OH-BUDDY: Mobile Phone Texting Based Intervention for Diabetes and Oral Health Management

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Abstract

The high prevalence of comorbid chronic conditions among minorities and underserved individuals is a public health problem that deserves research attention. We used the Design Science Research approach to iteratively build a persuasive mobile phone texting (SMS) based behavior change support intervention (OH-Buddy) that (1) addresses comorbid diabetes and periodontal chronic conditions; (2) uses the ubiquitous SMS as an intervention delivery channel to make it accessible to underserved populations; (3) and uses an informal caregiver ("buddy") as a supplementary means of support for patients.

We are currently evaluating the OH-Buddy intervention in terms of its ability to engage participants and enable them to better self-manage their conditions. Expected outcomes include improvement in oral hygiene, blood glucose monitoring, medication adherence, physical activity, and healthy eating. Preliminary results based on self-reported performance data indicates the existence of moderate but steady improvement in patient engagement and self-management.
Keywords: Mobile health, text-based intervention, comorbid chronic disease self-management, self-management support, buddy support, diabetes, periodontitis, oral health.

1 Introduction

The prevalence of chronic diseases is unacceptably high and growing. In 2005, 133 million Americans were living with at least one chronic condition. In 2020, this number is expected to grow to 157 million. In 2005, sixty-three million people had multiple chronic illnesses, and that number will reach eighty-one million in 2020 [1]. Unlike acute illnesses, chronic illnesses require patients to play an active role in self-managing a wide range of risk factors [2]. For instance, people with diabetes are expected to provide nearly 95% of tasks involved in the management of their illness [2, 3]. This burden of self-management is even worse for people with multiple chronic conditions, most of whom are elderly or members of minority and traditionally underserved populations.

Self-management support initiatives are meant to provide patients with the assistance they need to effectively self-manage their conditions [2]. Unfortunately, the health care system, which remains rooted in acute-based care, is too overburdened to provide the level of self-care support needed by chronically ill patients. Consequently, individuals with chronic illnesses, especially those from traditionally underserved populations, have little or no access to self-management programs.

Two often comorbid chronic conditions, each of which has wide prevalence, are diabetes model [4] and periodontitis [5].

Diabetes is a chronic disease that presents significant long-term health, disability and financial burden at both individual and societal levels [6]. In United States alone, 22.3 million people were diagnosed with diabetes in 2012 [7], with 1.9 million new cases diagnosed in 2010 [8]. These patients incurred $176 billion in direct medical costs attributed to diabetes and a further sum of $69 billion in indirect costs due to absenteeism, lost productivity, disability, and premature mortality [8].

Diabetes disproportionately affects older people and people from minority populations. For instance, 26.9% of Americans aged 65 years and older have diabetes. It is the leading cause of complications such as kidney failure, non-traumatic lower-limb amputations, and new cases of blindness among adults in the United States. It is a major cause of heart disease and stroke and the seventh leading cause of death in the United States [8].

Periodontitis, a complication of diabetes, is a slowly progressing disease in which the inflammation of the gingiva (gingivitis) has extended, resulting in tissue destruction, alveolar bone resorption, and consequently the formation of a periodontal pocket between the gingiva and the tooth. In advanced cases, patients experience gingival bleeding, gingival recession, tooth movement, and/or tooth loss [9]. In the United States, periodontitis afflicts 47% of individuals aged 30 or above, 70.1% of those 65 years and above, 65.4% of adults living below the federal poverty level, 66.9% of adults with less than a high school education, and 64.2% of current smokers [5].

Incidentally, a bidirectional relationship has been suggested to exist between diabetes and periodontitis [9, 10]. On the one hand, diabetes is considered as a major risk factor for periodontitis [11-13]. Individuals with diabetes are three times more likely to develop periodontitis than others [14] and there is a higher prevalence of severe periodontitis among populations characterized by poor glycemic control [15]. On the other hand, there is evidence for periodontitis having an adverse but modifiable effect on glycemic control in diabetes [16-18]. Severe periodontal disease can increase blood sugar, thereby adversely impacting glycemic control. The clinical implication is that people with these two chronic conditions require more sustainable self-management support that addresses the totality of the self-care behaviors their comorbid situation requires them to perform.

