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ORIGINAL ARTICLES

Communication Plays a Critical Role in Web-Based Monitoring

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Abstract

Background:

Patient–health care practitioner (HCP) interaction via a Web-based diabetes management system may increase patient monitoring of their blood glucose (BG) levels.

Methods:

A three-center, nonrandomized, prospective feasibility study of 109 Native Americans with poorly controlled type 1 diabetes mellitus and type 2 diabetes mellitus were recruited from Alabama, Idaho, and Arizona. The study intervention included the use of a Web-based diabetes management application (MyCareTeam®) that allowed timely interaction between patients and HCPs. Information about diabetes, nutrition, and exercise was also available. Finally, patients were able to provide BG readings to their HCP via the MyCareTeam system.

Results:

As a result, 59.6% of the patients sent one or more messages to their HCP, 92.67% received one or more messages from their HCP, and 78.89% received one or more person-centered messages from their HCP. Additionally, the number of times a patient logged into the system and the frequency with which they tested their blood sugar were correlated with (a) the number of messages sent to their HCP, (b) the total number of messages received from their HCP, and (c) the number of person-centered messages received from their HCP. Thus patients who sent more messages also tested their BG more frequently, as measured by the number of BG readings uploaded from their meter to the MyCareTeam database. Person-centered messages seem to be particularly important to motivating the patient to monitor their BG levels and use the Web-based system.

Conclusions:

These results suggest that patient–HCP interaction and, in particular, more personalized interactions increases patient frequency of BG monitoring.

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Abbreviations: (BG) blood glucose, (CDC) Centers for Disease Control and Prevention, (HCP) health care practitioner, (T1DM) type 1 diabetes mellitus, (T2DM) type 2 diabetes mellitus

Keywords: communication, diabetes management, health information technology, self-monitoring of blood glucose, telemedicine

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Introduction

The Centers for Disease Control and Prevention (CDC)[1] estimated that, in the United States, the number of people diagnosed with diabetes increased from 5.8 million in 1980 to 15.8 million in 2005, and as of 2009, 23.6 million people have diabetes. Approximately 17.9 million people in the United States have been diagnosed with type 1 diabetes mellitus (T1DM) or type 2 diabetes mellitus (T2DM), with T2DM comprising approximately 90% of all diagnosed cases.[2] The illness affects age, ethnic, and racial cohorts differentially. Native Americans and Alaskan Natives are at an increased risk for diabetes. In fact, the CDC[1] estimates that, in 2007, 16.5% of all Native Americans and Alaskan Natives suffered from diabetes. The Pima of the Gila River Indian Community in Arizona estimates that 50% of their adult population has diabetes.

Successful treatment and management of diabetes, like other chronic illnesses, have been shown to be linked to patient–health care practitioner (HCP) interaction.[3] Unfortunately, many barriers exist that prevent clear communication and understanding between the HCP and patient during an office visit. These barriers can reduce the effectiveness of diagnosis and treatment as well as increase the levels of uncertainty a patient experiences.[4] One challenge to the management of uncertainty within patients is providing an adequate explanation at the time when the patient needs it.

New communication technologies create a window of availability to patients. Often described as telemedicine, technological innovations allow patients to be treated from afar while increasing the timely availability of HCPs to their patients. This increased opportunity for interaction is a significant improvement for managing the uncertainty of patients and increasing the patients' involvement in the health care process. MyCareTeam®, one example of a virtual space, allows patients with diabetes the opportunity to log in and find education, provides a portal for logging blood glucose (BG) readings, and creates a space where patients can discuss their condition with a HCP and exchange information related to diabetes management. In earlier studies, improved clinical outcomes, as measured by reductions in HbA1C, were seen by participants who used MyCareTeam regularly.[5,6] The communication in this virtual space removes the pressures of time and immediacy from the encounter and provides an ongoing management of uncertainty for participants. More detailed descriptions of the MyCareTeam diabetes management system are provided by Smith and colleagues[5] and McMahon and associates.[6]

While past studies have explored the use of email between doctors and patients as a means of augmenting communication,[7–9] no studies have examined the use of email in combination with a virtual system of care. Thus the purpose of this investigation is to explore the efficacy of this new communication channel on health outcomes and social support within the context of diabetes care management.

