



A two-way text-messaging system answering health questions for low-income pregnant women

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ABSTRACT

Objective: The purpose of the study was to gauge the effectiveness of a low-cost, automated, two-way text-messaging system to distribute pregnancy and health-related information to low-income expectant women.

Methods: In total, 20 participants were recruited for a one-month intervention involving the use of cell phones to text pregnancy-related questions to the system. Participants received either a direct answer or encouragement to seek answers from health care providers. Pre- and post-tests as well as a focus group at the end of the intervention were conducted.

Results: Participants uniformly found the system easy to use and accessible. Using the system increased levels of perceived pregnancy-related knowledge and facilitated patient-provider communication. Moreover, participants reported significant reductions in stress and depression and improved mental health after using the system. The system responded to most known questions quickly and accurately, and also encountered many new topics and linguistic expressions.

Conclusion: Overall, the data indicated that the text messaging system offered psychological benefits and promoted health communication by providing health information and encouraging patient-provider communication.

Practice implications: An automated, two-way text messaging system is an efficient, cost-effective, and acceptable method for providing health information to low-income pregnant women.

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1. Introduction

In 2004, United States ranked 29th lowest in the world in infant mortality, with a rate of 6.9 deaths per 1000 live births, compared to 22 countries with rates below 5.0 [1]. In Milwaukee, the infant mortality rate is even higher, with an average of 11 deaths reported per 1000 live births and 15.7 among African Americans from 2005 to 2008 [2]. Many of these deaths are considered preventable, as more than half have been associated with premature labor and births or unsafe sleep [2]. We believe that utilization of mobile phones to communicate health information is a viable approach to reduce rates of infant mortality by improving access to quality health information as well as by

increasing patient participation and advocacy in the health care setting [2]. In health care, mobile phones have been used for a variety of health promotion and patient-monitoring applications, such as sending text messages with educational information or reminders about weight reduction, smoking cessation, and exercise [3]. The National Healthy Mothers, Healthy Babies Coalition launched U.S. Text4Baby, a free text-messaging service that sends health information to pregnant women and new mothers [4]. These interventions have been promising and show benefits to health outcomes [3].

However, none of the existing applications support interactive, real-time dialog where patients can ask questions and get an immediate, automated response. This study is unique in its focus on the applied use of a low-cost, automated, two-way text-messaging system to communicate locale-specific, pregnancy- and health-related information to low-income, expectant women. Our system allowed users to ask questions and receive responses in comprehensible “chunks” targeted to the unique demographics and needs of the population.

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We propose that two-way automated interaction can promote health communication and offer psychological benefits to the target population. First, the system may represent a practical method of delivering health information to the target population. Digital divide research has revealed that key ethnic disparities can be found in Internet access, as 51% of African Americans have a computer at home, compared to 65% of Whites [5]. Conversely, 70% of African Americans and English-speaking Latinos use text messaging, while just over half of Whites text message [5]. Furthermore, low literacy has been associated with being female, a minority, and having a low income status [6]. Pregnant women with low-literacy levels, therefore, may be better served by receiving health information shared in small and readable chunks, which is characteristic of the text message format. Two-way interaction may also enable patients to obtain additional information when they are most ready for it and preserve their sense of control over a device that they own.

In addition, use of the system may expand the breadth and depth of communication between patient and healthcare professional by encouraging patients to generate questions and seek information about pregnancy. Research on patient–provider communication indicates that patients who ask questions and express concerns are more likely to obtain information from their physician about diagnosis, health matters, and treatment [7]. Additionally, low-income pregnant women who engage in health information-seeking are more likely to feel a greater sense of self-efficacy and control over what happens to the fetus [8]. Therefore, the system may not only serve as a jumping-off point for increased information-sharing between patient and provider about pregnancy-related issues but it may also engender increased self-advocacy behaviors, such as searching for information about pregnancy and discussing questions with friends and family.