Unfortunately, there is little research focusing on the ways and means for providing this support in a sustained basis given the long-term nature of these chronic conditions; the essential features needed for making such support accessible to as many individuals as possible; or the requirements for providing support that is relevant in comorbid contexts. We present a novel automated IT-based intervention to engage patients with diabetes and periodontal diseases to self-manage their conditions.

2 Problem Statement

Granted self-management support is essential for patients with chronic conditions [19]; it is even more so for those with comorbid chronic conditions, particularly those from minority and /or underserved populations. There is therefore a need for self-management support programs that (1) are designed to be accessible to all, (2) have the functionality to target multiple chronic conditions, and (3) include processes for sustaining patients’ engagement and performance of self-care behaviors.
Practically every adult has a mobile phone [20, 21] as cell phones have penetrated all segments of society, in consequence providing an opportunity for enhancing healthcare access to far-flung and demographically disparate patient populations. SMS incidentally lends itself to use in situations where access to care needs to be extended to far-flung populations of patients with limited access to usual care. While half of all Americans do have smartphones, nearly 92% of them have at least a basic cell phone with texting capability. Thus, text messaging, in contrast to mobile applications, provides a better option for effectively reaching a broader, more inclusive population of patients. Mobile SMS messaging is an excellent means of making health information accessible to many underserved individuals who are more likely to have a mobile texting plan than a data plan.

To sustain the support being provided by such an initiative, it has to have the ability to engage patients, provide them with targeted and tailored support, and reinforce their individual self-care behavior. The delivery of support has to be automated in order to make the support available despite clinical resource time-space limitations. This research seeks to provide answers to the following research questions:

- How accessible to the target population are self-management support interventions delivered via SMS given the SMS size constraint of 160 7-bit characters?
- Can the introduction of an informal social support through the mechanism of a “buddy” (spouse, friend, or someone the patient trusts) increase patients’ engagement over time and motivate them to perform required self-management activities?
- Can an SMS-based self-management intervention effectively support multiple self-care behaviors?
- Can an SMS-based self-management intervention effectively support multiple chronic conditions?
- Can the combination of SMS messaging and buddy support succeed in improving patients’ self-management behaviors and diabetes and oral health clinical outcomes?

3 Related Work

Here, we briefly look at prior literature in this area. A study, in which patients were randomly distributed into individual education (IE), group education (GE), and usual care (UC), evaluated whether short term outcomes obtained from self-management education are sustained [22]. According to the findings, no differences were registered in the GE and UC groups. However, improved self-efficacy and lower diabetes distress observed with the IE group in the short-term were sustained long-term. However, short-term improvements in glucose control and self-management behaviors (medication, physical activity, and nutrition) were not sustained among patients in the group.

Hussein et al. [23] propose an SMS-based intervention between patients and clinicians, the aim being to reduce clinical costs to the patients. The study assesses the feasibility and utility of using this between-clinical-visits intervention to extend clinical support to patients with type 2 diabetes. Participants in the intervention group (n = 12) were given two mobile numbers to which to send free SMS disease management enquiries, as well as blood glucose values. The control group was not enrolled in the SMS service. HbA$_{1C}$ values were measured at baseline and after three months for both the experimental and control groups. In addition, an exit questionnaire survey was completed regarding the feasibility and user acceptance of the intervention. The results show the intervention group to have significantly greater reduction in A$_{1C}$ than the control, indicating the effectiveness of the intervention. This study is, however, not scalable as it still demands clinicians’ attention in regard to responding to patients’ inquiries.

In another study, researchers investigated the feasibility and efficacy of an SMS based intervention for diabetes patients on long-acting insulin therapy [24]. The results show that the glucose levels of the intervention group declined earlier than those of the control group. Another study explored whether an intervention using SMS and web browser for data entry would help decrease the body weight of obese diabetes patients and improve their plasma glucose levels at 3, 6, 9, and 12 months [25]. The results show significantly greater reduction in glycosylated hemoglobin and post-prandial glucose levels among participants in the intervention group.

