Published in final edited form as:

Home Health Care Manag Pract. 2011 December 2; 23(6): 454–460. doi:10.1177/1084822311411565.

Patient Reactions to Vital Sign Measures: Comparing Home Monitoring Technology to Face-to-Face Delivery

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Abstract

Increasingly home health agencies are using home-based technologies to monitor vital signs of chronically ill patients. Patients receive measurements such as blood pressure and weight that indicate risks to their health. Cognitive reactions to risk measures have been studied for face-to-face delivery; however, it is unknown whether the same reactions exist with technology delivery. Reported in this article are study results of a comparative content expert analysis of reactions to technology-delivered health-risk measures. Results suggest that patients have the similar reactions but may be more likely to just accept, without evaluating or considering threats to their health. As home telemonitoring applications continue to evolve, care must be taken avoid creating passive patients and develop best practices that use technology to encourage beneficial self-care behaviors.

Keywords

nursing; telemedicine; human–computer interaction; chronic illness; telehealth

Researchers project that more than 30 million older adults will be living with at least one chronic illness by 2030 (U.S. Bureau of the Census & Day, 1993). Chronically ill patients are discharged home after short hospital stays that places increasing demands on home health nurses to care for sicker patients. Home health nurses are experts at monitoring for signs and symptoms of illness exacerbation. In addition to monitoring, nurses teach, demonstrate, and encourage beneficial self-care behaviors to patients. Increasingly, the transition period of patient stabilization is being facilitated by electronic monitoring of patients in their home from a remote nursing station. Remote monitoring is a major component of the projected 4-million dollar home health technology industry (Park Associates, 2009). Telemonitoring has become a frequent supplement to home health visits and allows nurses to virtually measure patients' vital signs more frequently. Electronic monitoring has been placed in homes with assumptions that patients will utilize, perceive, and react to the information delivered by this technology in the same manner as when the nurse gives information to them face to face. Understanding best practices for using telemonitoring requires an evaluation of these assumptions. Researchers found patients' cognitive reactions to the delivery of health risk measurements, such as blood pressure, are based on a complex interplay of conditions, but have only explored face-to-face delivery (Panzer & Renner, 2008; Renner, 2004). Still unknown is whether patients react to measurements delivered by technology in the same way as they react to those delivered face

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Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

to face. Consequently, researchers do not know whether patients' cognitive reactions to technology-delivered information are beneficial in promoting self-care behaviors. To effectively utilize telemonitoring technology in the home, every effort should be made to understand and develop its use in a manner that enhances the efforts of the home health nurse.

This Phase 1 study was conducted to determine whether face-to-face reactions are similar to technology-delivered reactions. Understanding how patients cognitively react will help home health nurses provide more comprehensive care that motivates chronically ill patients to engage in health promoting behaviors when remote monitoring technology is used. Reported in this article are study results of a comparative content expert analysis of reactions to technology-delivered health-risk measures (i.e., weight and blood pressure). These reactions must be explored prior to further studies on how home monitoring technology influences outcomes such as readmissions.

Reactions to Telemonitored Measurements

Chronically ill patients routinely receive measurements of their internal body status that quantify pending risks to their health conditions. For example, blood samples can be evaluated for levels of glucose, cholesterol, iron, or thyroid-stimulating hormones. Other vital sign measurements such as blood pressure, weight, heart rhythm, or respiratory volumes evaluate organ function. Human motivation, individual patient characteristics, and feedback are key components in developing strategies to encourage patients to practice behaviors that maintain or optimize health (Bodenheimer, Lorig, Holman, & Grumbach, 2002; Houser-Marko & Sheldon, 2008). Instinctively, home health nurses evaluate individual patient characteristics to determine what type of encouragement and feedback is likely to be most effective for each individual. Chronically ill patients have many characteristics that affect how they react to monitored values and subsequently determine how they manage their health such as age, gender, emotional support, how they relate to their environment, the severity of their illness, and the length of time with their condition (Bondmass, Bolger, Castro, & Avitall, 2000; Pare, Jaana, & Sicotte, 2007).