Considerable research has explored the use of email between patients and HCPs and its viability as a means of communication.[7–11] These studies suggest that email provides an opportunity to augment the communication received through face-to-face encounters. Despite increased use of email and the potential offered by email communication, the adoption of email has been slow.[10,11] Physicians are concerned with the time associated with responding to patient concerns by email as well as the lack of reimbursement. Therefore, research needs to explore the link between patient outcomes and the use of email communication.

The management of chronic diseases such as diabetes consumes 70% of health care spending in the United States and is the primary reason that patients seek medical care.[12] Effective chronic disease management requires attention to the patient's lifestyle to encourage behaviors that build physiological reserves (e.g., sleep, exercise, and nutrition), adherence to treatment protocols, monitoring of the patient's physical and emotional status, and management of the disease's impact on the patient's ability to interact in the world.[13] As a result, patients and HCPs must form a partnership that spans the life of the patient, with both participants in the partnership providing necessary information for treatment and HCPs providing encouragement to promote patient compliance.

Because chronic illness management is an ongoing and sustained relationship between the patient and the HCP, the development of remote illness management has emerged as a means by which the patient and HCP can stay connected. Previous research has found that remote monitoring systems such as automated telephone follow-up

coupled with online systems can be effective with diabetes patients.[14] The current study of the MyCareTeam project provides the opportunity to explore the promise of many of these remote monitoring systems when integrated with a communication component.

The purpose of this investigation is to determine the effectiveness of the MyCareTeam technology and to determine how the system is used by the patients. Previous research suggests that physicians' use of email communication with patients can increase rapport by opening communication opportunities.[8,11] The use of the MyCareTeam diabetes management system provides patients an opportunity to interact with a HCP every time they log onto the system and should encourage interaction or conversation with their HCP. Thus hypothesis 1 states: As patient use of the MyCareTeam system increases, the amount of patient–HCP interaction increases. Similarly, hypothesis 2 states: As the amount of patient use of the MyCareTeam system increases, the number of person-centered email messages received from their HCP also increases.

While a system that promotes patient–HCP interaction is undoubtedly beneficial, linking interaction with patient health outcomes is a goal of any diabetes management system. Blood glucose monitoring is critical to the treatment and management of diabetes, and consequently, any technology that can assist in this monitoring is a potentially tremendous health asset. The MyCareTeam system provides patients a convenient vehicle for communicating their BG readings to their HCP and provides patients an opportunity to be more involved in their own health care. Thus hypothesis 3 states: As the level of patient–HCP interaction increases, the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded in their meter, will also increase. Hypothesis 4 states: As the number of person-centered messages received by a patient increases, the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded in their meter, also increases. A more strident test of the relationship between the number of person-centered messages received and the frequency with which they check their blood sugar would control the number of total messages sent and received by the patient. Thus hypothesis 5 states: After controlling for the total number of messages sent and received by patients, the number of person-centered messages received by a patient will be positively related to the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded in their meter.

Research Design and Methods

This nonrandomized prospective feasibility study employed 109 Native Americans diagnosed with diabetes. These patients were recruited from Indian Health Centers in Alabama, Idaho, and Arizona. Institutional Review Board approval was received from multiple organizations, and informed written consent was received from all participants. Patients were eligible for the study if they were over 18 years of age, had been diagnosed with T1DM or T2DM, used a BG meter regularly, were willing to use a computer, and had an HbA1C level above 7 within 3 months prior to enrollment in the study.

All 109 participants in the study were given access to MyCareTeam. MyCareTeam is a Web-based disease management system that was introduced into existing diabetes management programs at each of the selected Native communities. Patients checked their blood sugar using standard glucose meters and transmitted the results to a secured database, where their blood sugar results were analyzed and presented in multiple formats. Participants used MyCareTeam to communicate with their diabetes HCPs. Educational material regarding diabetes and Native communities was provided and was adapted to be culturally appropriate.