These studies together make a strong case for the efficacy of SMS-based interventions for supporting self-management. However, they fail to address the more serious problem of sustaining patients’ engagement in self-management activities. Nor do they address the problem of comorbid chronic conditions. The present study seeks to tackle this problem by ensuring that the messages that patients receive are relevant to their disease management needs at any given time. Moreover, there is hardly any study to our knowledge that has focused on the design of interventions that simultaneously support multiple self-care behaviors of people living with the comorbid chronic conditions of diabetes and periodontitis, which is the focus of our study.
4 Methods

We used the design science research (DSR) approach [26-28] to frame the development and evaluation of an information systems (IS) based, easily accessible initiative to support and motivate individuals living with diabetes and periodontitis. DSR enables this research to make contributions as to the issues to consider when designing (1) an IS initiative meant to reach underserved individuals and (2) a behavior change support system for patients with multiple chronic conditions when the aim is to holistically target multiple self-management behaviors using mobile text messaging.

Research evidence suggests that healthcare interventions that are grounded on social and behavioral science theories are more effective than those that are not [29]. This research, accordingly, draws on the health belief model and the self-efficacy theory for the constructs that are antecedent to self-management behavior. Social support is another construct that has been shown to have a positive, but nonlinear effect on health behavior [30]. We created a social network dyad, consisting of the patient and a buddy, partly to alleviate chronic social isolation [31] and partly to implement a performance feedback and reinforcement process as part of the system’s embedded persuasive strategy.

In addition, diabetes and periodontitis self-care support knowledge was iteratively elicited from both documentary and human sources.

A number of studies from the persuasive technologies sub-field of IS [27, 32-35] provided the procedural framework in the selection of persuasive strategies to employ, the development of a set of design propositions from those strategies, and the building and implementation of the system. The functional triad framework, for instance, presents three persuasive roles that a persuasive technology can play: tool, medium, and social actor [32], each of which has its corresponding persuasive design principles.

The main design requirements of this study are therefore for the OH-Buddy system to be able to engage patients, induce behavior change in terms of adherence to desirable self-management behaviors [10-13], and sustain those behaviors over time using (1) automated SMS-based persuasive messaging system; and (2) a system-initiated, but human buddy-delivered reinforcement of patients’ self-management behavior. This entails developing a system capable of sending tidbits of knowledge and cues to action that not only modify patients’ health beliefs but also enhances their self-efficacy and lead to the desired self-management behaviors.

Section 6 below discusses the evaluation phase of the research.

5 Description of the Oral Health (OH-Buddy) System

This study seeks to use technology as a persuasive tool to lower the barriers to diabetes and periodontal self-management as well as increase patients’ abilities and self-efficacy with respect to brushing, flossing, blood glucose monitoring, weight management, and medication adherence [27]. It is also employing technology as a persuasive medium by using the OH-Buddy to provide interactive and engaging experiences that motivate or help people to rehearse desired behaviors—persuasion is achieved by boosting self-efficacy, enhancing skills learning, or improving motivation. Through a series of short messages to each individual user, the OH-Buddy artifact is aiming to coax and encourage the sustenance of hitherto difficult to maintain behaviors [27]. In its role as a persuasive social actor, the OH-Buddy intervention embodies a self-management behavior support system that simulates the patient support roles of human experts. To effectively do this, the build phase included knowledge engineering processes, whereby periodontal and diabetes self-management support knowledge were elicited from domain experts (two of whom are coauthors of this paper) and evidence-based guidelines. As such, the system mimics the actions of multidisciplinary experts in periodontal and diabetes self-care—giving pertinent recommendations and encouragement and making inquiries regarding individual patients’ self-care behaviors. The relevant persuasive strategies being translated are the social roles of a guide, coach, teacher, assistant, and family caregiver [27]

5.1 The Iterative Build Phase

Several iterations of the build phase were carried out, including two pilot studies conducted to elucidate how the research goals can best be translated into design principles and system functionalities. Particularly at issue was the need to clarify requirements about the overall design of the intervention as well as its various components—the timing and frequency of the text messages to be sent to patients and their buddy; the nature, framing, and content of those text messages; the sustainment of participants’ engagement with the intervention; and the visualization and presentation of information to clinicians regarding patients’ engagement with the system and their completion of recommended self-care behaviors.