The first step in the process of behavior change is receipt of information followed by a perception or cognitive reaction to the information. Behavioral researchers have examined how participants cognitively react to monitored measurements of blood pressure and cholesterol that are delivered during a face-to-face meeting (Renner, 2004). These researchers found that there is an interaction between expectancy, feedback, and consistency that contribute to patients' spontaneous reactions to receiving blood pressure and cholesterol levels in a face-to-face meeting with a health care professional. A study of health-risk measurements in 629 adults (16–90 years old) found that there are cognitive perceptions in response to receiving the results of blood pressure and cholesterol measurement: (a) threat to health, (b) pressure to change behaviors, (c) inaccuracy with need for more information, and (d) acceptance (Renner, 2004). Intensity and combinations of the reactions were influenced by expectancy, consistency, and feedback valence (positive or negative). More than half (55%) had a single reaction and 45% had two or more reactions. Patients who have lived with and managed their illness for longer durations have life experiences that influence their expectations and their perceptions. These may differ based on the consistency of the measurement with past experiences; patients who have abnormal blood pressure readings react with a decreased perception of seriousness (Croyle, 1990). Negative feedback or unexpected positive feedback evokes more elaborative cognitive processing. Cognitive reactions coupled with feedback valence are of central importance when patients assess risks to their health (Croyle et al., 2006; Ditto, Munro, Apanovitch, Scepansky, & Lockhart, 2003; Panzer & Renner, 2008; Renner, 2004). Panzer and Renner validated these findings.

The most frequent reactions to receiving measurements that were indicative of a health risk were perceived pressure to change behaviors (22%), threat to health (12%), need for more information (5%), and acceptance (3%; Panzer & Renner, 2008). Both studies concluded that motivation to change health behaviors depended on a unique combination of expectancy, feedback valence, consistency, and reactions. The findings were consistent across all ages and genders, with the exception that adults older than 35 years of age were less likely to react with worry about implications for health. No research has been performed on patient reactions to monitored measurements delivered by technology.

Home telemonitoring technology has become a widespread addition to home health nursing care that decreases the cost of time and travel by providing oversight from a remote nurse who is not physically present when the patient is being monitored. Telemonitoring is often used for older chronically ill patients who have frequent admissions to the hospital for acute exacerbations. Patients typically use blood pressure cuffs, weight scales, pulse oximeters, and/or glucometers to obtain measurements that are transmitted to the patient's home-based electronic display as well as the remote nurse's computer. The nurse will initiate corrective action, if needed. Patients receive an electronic survey or phone call in response to measurements that are outside a preestablished therapeutic range and indicative of a health risk. The efficiency of remote monitoring is that nurses only contact patients when an intervention is needed due to an indicated health risk. This is a distinct difference from when nurses are physically present and have the opportunity to discuss measurements that are within a therapeutic range. These discussions are part of a process that can provide timely information that improves a patient's understanding of diet, exercise, medication administration, or other behaviors that are helpful toward maintaining health and decreasing future exacerbations.

This study examined cognitive reactions to telemonitored measurements, which begins the process of engaging in healthy behaviors. Patients receive measurements, cognitively react, and then may or may not physically engage in behaviors. Phase 2 (in process) examines how feedback that is combined with reactions, expectancy, and consistency influence behaviors. Validation of reactions to telemonitored measurements will provide a platform for continued research into patients' use of home-based monitoring technology that can be used to motivate health behavior changes. Understanding how patients react to the monitored measurements will assist nurses in encouraging patients and providing feedback in an effective manner. Best uses of the devices for monitoring and promoting healthy behaviors begin with an understanding of how patients react to information they receive daily from the devices.

Method

Phase 1 was a qualitative content analysis that explores nursing experts' coding relative to how Renner's four categories (referred to as *worry*, *actuation*, *evaluation*, and *acceptance*) could apply to telemonitored chronically ill patients. Expert intercoding agreement was chosen as the analysis method because it measures "the extent to which the different judges tend to assign the same rating to each object" (Tinsley & Weiss, 2000, p. 98). The study proposal was approved by Banner Health's human subjects review board. Study participants were recruited from the institution's home health agency in Gilbert, Arizona. Inclusion criteria were as follows: patients aged 62 years or older, elected home health telemonitoring services, and discharged to home health following a hospitalization for Stage II or III heart failure (HF).

The purposive sample consisted of HF patients who received home telemonitoring services. Patients living with HF are the most frequently telemonitored patients with a chronic illness

(Pare et al., 2007). During an initial 90-min interview in the home, the investigators gathered information on various aspects, including the following: age, gender, length of time with illness, and available emotional support. The researchers asked structured open-ended questions about current reactions to that morning's monitored measurements (see Table 1). Investigators then guided participants through four separate case scenarios that used personalized lifestyle activities and asked them to project how they would react. Each scenario depicted either a healthy or an unhealthy behavior and the measurements that resulted after engaging in that behavior: (1) an unhealthy behavior with out-of-range results, (2) healthy behavior with in-range results, (3) an unhealthy behavior with in-range results, and (4) healthy behavior with out-of-range results. An example of an unhealthy behavior with in-range results that pertained to one participant's lifestyle is as follows:

You get up in the morning and feel tired because you went to a friend's retirement celebration and couldn't sleep when you got home. Your stomach was upset because you ate a large hamburger and many salty peanuts with several sodas. You use your telemonitoring equipment, and your blood pressure and weight are normal. How would you react?

