addressed in these either of these two models, we decided to their strategies to ground our work on ICDMI Model to address issues specific to DCCs care and treatment.

Type-2 Diabetes and DCCs care model
Like the management of diabetes, the care and treatment of type-2 diabetes and DCCs requires lifetime engagement with a healthcare system. There is a continuous need to tweak strategies as a patient goes through unstable cycles in an attempt to find a new normal which a majority of patients with DCCs experience for short period of time.

Unlike cancer or diabetes, the management of DCCs requires utmost consideration of multiple aspects of patients health, one tweak to management for one disease may negatively impact the other one. This adds complexity, shorter times of stability (potentially), longer times of tweaking, harder detective work, difficulty in getting quality information.

Alongside the challenging complex issue that patients with DCCs have to deal with, it's very difficult for them to contextualize most causes of the symptoms they experience, given the multitude of the conditions they address. For patients with diabetes or cancer, the diagnosis process is simplified, it's either yes or no, while with DCCs there is always a need to ask "but which one?"

Although patients with DCCs may benefit from Hayes et al's cancer journey work and Mamykina et al's diabetes management models, they usually experience complex disease interactions and episodes that are not fully addressed in either of these two models. Niether of these two models has explored how to engage end-users in designing systems that implement empirical models. Therefore, We used the strategies highlighted in these models, the results from our prior studies, and design sessions with participants to develop mobile app prototype that implements the ICDMI model.

Iterative Design

We extracted design features from best state-of-art and popular tools, processes, models and mobile applications to inform the design of a mobile app. The purpose of the apps is to help patients with DCCs as well as their multiple providers visualize the complex and multifaceted data, and prioritize care and treatment plans. We mapped the features we extracted onto ICDMI model and sketched paper prototype. We iterated over it using a series of design sessions with 4 groups of participants to evaluate and reflect on prototype's basic flow, process, and visual representation of the ICDMI model as it evolved.

Prototyping
After brainstorming on interface design opportunities and deciding on the features of the mobile app, we started creating paper prototypes and conducted four rounds of design sessions with participants to evaluate its basic flow, process, and visual representation. The first design session tested whether i) participants were able to navigate through the prototype and perform tasks related to the care of the imagined combination of their DCCs, and ii) what a participant didn't understand that we assumed they should. We refined issues highlighted in this session including reducing the number of steps participants had to navigate to complete a task, making the process simple and also changing its shape and then prepared for a second evaluation with a different set of participants. The second design session tested the participants' ability to navigate through the prototype as we allowed them to think aloud. We noted what they saw, what they understood and what they did not un-

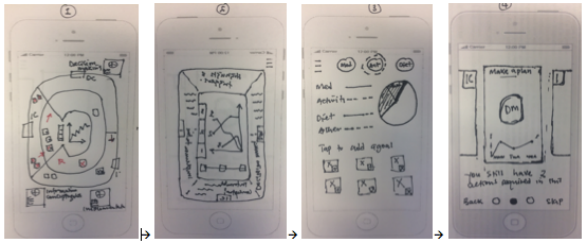

Figure 7: Prototype design iterations

derstand. We then refined these findings and created a newer simplified version of the ISDMI model with additional design elements and evaluated it in the third design session. In the third session, we brought in a new set of four participants to explain the purpose of the prototype and tasked them to immerse themselves in the situation of a patient with DCCs. We asked them what they needed to know and do, their thoughts about the design, and how they thought it should work. Most participants role played using the experiences of their relatives. In fact, in evaluating our prototype one participant used the experience that his father underwent.

In preparation for the final design session, we focused on things highlighted by the majority of participants that were relevant to our research at that stage and then created a persona which we used to iterate the prototype and made it ready for the final evaluation with the last group of four participants. We also used this persona to brief the participants about our expectations for the study and their role in it and to ask to use them to role play that persona. We aimed to capture what participants would do differently with a given persona and whether they could get through a different phase of the prototype with ease. We observed the instances where participants could not understand and asked why. We used the feedback to redesign our final prototype, showing the basic flow and process that we plan to use to engage patients with DCCs to co-design app detail features, visual interaction, and representation of multifaceted data, and to tease out goal setting and implementation strategies.

Future work and Conclusion

This paper reports the early stages of prototype design process to make the use of efficient and innovate yet simple visual futures to support the patients contextualize their multifaceted and complex data and prioritize their care and treatment plans. Thudt et al.[8] emphasized the importance of and role that personal visualization including behavioral change, fostering prolonged engagement and curiosity among others. Similarly, in this work we believe that, once patients with type-2 diabetes and DCCs are empowered to take ownership of their health, the burden of living with multiple chronic conditions will be reduced hence improving the quality of life and well being of patients with DCCs.

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