Plain language principles were used to craft over a hundred short motivational and informational messages covering the diabetes and periodontal self-management
domains. In doing so, the research team had recourse to best practice guidelines from the American Diabetes Association, the American Dental Association, and the American Academy of Periodontology as well as existing literature on health messages. Also, the messages were phrased to be at most 140 characters in length in order to be contained in one SMS message. The social support buddies were coached on how to interpret messages coming from the technical system and provide reinforcing support to the patients.

The lessons learned from the first pilot study included scaling down the frequency of messaging to participants to avoid messaging burnout, expanding the target domains to include diabetes self-care behaviors, and redesigning the buddy alert firing algorithm to reduce the number of buddy messages being sent. It had become imperative that the intervention did not constitute a nuisance factor for both patients and buddies. The buddies of patients who were not responding to the system could potentially receive as many messages as the patients [36, 37].

The second pilot study consisted of several trial runs and iterations of the OH-Buddy system aimed at taking the build phase to its completion. Over the course of those iterations, many changes were implemented, including the introduction of a dashboard interface for clinicians to be able to gain insightful visualization of patients’ performance for any self-care behavior being measured. Several underlying algorithms were designed and implemented. These include algorithms for calculating patients’ individual engagement with the technical system, their self-management based on their response to self-care assessment polls, the appropriate buddy messages to send, and the parsing of incoming patients’ responses to assessment polls.

Alerts to buddies became time-based, with two messages sent every Monday informing the buddy of the patients’ overall percentile performance in terms of engagement with the system and achievement of self-care goals during the previous week. The buddy messages additionally included tailored suggestions as to how the buddy could encourage and reinforce the patient. The issues of message framing and content validity were raised. Further research was conducted into the health messaging literature for diabetes and periodontitis [38-44].

Messages were tailored using patient's characteristics (name, gender, buddy’s name) as well as their engagement history, previous SMS responses, and blood glucose level. Also, even though a weekly schedule was followed, the daily schedules were randomized to reduce monotony. Figure 1 above shows the polling questions and conversation between a mock patient and OH-Buddy system. As can be seen, follow-up messages vary depending on patients’ response. In its present messaging incarnation, the OH-Buddy system employs a weekly schedule for sending messages (Figure 2). It sends to each participant two motivational or educational messages; one self-care assessment poll each for brushing, brushing duration, flossing, blood-sugar monitoring, blood sugar value, medication taking, and exercise (list of which is shown in Figure 3); and follow-up messages, which depend on participants’ response to the polling questions.

The repetitive nature of these assessment questions is meant to serve as a heuristic reminder for patients to perform their daily self-management behaviors. In addition, the two-way communication
enables the process evaluation of the intervention to determine patients’ performance in terms of engagement with the system and performance of self-care activities. It also enables the collection of data on patients’ engagement with the system, their self-care performance, the status of their health, and actions taken by the system to influence their health behavior.

5.2 System Features

Continuous Content Delivery: The OH-Buddy system is characterized by the automated and continuous delivery of informational, motivational, and self-care assessment messages to patients and their buddies. System-initiated messages to patients and buddies are fired in accordance with an automated message scheduler while follow-up messages are sent in response to patients’ response to the assessment polls. The OH-Buddy intervention involves IT people working collaboratively with diabetes and periodontal disease experts from initial requirements gathering to system implementation stages, so that the messaging system will effectively convey health messages to patients and buddies as intended by these experts. This entails incorporating some knowledge capturing processes in the build phase of the research. We reviewed evidence-based guidelines for the self-management of diabetes and periodontitis and interviewed domain experts in the management of both conditions.

Persuasive Functionalities: The build phase of the study draws procedural inspiration from Oinas-Kukkonen and Harjuma’s [35] Persuasive System Design framework in translating select persuasive strategies and design principles into software requirements and implemented features in the completed OH-Buddy system. Design principles aimed at enhancing the persuasiveness of the messages were incorporated. These afford features that assist the self-care efforts of patients by providing three broad categories of support—primary task support, dialogue support, and social support [35].