Digital recordings of responses were transcribed into a table with 12 items (8 questions and 4 case scenarios) as columns and 5 de-identified patients' as rows. The interview content data were transcribed for each participant's answer to each item. Four content experts (two home health RNs and two informatics RN researchers) who were not associated with the research study were provided with written instructions on how to color code participant reaction types for each participant and item in the table. Content experts had ongoing access to researchers for any questions. Definitions for the reaction types (*worry*, *accept*, *evaluate*, *actuate*, and *other*) were provided. The explanation of each reaction was consistent with Renner's (2004) definitions of four types of reactions: *worry* (implications for the future), *accept* (believe as presented), *evaluate* (more information is needed before accepting), *actuate* (plans to engage in healthy lifestyle behaviors), and *other* (none of the previous four). The reaction type designated *other* provided the opportunity for experts to identify reactions other than those found in the research on face-to-face reactions. Colors were assigned to each of the five reaction types.

After the table was color coded, experts were instructed to identify the most prominent reaction to each item on a separate table. Agreement among the main reactions was analyzed for significance. Agreement among experts was also analyzed for a single item that asked, "How did you react to today's vital signs?" This agreement was considered the secondary reaction. The participant's answer to a single multiple-choice self-identification question, "Which of the following best describes your reaction to the reading today?" was referred to as the primary reaction. Comparisons were made between primary and secondary reactions. In addition, the content of *other* was analyzed to determine what additional reactions might be present in technology monitoring.

Analysis

Analysis of the transcribed answers to the 8 open-ended questions resulted in 40 potential coding agreements/disagreements, and 4 case scenarios resulted in 20 potential coding agreements/disagreements among the 5 reaction choices. Agreement among experts was determined by calculating the ratio of (number of coding agreements)/(number of coding agreements plus number of coding disagreements) for each item. Scores greater than .70 indicate significant agreement (Cohen, 1968).

The main reactions to each open-ended question were quantified using Cohen's Kappa threshold for determining significant agreement. Agreement among expert main reactions (questions and case scenarios) and percentage of agreement by reaction types were

compared for levels of significance. A comparison between participant's self-identification of reactions (single multiple-choice question) and expert agreement provided evidence of primary and secondary reactions. All reactions coded as *other* were systematically examined for content.

Results

The five participants included 3 women, 2 men, 2 were African American, 2 White, and 1 Hispanic. Ages ranged from 62 to 85. Two participants stored and used the telemonitoring devices in their kitchen, two in the living room, and one in the bedroom. Length of time with illness ranged from 10 months to 14 years. All participants considered blood pressure, weight, or both to be the most important measurements obtained from telemonitoring. Three participants did not remember the morning's blood pressure measurement, and one did not remember his weight. Participant 3 had a higher-than-normal reading and Participant 5 had a lower-than-normal reading.

The open-ended questions resulted in a high level of agreement for participants' reactions. Table 1 displays the questions and experts' reaction agreement levels for each participant. Experts had significant agreement (identified with *) on participant reaction types. Reactions corresponded with the type of question; for example, when asked whether the vital signs made the participant worry, 3 of 5 *worried* about reactions and 2 of 5 *accepted* the measures as presented. Participants were more likely to be identified as falling in the *accept* category or *actuate* category. There was significant agreement (>.70) for each participant's reactions on six out of eight questions. Participants 3 and 5 had out-of-range blood pressure readings but did not react by perceiving a threat to health (*worry*).

Table 2 compares open-ended questions to case scenarios for prevalence of each reaction type and level of agreement. There was significant agreement among experts for open-ended questions (.75) on current reactions but not for case scenarios (.60) that asked a participant to project how he or she would react. None of the reaction types had significant agreement in the projected case scenarios. Current reactions were significant for *worry*, *accept*, and *actuate* (.82, .81, .71, respectively), though *worry* was not agreed on nearly as frequently as *accept* and *actuate* in present reactions (.14, .51, .30, respectively). *Evaluate* was a projected reaction but rarely identified in the current responses and not agreed on. *Other* was not agreed on often (.57) in the present but significantly agreed on when projecting (.79).