After enrollment, the 109 participants were given a cable to connect their glucose meter to a computer or, for those less technically inclined, to a modem that allowed them to transmit their BG readings directly to a remote secured database over a telephone line. Like nearly all Internet applications, the MyCareTeam portal benefits from high-speed Internet access, but such high-speed access is not required.

They were instructed on how to access the information from any Internet browser and how to interpret the results. Participants were told to continue checking their BG as directed by their HCP and to upload the readings at least once every 2 weeks or more frequently if they chose. Patients could interact with their HCP asynchronously if health issues arose or to explain what was going on in their lives to help the practitioners provide better health care. It is important to note that whenever patients tested their BG levels, the resultant reading was captured and maintained within the glucose monitor. While the patients were asked to upload their BG scores at least once every 2 weeks to the MyCareTeam database, all new BG scores recorded with their glucose meter were transferred whenever the patient uploaded their readings. Thus if a patient waited 6 months to upload their BG

score, an accurate record of their monitoring efforts over those 6 months as noted by the BG scores are captured through the MyCareTeam software.

Providers checked daily for new BG readings, messages, or other information from their patients and would respond via the Web site. Providers could also initiate interaction with the patients when they had global announcements, noticed problems (and successes) with the patients' BG readings, or noted that the patients had not recently uploaded their BG readings.

Our focus was on patient system usage, patient–HCP interaction, and patient health. Patient interaction with the system was measured using the number of times the patient logged into the system over a 6 month period (recoded into three categories: no logins after the initial enrollment, infrequent logins, and frequent logins). The number of BG readings transmitted by participants during their involvement with the MyCareTeam program was also recorded and coded as readings. Finally, email contact initiated by patients was coded as messages sent. All email messages sent by a HCP to a patient were coded as messages received. Those messages sent to patients by a HCP that contained personal information about the patient were coded as person-centered messages. A person-centered message consisted of a message that was sent only to that individual participant. While some messages were sent to the group as a whole, a person-centered message was directed at and created for one individual. Person-centered messages include HCP efforts at providing health information, soliciting information from the patient, and asking the patient to upload their BG meter in a timely manner. In addition, person-centered messages also contained concerns about patient BG readings and encouragement. Hypotheses 1 and 2 were tested using Spearman Rho correlations, because the patient involvement data were measured at the ordinal level. Initially, the variable logins were measured at the ratio level but were then recoded into three categories (no logins after initial enrollment, infrequent logins, and frequent logins). The variable was recoded to remove the effect of false and failed initial login efforts. The number of messages sent, messages received, as well as the number of person-centered messages were measured at the ratio level. Hypotheses 3 and 4 were tested using Pearson Product Moment Correlations, because both variables—the number of BG readings and the number of messages or person-centered messages—were measured at the ratio level. Hypothesis 5 was tested using partial correlation. All correlations were calculated as two tailed tests, and an alpha level of 0.05 was adopted *a priori* to reduce the likelihood of making a type I error (i.e., rejecting the null hypothesis when it is true).

Results

Respondent use of the telemedicine system varied. Just over 25% of the 109 respondents did not use the system after their initial login/registration, 65% used the system an average of once a month, and the remaining 46 respondents used the system two or more times a month. In terms of message length, the mean length of person-centered messages was 53.73 words, the median length was 43 words, and the mode was 41 words per message. Interviews with the HCPs suggest the typical time spent replying to a message was between 30 s and 5 min, depending on the complexity of the issues being raised.