Primary Task Support: The OH-Buddy system provides functionality that supports the primary task of self-managing comorbid chronic conditions by operationalizing the following design principles with regard to the needs of patients with comorbid diabetes and periodontitis—reduction, tunneling, tailoring, and self-monitoring.

Dialogue Support: The OH-Buddy system also implements persuasive strategies related to dialogue support—praise, reminders, suggestion, similarity, and social role. It uses praise via follow-up messages and buddy support to reinforce patients’ performance. The repetitive polling of patients for their self-care activities also doubles as a heuristic reminder that they should perform those activities. Follow up messages also remind patients of their target behaviors.

Social Support: The OH-Buddy system implements persuasive functionality—social comparison and normative influence—that provides social support to patients. It does social comparison by providing means for patients to compare their performance with others’. Patients can compare their weekly performance via summary messages detailing their performance scores in relation to other patients. With respect to normative influence, the OH-Buddy provides a platform for patients to be influenced by social agents other than their clinicians. It does so by enabling patients to experience normative influence via the buddy encounters, during which their buddies challenge and support their self-care activities.

5.3 Components of the Intervention

The OH-Buddy System is made up of four components—the application environment, the web backend, the database backend, and the messaging scheduler.

Human Elements: The application environment (Figure 3) is a high-level overview of the sociotechnical components of the intervention consisting of the patients, their buddies, the clinicians, and the messaging and dashboard interfaces through which interactions occur between the technical system and the human elements of the intervention. Within each patient’s application environment, the buddy uses feedbacks received from the technical subsystem to reinforce and hopefully impact the patient’s adherence to recommended self-management behaviors and engagement with the system. The technical subsystem, consisting of the non-human elements of the application.
environment, essentially serves as a software agent for the clinician, brokering and keeping up a delegated conversation around the self-management of the chronic conditions with each participating patient.

**Clinician Interfaces:** Clinician interfaces enable the flow of meaningful conversation between clinicians and any given patient-buddy dyad. The web-based dashboard affords clinicians textual and visual access to individual patients’ history of brushing, flossing, exercising, medication adherence, and blood glucose monitoring levels. Armed with this knowledge, they are able to manage by exception those patients that have difficulty in self-managing their condition. This is crucial because the clinician can vary the SMS support patients are receiving without the patients having to visit the clinic. Clinicians also have access to web forms that allow them to make additions, deletions, and modifications to the messaging scheduler and the corpus of informational and motivational messages in the database. Figure 4 shows a dashboard view of a patient’s daily performance while Figure 5 shows a visualization of a participant’s composite response and compliance performance, which is one click away from the web-based performance dashboard. In addition to these composite values, the performance values for each of the self-management domains will also be calculated. These values are also available in text form through object relational mapping queries to the database.

**Messaging Interfaces:** The technical subsystem uses the messaging interface for automated sending of content, behavioral prescriptions, feedbacks and reinforcements to patients and their buddies. The messaging process: The core task of sending and receiving messages is handled by the messaging process, which has two subcomponents—the messaging scheduler and the message handler. The messaging scheduler schedules messaging tasks based on a weekly schedule stored in the database. This weekly schedule is modifiable through a web form made available to clinicians. This subcomponent initiates four types of messages, namely, two-way performance assessment polls; one way push motivational and informative messages; one-way tailored feedback and support messages to buddies; and two-way buddy performance assessment polls to patients. The message handler interface also captures patients’ response to self-management polls (shown in Figure 3 above).

| DataCategoryId | PollStatus | PollDate | PollCount | Response | Response?
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**Figure 4:** A Section of a Patient’s Self-Management Data

**Web Backend:** The web backend component houses the behavior change support application, which includes functionality for sending appropriate self-management support interventions to patients and the necessary periodic feedbacks to the buddies. This functionality is implemented through three imbued characteristics—the self-care domains being targeted, the persuasive strategies implemented, and the algorithms that are the software implementation of those strategies for the given domains for each patient (see Figure 6).

