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

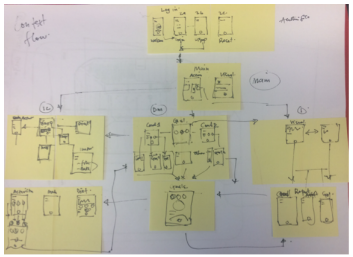

Figure 2: Context flow model of the first paper prototype

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 and DCCs. Also, despite the fact that challenges of managing multiple chronic diseases are well explored in the recent literature, the plethora of the 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) conceptual model to help HCI designers make use of simple and yet sustained reflection of patients' conditions, symptoms, capabilities, and concerns at every stage of care and treatment while 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 multiple providers are the integral aspects of these components. In this paper, we discuss the outline of early stages

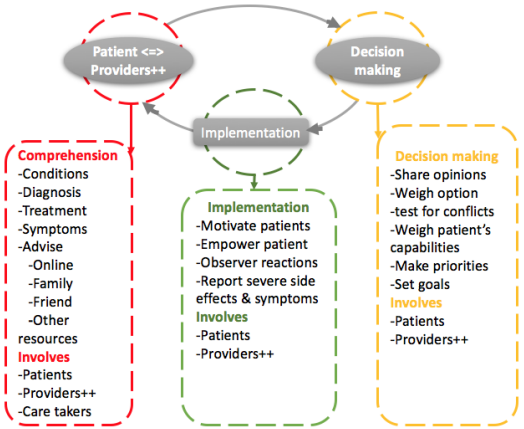

Figure 3: ICDMI model

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 ICDMI conceptual model. We iterated on the mobile app paper prototypes through a series of design sessions as they envolved. The paper prototype was created with the goal to help patients and providers visualize different aspects of their health and better prioritize their care and treatment plans.

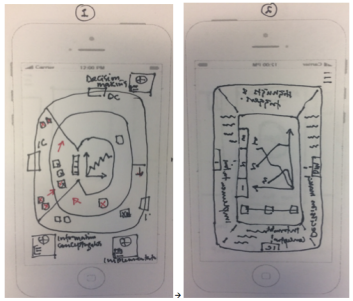

Figure 4: Paper prototype of the first and second design iteration

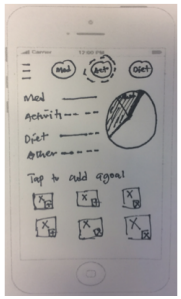

Figure 5: Paper prototype of the third design iteration

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

Background

Models and Frameworks

There is interesting work done on integrating the use of the conceptual models and frameworks to influence designs of social-technical systems. For examples, works 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].

Cancer care model

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

For example, a study conducted by Hayes and colleagues discussed four(4) phases of cancer care i) screening and diagnosis, ii) initial information seeking, iii) acute care and treatment, iv) no evidence of disease, or chronic disease management [3]. This work has informed the design of frameworks and interventions including *"cancer journey framework"* and *"my journey campus"* now being used to help patients with breast cancer to navigate through their healthcare needs right from the cause of diagnosis "screening" into 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 and pervasive health, there is work being done in exploring the design and implementation of tools that i) support patient track 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, iv) and implementing these behaviors while at the same time monitoring for 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 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

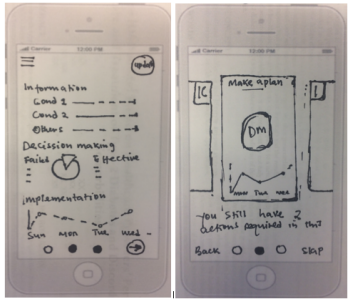

Figure 6: Final design showing floating and action main pages

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 health care system. There is a continuous need to tweak strategies as a patient goes through unstable cycles, with an attempt to find a new normal which majority 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?"

Iterative Design

We extracted design features from best state-of-art and popular tools, processes, models and mobile applications to inform our design for a tool (mobile app) to help patients with DCCs as well as their multiple providers, visualize complex and multifaceted data they capture across along and complex process and prioritize care and treatment plans. We mapped those features we extracted to the onto ICDMI model and sketched paper prototype. We then iterated over it using a series of design sessions with 4 groups of HCI students 4 in each group to evaluated and reflected on prototype basic flow, process, and visual representation of the ICDMI model as they evolved.