Hypothesis 1, which stated that as patient use of the MyCareTeam system increases, the amount of patient–HCP interaction increases, was supported. The Spearman Rho nonparametric correlation suggests that the more times a patient logged into the MyCareTeam system, the more email messages they sent their HCP ($r = 0.659$, $N = 109$, $p < .01$). Since interaction is not simply the sending of messages but rather the sending and receiving of messages, a second nonparametric correlation was calculated, examining the relationship between receiving messages and logging into the system. The data suggest that the more times a patient logged into the MyCareTeam system, the more email messages they received from their HCP ($r = 0.409$, $N = 109$, $p < .01$). Hypothesis 2 stated that as the amount of patient use of the MyCareTeam system increases, the number of person-centered email messages received from their HCP also increases. Again, this hypothesis was supported. As the number of patient logins increased, the number of person-centered messages they received from their HCP also increased ($r = 0.581$, $N = 109$, $p < .01$).

Hypothesis 3 stated that as the level of patient–HCP interaction increases, the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded in their meter, will also increase. The Pearson Product Moment Correlation suggests that the more messages a patient sends to their HCP, the more frequently they test their BG readings, as measured by the number of BG readings recorded in their meter, and transfer the readings to the MyCareTeam system ($r = 0.237$, $N = 109$, $p < .05$). Similarly, the more messages a patient receives from their HCP, the more frequently they test their BG readings, as measured by the number

of BG readings recorded in their meter, and transfer them to the MyCareTeam system ($r = 0.350$, $N = 109$, $p < .01$). Hypothesis 4 stated that as the number of person-centered messages received by a patient increases, the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded in their meter, also increases. This hypothesis was supported ($r = 0.364$, $N = 109$, $p < .01$). Hypothesis 5, which stated that after controlling for the total number of messages sent and received by patients, the number of person-centered messages received by a patient will be positively related to the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded their meter, has also been supported ($r = 0.339$, $N = 109$, $p < .01$) (see **Table 1**).

Table 1.
Correlations between Messaging, Logins, and Blood Glucose Scores

	Total messages sent	Total messages received	Person-centered messages received
Logins (over 1 month) Spearman Rho (two-tailed) Correlation	$r = 0.659$, $p < .01$	$r = 0.409$, $p < .01$	$r = 0.581$, $p < .01$
BG measures (1 month) Pearson Correlation (two-tailed)	$r = 0.237$, $p < .01$	$r = 0.350$, $p < .01$	$r = 0.364$, $p < .01$
BG measures (1 month) partial correlation, after controlling for total messages sent and received (two-tailed)			$r = 0.339$, $p < .001$)

Discussion

The data presented here suggest that the MyCareTeam diabetes management system encourages interaction between patients and HCPs by providing not only an avenue or channel for such interaction but also health information. In addition, the uploading of BG readings provides a reason for interacting. Patients can provide information about their diet or their exercise regimen and explain exigencies such as travel that may have affected their readings. Their HCP can provide support and encouragement and praise as well as remind patients to monitor their BG readings. These opportunities for interaction undoubtedly help patients by maintaining a feeling of accountability and an opportunity for answering questions they might have.

In addition, the interaction also allows patients and HCPs to provide personal information that can lead to increased feelings of relational closeness. These benefits are often discussed within the social support literature: a literature that suggests that the development of friendships can benefit older adults more than familial interaction and relationships. This increased level of patient usage of the system can change the nature of a patient–HCP relationship from a purely professional relationship to a more personal one. This relational change is apparent with most cursory examinations of the messages sent between patients and HCPs as well as by the significant partial correlation supporting hypothesis 5.

Since the BG monitors retain all the patients' scores, respondents who never logged into the system after being enrolled into the program present a potential problem. It is possible that those individuals were meticulous in keeping up with glucometer testing and were simply not uploading any data to their HCP. To ensure this potential problem was not confounding the study, a *post hoc* examination of the relationship between the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded in their meter, and the number of person-centered messaged received was performed. It is clear from this analysis that, even after removing the 28 respondents failing to upload BG scores a single time after enrollment, the expected relationship remained ($r = 0.263$, $N = 86$, $p = .015$, two-tailed).

The final relational benefit of increased interaction stems from an increase in understanding. Slight changes in perceptions of their relationship can dramatically change the meanings they derive from the messages they receive. By increasing interaction, patient and HCP perceptions or definitions of the relationship can be made more stable through the increase in messages containing that relationship information. It is not simply the increased relational closeness that benefits the patient in decoding HCP messages, but in addition, it is the certainty about the nature of their relationship that can be clarifying.