**The Messaging Process:** The core task of sending and receiving messages is handled by the messaging process, which has two subcomponents—the messaging scheduler and the message handler. The messaging scheduler schedules messaging tasks based on a weekly schedule stored in the database. This weekly schedule is modifiable through a web form made available to clinicians. This subcomponent initiates four types of messages, namely, two-way performance assessment polls; one way push motivational and informative messages; one-way tailored feedback and support messages to buddies; and two-way buddy performance assessment polls to patients. The message handler

**Figure 5:** Change in Composite Engagement Self-Management Adherence
subcomponent parses incoming messages from patients, translating coded responses to their actual values and posting these values to the database.

6 Evaluation

The aim of the evaluation study is to measure whether the OH-Buddy is capable of delivering interventions to underserved patients and whether patients become better at managing their comorbid conditions after receiving this intervention. More specifically, we are examining:

1. Whether the system is reaching eligible patients and providing the self-management support activities.
2. The extent to which the buddy was supportive of the patient and its impact on patients’ self-management behavior.
3. Whether patients’ knowledge and self-efficacy have increased with self-management support from the system.
4. Whether patients’ self-management behaviors have changed with self-management support from the system.

Participants: Study participants consist of thirty-one adult dentate patients diagnosed with comorbid Type 2 diabetes and periodontitis. As part of the recruitment exercise, each participant nominated a “buddy”, who would provide “buddy support” over the course of the four-month duration of the single-arm, pre- and post-test intervention design. The participants received self-management support from the technical OH-Buddy system and from the buddy.

6.1 Measures

The study measures the following behavioral and psychosocial outcomes at baseline and end of study:

a. Reach: The extent to which the OH-Buddy is accessible to the target population [2].

b. Diabetes and periodontitis knowledge by means of the Diabetes Knowledge Test (as modified to include items on periodontitis).

c. Physical activity using the Physical Activity Scale for the Elderly (PASE) [45], an instrument designed to assess the level, duration, frequency, and amount of physical activity performed over a seven-day period by an individual 65 years and older.

d. Medication-taking using the Morisky 8-Item Medication Adherence Scale (MMAS) [46], an instrument widely used as a medication adherence measurement tool.

e. Dietary compliance using the Starting the Conversation Scale [47], which is a simplified screener for assessing patients for their dietary intake.

f. General adherence and individual domain adherence using patients’ self-reported data as collected throughout the duration of the study via SMS polls of patients’ self-management activities.

g. Self-efficacy using a modified Diabetes Empowerment Scale—Short Form [48], a short form measure of the psychosocial self-efficacy regarding diabetes self-management activities.

h. Disease control [2], measuring baseline and post treatment values of glycated hemoglobin and periodontal pockets.

6.2 Analyses

We are using Spearman’s rank correlation to test the association between self-management support, diabetes and periodontal knowledge, and self-care behaviors (medication adherence, diet, physical activity, blood glucose testing, and oral care). Second, we are running multiple regression models to measure the independent associations between self-management support and diabetes-periodontitis knowledge, as well as between self-management support and self-care behaviors (medication adherence, diet, physical activity, blood sugar testing, and oral care), while controlling for gender and ethnicity as covariates. Self-management support is the independent variable for each regression model, while diabetes-periodontitis knowledge and self-care behaviors (medication adherence, diet, physical activity, blood sugar testing, and oral care) are the dependent variables. Finally, we are running a multiple regression model to assess the independent effect of self-management support on glycemic control and dental pockets, controlling for diabetes-periodontitis knowledge and self-care behaviors. Here, HbA1c and dental pockets are the dependent variables, while self-management support is the primary independent variable, and diabetes-periodontitis knowledge and self-care behaviors are covariates. A two-tailed $\alpha$ of 0.05 is being used to assess for significance.