Prototyping
After brainstorming on the interface design opportunities and deciding on the features of the mobile app, we started creating paper prototypes and conducted 4 rounds of design sessions with HCI student to evaluate the basic flow, process and visual representation of our paper prototypes. Our first design session was used to test whether each participant is; i) able to navigate through the prototype and perform tasks related to the care of the imagined combination of their DCCs, ii) what a participant didn't understand and we assumed they should have. We refined issues highlighted in this session including reducing the numbers of steps participant had to navigate to complete a task, making the process simple and also changing the shape and then prepare for second evaluated with a different set of participants. The second design session tested the partici-

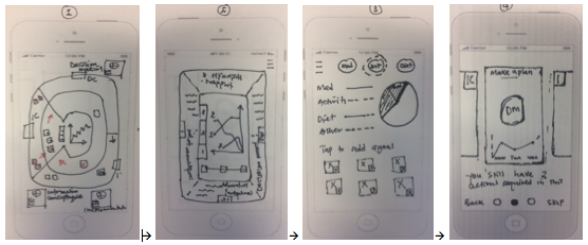

Figure 7: Prototype design iterations

pant's ability walk through prototype, we allowed to them to think aloud as they navigated through the prototype, and we noted what they see, what they understood and what they did not. We refined these findings and curated a newer simplified version with additional design elements to be evaluated during the third design session. In the third session,

we brought in the new set of four participants and asked them what they needed to know and do, their thoughts about the design and how it was supposed to work? Most participants expressed interests in the interplay of visual tools such as graphs, progress bars and reports and links.

In preparation for our final design session, we focused on things highlighted by the majority of participants and were relevant to out research at that stage and created a persona. We used this persona to iterate on the prototype, made it ready for the final evaluation with the last group of 4 participants to capture what they would do differently, whether they can get through the different phase of the prototype with easy. We observed the instances where participants could not understand and asked why the feedback was integrated when with our final prototype showing basic flow and process, the participants also suggested a seamless interaction between and with stages of care, were they could easily transition from one stage of DCCs management to another, the prototype evolved at every interaction. The next phase of this study is to engage patients with type-2 diabetes in series of participatory design workshop to tease out goal setting and implementation strategies, details of the app and choices for visual tools to represent multifaceted and complex patients data.

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.

REFERENCES

1. Kay Connelly, Katie A Siek, Beenish Chaudry, Josette Jones, Kim Astroth, and Janet L Welch. 2012. An offline mobile nutrition monitoring intervention for varying-literacy patients receiving hemodialysis: a pilot study examining usage and usability. *Journal of the American Medical Informatics Association* 19, 5 (2012), 705–712.
2. Sunny Consolvo, Predrag Klasnja, David W McDonald, James A Landay, and others. 2014. Designing for healthy lifestyles: Design considerations for mobile technologies to encourage consumer health and wellness. *Foundations and Trends® in Human–Computer Interaction* 6, 3–4 (2014), 167–315.
3. Gillian R Hayes, Gregory D Abowd, John S Davis, Marion L Blount, Maria Ebling, and Elizabeth D Mynatt. 2008. Opportunities for pervasive computing in chronic cancer care. In *International Conference on Pervasive Computing*. Springer, 262–279.
4. Maia Jacobs, James Clawson, and Elizabeth D Mynatt. 2016. A cancer journey framework: guiding the design of holistic health technology. In *Proceedings of the 10th EAI International Conference on Pervasive Computing Technologies for Healthcare*. ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), 114–121.
5. Lena Mamykina, Elizabeth M Heitkemper, Arlene M Smaldone, Rita Kukafka, Heather Cole-Lewis, Patricia G Davidson, Elizabeth D Mynatt, Jonathan N Tobin, Andrea Cassells, Carrie Goodman, and others. 2016. Structured scaffolding for reflection and problem solving in diabetes self-management: qualitative study of mobile diabetes detective. *Journal of the American Medical Informatics Association* 23, 1 (2016), 129–136.
6. Tom Ongwere, Gabrielle Cantor, Patrick C. Shih, James Clawson, and Kay Connelly. "". (????).
7. Carol Sinnott, Stewart W Mercer, Rupert A Payne, Martin Duerden, Colin P Bradley, and Molly Byrne. 2015. Improving medication management in multimorbidity: development of the MultimorbiditY COllaborative Medication Review And DEcision making (MY COMRADE) intervention using the Behaviour Change Wheel. *Implementation Science* 10, 1 (2015), 132.
8. Alice Thudt, Bongshin Lee, Eun Kyoung Choe, and Sheelagh Carpendale. 2017. Expanding research methods for a realistic understanding of personal visualization. *IEEE computer graphics and applications* 37, 2 (2017), 12–18.
9. Tammy R Toscos, Stephen W Ponder, Barbara J Anderson, Mayer B Davidson, Martin L Lee, Elaine Montemayor-Gonzalez, Patricia Reyes, Eric Link, and Kevin L McMahon. 2012. Integrating an automated diabetes management system into the family management of children with type 1 diabetes: Results from a 12-month randomized controlled technology trial. *Diabetes care* 35, 3 (2012), 498–502.
10. Silje C Wangberg. 2007. An Internet-based diabetes self-care intervention tailored to self-efficacy. *Health Education Research* 23, 1 (2007), 170–179.
11. Donna M Zulman, Eve A Kerr, Timothy P Hofer, Michele Heisler, and Brian J Zikmund-Fisher. 2010. Patient-provider concordance in the prioritization of health conditions among hypertensive diabetes patients. *Journal of general internal medicine* 25, 5 (2010), 408–414.