Increased interaction provides additional opportunities for patients to request health information and use the system as a portal for gaining access to accurate and up-to-date information about their illness, treatment regimen, nutrition, and exercise. In addition, the increased levels of interaction are also related to patient BG monitoring. Not only do the patients monitor their BG more frequently, but also, they are able to get their BG readings to their HCP in a more timely fashion. This is important for illnesses that can change as quickly as diabetes.

The increase in patient–HCP interaction provides an opportunity for increased familiarity and an increased opportunity for relational closeness to develop between patients and HCPs. This closeness is important, because it increases the sense of accountability that accompanies the increased closeness of the relationship. Many HCPs are unaware that all messages contain both content and relationship dimensions or components.[15] This means that messages contain both information that is rooted in the language (e.g., exercise 30 min per day at least 3 days a week) and information that is rooted in the nature of the relationship between communicants. For example, a HCP telling a patient to exercise can be viewed as a command or a demand from a HCP, or it can be viewed as a message of caring from a knowledgeable practitioner. How that message about exercise is contextualized is determined by the relationship between communicants. Thus increasing the level of affinity changes the way a message is understood. Exercise is not something you are doing to humor your HCP, but rather it is a reminder from a friend or an acquaintance that your health is important to you and to them. For many of us, that relationship could be the difference in our decision to comply with a health care regimen or not.

Sending and receiving messages—particularly receiving person-centered messages—is related to the frequency with which patients check their blood sugar, as measured by the number of BG readings recorded in their meter. This increase in blood sugar monitoring is advantageous to the health of the patient,[16–18] allowing for timely changes in treatment, offers of encouragement, and reminders that may promote patient accountability for their health. Perhaps most importantly, the data suggest that increasing the relational closeness between patient and practitioner further increases the likelihood of blood sugar monitoring by the patient. These data suggest that ongoing interaction is an important element for some patients. Systems that do not incorporate some type of communication or that generate nonpersonal or automated messages may not achieve the same levels of cooperation from patients.

Of course, the system is not a panacea. Some patients will undoubtedly not benefit from the opportunity to gain information about their illness, exercise, and/or diet, nor will they necessarily benefit from the interaction with their HCP. Glucometer monitoring and related health behaviors are affected by a variety of factors, and future research needs to take those factors into consideration.

While the nature of the relational change is not completely understood, it can, perhaps, be better understood by examining the findings from the interactional perspective proposed by Watzlawick and coworkers,[15] suggesting that all messages have two dimensions: the content dimension contains the verbal component of the message, and the relationship dimension contains contextual information needed for interpreting the verbal message. The relationship dimension is often called the contextual dimension, because the relationship between communicants plays such an important role in contextualizing information. It is also called the contextual dimension because all messages contain information about the nature of the relationship between communicants. Thus the personalized messages provide context information that helps patients and providers better understand the meaning behind the messages. In addition, the personalized messages also promote a sense of accountability to the HCP. Finally, the nature of the relationship also changes the "interpersonal value" they gain by maintaining their health care regimen. These factors—along with the benefit of timely information—suggest that such a system is undoubtedly helpful for at least some patients.

Conclusions

The data suggest that use of the MyCareTeam system appears to have encouraged patient–HCP interaction. Similarly, this interaction, which resulted in more personalized or person-centered communication, was related to an increase in BG monitoring.

A more detailed analysis of the messages sent between patients and HCPs is currently underway and may shed more light on the types of message and the kinds of relationship that promote improved patient BG monitoring efforts. Future research needs to more closely examine the nature of these messages and the development of closer relationships between patients and HCPs. Finally, an examination of the relationship between messaging and clinical health benefits should be pursued.

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Disclosure:

Betty A. Levine and Tang Ming-Jye Hu own less than 5% of the stock in a company that has licensed the MyCareTeam technology.

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