6.3 Results

The first task of the evaluation study is to determine whether the OH-Buddy is capable of sustained, automated delivery of support to the target population of patients. The ability of the system to deliver health messages was tested during the two pilot studies. Several questions were raised: Could messages reach patients, no matter where they are and the type of mobile phone they use? What medium (text or voice) should be used to support the buddies in order to engage them in their role?
Preliminary results suggest that the intervention is equally capable of reaching and engaging older (age 65 and above) patients as it does the younger ones. Informal exit interviews conducted with the patients and buddies indicated that study participants are comfortable with mobile texting as the medium for delivering health information. At study conclusion, composite and individual self-efficacy and self-management results for brushing, flossing, blood glucose monitoring, dieting, exercising, and medication will be presented and discussed. Disease control results for diabetes and oral health will also be discussed.

Figure 5 above shows the detail data that we have collected for a particular patient. Such data are available for all patients. As seen in Figure 5, for each date, we store brushing/flossing responses as well as diabetes-related queries. We are currently plotting these and analyzing for trends and patterns.

7 Conclusions & Future Research

We used the Design Science Research Framework [28] to iteratively build an SMS-based behavior change support intervention that is accessible to underserved populations and capable of automated pushing of educational and motivational self-management support to patients. We introduced an informal self-management support giver into each patient’s self-care milieu, thereby creating a triad consisting of the patient, the buddy, and the clinicians. We imbued the technical part of the OH-Buddy with the affordance to stimulate, broker, and foster three types of conversations within each triad: informational and motivational conversations between clinicians and the patient; tailored feedbacks and patient reinforcement messages from clinicians to the buddy; and informed social support from the buddy to the patient. The content, phrasing, nature, and frequency of the messages, as well as the inclusion of the buddy, are grounded on behavioral and persuasive technology theories.

7.1 Contributions of the Study

The OH-Buddy provides a platform for individuals with multiple chronic conditions to receive interactive persuasive messages in a manner that does not cognitively overload them, while bolstering their self-efficacy for a plurality of self-care behaviors. This study also makes contributions to science, healthcare, and the society at large in addition to the direct support it renders at the individual level.

The improved behavior engendered by the use of the OH-Buddy system and the consequent better control of multiple chronic conditions should, in turn, lead to better health outcomes and reduced utilization of healthcare services. It should, ultimately, result in reduced healthcare costs. Also, by enabling access to patients traditionally excluded from healthcare services, we keep alive the conversation on how to enact more inclusive healthcare systems around the world.

We have provided a way to improve the delivery of self-management support that is inclusive and easily accessible. It is flexible in that it can be positioned either within a primary care setting or at the health plan setting. The critical social theoretic underpinnings of this research, which motivated our use of the ubiquitous SMS as our intervention delivery medium, raises issues around why and how the IS research community can design inclusive self-care support solutions.

Our research is both innovative and cutting-edge as we used a combination of (1) SMS-based continuous assessment of the self-management behaviors of patients living with comorbid chronic conditions; (2) patient feedback and reinforcement, in the light of the results from the assessment) delivered by a buddy of the patient; complemented by (3) informational and motivational messages delivered through SMS to patients, and (4) a web-based performance dashboard through which clinicians can gain insight about patients’ performance.

7.2 Limitations and Further Research

The additional care delivered by buddies, based on the two pilot studies preceding this study, seems to have beneficial effects on patients’ self-care behaviors. The question, however, arises as to how to keep these buddies motivated and engaged in performing their supporting role over longer periods of time. One possible means of keeping them would be to incorporate a module that periodically checks on them and samples their opinion on the patient’s progress. Another could be to do away altogether with human buddies and use software agents to perform the buddy role. This study makes the limiting assumption that these buddies are already well motivated to perform their role. To reflect this assumption in the evaluation study, the buddies were kept motivated by having them first undergo some inductive training, during which their role in relation to the patients was explained to them. They also additionally received weekly follow-up support via text messages from University of Michigan dental hygiene students.

How to keep buddies motivated to perform their supporting role to the patient is therefore suggested as an area for future studies. It is also possible that some exogenous factors can prevent the continuation of a patient-buddy relationship. Such further studies should also address this. It would warrant additional research to explore the efficacy of using software agents either as buddies or as a medium to keep the human buddies...
engaged in their role. However, informal feedbacks from patients suggests that they generally like both the human and technological elements of the OH-Buddy system. They find it is easy to respond to and are particularly pleased when their buddy calls to discuss how they are doing.

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9 References