Table 3 compares primary (participants) to secondary (expert) reactions. Most participants have both types. There was no significant agreement between the experts for Participant 3.

Other was not chosen frequently in the case scenarios but had significant agreement. A detailed examination showed that most commonly *other* was coded when the participants' answers were stories or unrelated information, indicating more evidence of the challenge of projected reactions. Four *other* reactions did seem to be answers to the question and so were examined for a theme. The theme was identified as reassurance. An example of a response that was coded as *other* and could possibly be recoded as *reassurance* was, "Knowing those vital signs makes me feel very good, I like to know it's OK." The incidence was too small for reliability analysis. In the larger sample of Phase 2, reassurance will be further explored.

Limitations

This study was performed on a small sample of chronically ill patients. Several questions were asked about reactions to attempt to examine reactions from different perspectives; however, patient responses were a single snapshot in time.

Discussion

Experts agreed on the types of cognitive reactions as *actuate*, *accept*, and *worry* but not *evaluate* when participants answered questions about their current reactions. There was not significant agreement when participants projected how they would act in case scenarios. The fact that there was significant agreement (.75) among 4 experts with 5 options in this small sample of 5 participants suggests a trend of interest. This study suggests that cognitive reactions to health-risk measurements are the same despite different modes (face-to-face or technology) of delivery; however, the reactions exist with different prevalence. In face-to-face delivery, reactions in order of prevalence are *actuate*, *worry*, *evaluate*, and *accept*. In technology delivery, the order is *actuate*, *accept*, *worry*, and *evaluation*. Patients feel equally pressured to be engaged in healthy behaviors with technology delivery. Telemonitored measurements, however, were more frequently accepted without evaluation and worry than measurements delivered face-to-face. The absence of a professional health provider may omit the opportunity for discussions that promote in-depth consideration of the risk associated with the measurement, resulting in fewer questions or worries about a threat to future health conditions. Interestingly, participants reported lower acceptance when they projected how they would react in a given case scenario(s), perhaps suggesting that risk indicators should promote a more engaged response. They also projected that they would question and worry more when the measurements were inconsistent with what is expected. When asked to project reactions in the case scenarios, participants' answers were not agreed on by experts, perhaps because the answers were not as precise and apparent as reactions participants had actually experienced. The lack of agreement might be attributed to the participants' inability to consider all the influences on their projected reactions.

Differences between primary and secondary reactions indicate that patients may have more than one reaction, which is consistent with face-to-face reaction research. *Accept* was agreed on by experts for 4 participants; however, *accept* was only self-identified by 2 participants. Years of dealing with an illness may result in a difference between reporting expected and carrying out actual reactions. A patient's cognitive reaction may not be outwardly identifiable, perhaps as a learned coping mechanism. In this study, participants perceived that they act or worry; however, the experts agreed that participants accepted without question.

The significant identification of *other* provides more confirmation of the difficulty with projections in the case scenarios. Reassurance was present in case scenario situations where poor health behaviors were depicted. If a patient knows that he or she has engaged in a poor health behavior, he or she may be worrying about the effect of those behaviors. Receiving measurements provide comfort through confirmation of the patient's health status in response to the unhealthy behavior. The exact cause of reassurance is not clear. Reassurance may come from knowing that a nurse knows your health status or it may come from knowledgeable interpretation of the measurement. Future research will investigate the source of reassurance from telemonitoring.

Conclusion

Home health nurses provide oversight that eases a recently hospitalized patient back into his or her home and may decrease exacerbations that result in readmissions to the hospital. Home monitoring is becoming an important part of that oversight. Remote telemonitoring can provide daily services without the costs associated with daily nurse visits. When otherwise healthy patients received the measurements from health professionals their reactions were acceptance, actuation, worry, and/or evaluation (Panzer & Renner, 2008; Renner, 2004). This small research study affirmed these same reactions also arise when