Use of an automated text messaging system also may improve psychological outcomes, such as decreasing depression and stress, as well as improving overall mental well-being. Low-income pregnant women, especially those in teenage years, may be especially susceptible to chronic stress [9,10]. Furthermore, stress and anxiety during pregnancy has been found to influence fetal heart rate patterns [11], child emotional development [12], and increase the likelihood of pre-term births [13]. Having round-the-clock access to information about pregnancy may be one way to decrease stress and reduce the feelings of isolation that often accompany depression.

In this study, we tested the functionality of the two-way automated system (e.g., the system's ease of use, usability, coverage, and accuracy) as well as the real-life consequences of using the system (e.g., pregnancy-related knowledge gain, patient-provider communication facilitation, and stress reduction) for low-income, minority pregnant women. An additional goal was to develop and expand upon the pregnancy-related content housed in the system.

2. Methods

2.1. Developing the content

The first step of the project was to construct a preliminary list of typical and essential information needed by pregnant women, as well as a list of resources for obtaining trusted health and local social-service information. The project began by meeting with Milwaukee Health Department (MHD) nurses and social service providers who interact with low-income, minority pregnant women to gauge perceptions about the most important and frequently asked questions among the target population. We then formatted the preliminary list as a simple survey that was presented to patients during their home visits by MHD nurses [see

survey procedures discussed in Section 2.3]. The survey allowed participants to both pick from the list of previously recommended topics and to add new topics.

The second step of content development involved translating expressed information needs of participants into a question-and-answer format that would allow us to drive a dialog agent. Answers were compiled and revised to meet 5th-grade readability levels, and were then reviewed by MHD staff for accuracy.

2.2. Creating the messaging system

The general architecture of the messaging system was one of stimulus and response: participants initiated interaction by asking questions and the system attempted to provide the best answer based on its stored content. This allowed us to control the accuracy and readability of the answers. Significant flexibility was required, because participants' questions were not identical to those anticipated during the content development phase.

Our approach was to use TuTalk [14,15], an existing system for two-way, text-based dialog developed at the University of Pittsburgh. TuTalk uses a declarative scripting language and a number of easily replaceable modules for understanding and generating text. TuTalk is robust, secure, and capable of handling many users simultaneously [14,15]. However, because TuTalk was designed to support educational applications where the system asks the questions, it was unknown what would be required for effective patient-initiated communication.

We made only two additions to TuTalk. We added a component to read the file that contained our content model and to translate that text into the scripting language. The function for creating these scripts is run manually before the dialog server is started. Second, we added a component to read text messages sent to the system, transmit messages to the TuTalk engine, take the reply from TuTalk, and then send it out as a text message using e-mail.

The dialog manager of TuTalk has been implemented using a reactive planner. It is guided by concepts and scripts (i.e., plans for achieving a goal). In our system, scripts were of the form "If concept_i, then do goal_i", where the concept represented a set of questions corresponding to a single information need and the goal was an action to find and text the answer. Most of our scripts were created automatically, except for a few scripts for greeting the user, asking her to agree to the terms of our disclaimer regarding medical information, and encouraging her to ask a question if she had not done so recently.

We used the default function for matching questions to stored concepts, which uses shallow parsing to pick out key phrases and a minimum edit-distance function to select the best match. There is a configurable threshold for specifying how close a match must be; for example a threshold of 0.5 means that at least half the words in the normalized form must be the same as in the pattern. We used a matching threshold of 0.8.

The system selected an automated answer only if it corresponded to the correct, specific response (i.e., a match with very high precision). It deferred non-factual questions, and questions with unanticipated topics or conditions to the participant's provider.

2.3. Data collection procedures

The data were collected during two time periods, March–May 2011 and October–December 2011. During both phases of data collection, a total of 180 initial surveys were distributed to low income, pregnant women living in underserved communities in eight zip codes in Milwaukee (identified as "high risk zip codes" by MHD). All the participants were eligible for Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

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