measurements are delivered by technology to patients with a chronic heart failure condition; however, there are differences in the prevalence of the reaction types. For example, telemonitored measurements were more frequently accepted without evaluation and worry than measurements delivered face to face. The absence of a nurse may not have provided an opportunity for discussions that promoted in-depth consideration of the measurement, resulting in less questioning or thoughts of how risk measures relate to future health conditions. It was more difficult for experts to identify evaluation or worry. Participants did not question the reliability of the technology and readily accepted the measurements, perhaps complacent in knowing that they would receive a phone call if there was a risk. An additional reaction type was identified and labeled *reassurance*, which may represent the comfort patient's feel when he or she knows that a professional is keeping track of his or her health. The findings of this Phase 1 study suggest that the current use of telemonitoring technology does provide information that can motivate patients to change behaviors, but it may also promote passive acceptance without question or worry. Chronically ill patients may be susceptible to decreasing the seriousness of out-of-range measurements, resulting in accepting measurements. As home technology applications continue to evolve, care must be taken avoid creating passive patients who do not interpret or evaluate their own health care information. It is important to be careful not to use technology to disengage chronically ill patients from taking responsibility for monitoring their own health status. Transition to healthy independence is a goal of home health care, and telemonitoring technology should be used in a manner that is supportive of that goal. A balance between providing professional oversight and motivating patient self-care is imperative if home health nurse is to decrease hospital readmissions and prolong independent living. A second, larger phase of the study will investigate how reactions interact with other patient characteristics and technology to influence healthy behaviors. Understanding reactions to remotely monitored behaviors will ultimately allow for individualized use of technology with the goal of moving patients into lifestyle choices that maintain optimal health.

Acknowledgments

Funding

The author(s) received the following financial support for the research, authorship, and/or publication of this article: This study was funded by a grant from NIH/NINR-1K23NR011460-01.

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Table 1
Expert Agreement on Participant's Reactions Types When Responding to Open-Ended Questions

Open-ended questions	Participant					Number of significant agreements
	1	2	3	4	5	
After you sent the information to the telehealth nurse today, what did you do during the day in response to the vital signs, blood pressure, weight, and pulse? (diet, medication, exercise)	Accept * 1.0	Actuate * 1.0	Accept 0.5, Evaluate 0.5	Accept * 0.75	Accept * 0.75	4
Did you expect a phone call from the nurse? Why?	Accept * 0.75	Accept 0.50, Worry 0.25, Actuate 0.25	Accept * 0.75	Accept * 0.75	Accept * 0.75	4
Did the vital sign readings make you worry? Explain why you felt this way.	Worry * 1.0	Worry * 0.75	Accept * 1.0	Worry * 0.75	Accept 0.5, Other 0.5	4
Do you believe the readings were correct? Why?	Accept * 1.0	Accept 0.5, Other 0.25, Actuate 0.25	Accept 0.5, Evaluate 0.5	Accept * 0.75	Accept * 0.75	3
Do you feel that there is anything you can do to improve (maintain) the level of the readings? What?	Accept * 1.0	Actuate * 1.0	Other * 1.0	Actuate * 0.75	No agreement	4
How do you think the length of time that you have been living with this illness has influenced your reaction?	Accept 0.5, Evaluate 0.5	Worry * 1.0	Actuate * 0.75	Actuate 0.5, Worry 0.25, Other 0.25	Accept * 1.0	3
How does the information received and sent today make you feel about your illness?	Actuate * 0.75	Actuate * 1.0	Accept * 0.75	Actuate 0.5, Worry 0.25, Evaluate 0.25	Actuate * 0.75	4
Could you use the information you got from the telemonitoring equipment in your daily life today?	Accept * 1.0	Actuate * 0.75	Actuate * 1.0	Actuate * 0.75	Actuate * 0.75	5
% of times experts agreed	0.75 *					

Note: Experts rated using definitions of *accept*, *actuate*, *worry*, *evaluate* (*eval*) or *other*.

* denotes significance > .70.

Table 2
Agreement Among Reaction Coding of Open-Ended Questions and Case Scenarios

	Reaction type: number in significant agreement/number of times code selected = % of code selections with agreement						
	Agreement among main reactions		Worry	Evaluate	Accept	Actuate	Other
Open-ended questions	30/40 = 0.75 *		14/17 = 0.82 *	0/4 = 0	51/63 = 0.81 *	30/42 = 0.71 *	4/7 = 0.57
Case scenarios	12/20 = 0.60		3/7 = 0.43	8/19 = 0.42	3/8 = 0.38	15/27 = 0.56	15/19 = 0.79 *

* Significant agreement > .70.

Table 3

Comparison of Primary, Secondary, and Overall Reactions

Participant	Primary—which of following best describes today's reaction to vital signs? (participant's choice)	Secondary—how did you react to today's vital signs? (expert code agreement > .70)
1	Accept	Accept
2	Worry	Actuate
3	Accept	<i>No significant agreement</i>
4	Actuate	Accept
5	Actuate	Accept