Exploring Feasibility of Home Telemanagement in African Americans with Congestive Heart Failure

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Abstract

Existing telemonitoring systems provide limited support in implementing personalized treatment plans. We developed a Home Automated Telemanagement (HAT) system for patients with congestive heart failure (CHF) to provide support in following individualized treatment plans as well as to monitor symptoms, weight changes, and quality of life, while educating the patient on their disease. The system is designed to be placed in the patient's home and to communicate all patient data to a central server implementing real-time clinical decision support. The system questions the patient daily on their condition, monitors their weight, and provides the patient with instant feedback on their condition in the form of a 3-zone CHF action plan. Their medication regimen and suggested actions are determined by their care management team and integrated into the system, keeping a personalized approach to disease management while taking advantage of the technology available. The system is designed to be as simple as possible, making it usable by patients with no prior computer experience. A feasibility assessment in African American patients with CHF and without prior computer experience demonstrated high level of acceptance of the CHF HAT system.

Keyword:

Telemedicine, Congestive heart failure, Self-management

Introduction

Congestive heart failure (CHF) is a major public health problem which affects over 5 million Americans and costs $33.2 billion annually [1]. CHF morbidity is reaching epidemic proportions and African Americans are disproportionately affected [1-3]. Repeated emergency room visits and rehospitalizations for symptom relief contribute to CHF being the most costly cardiovascular illness in the US [1, 4-5]. Common reasons for CHF rehospitalization include delays in symptom recognition, medication and dietary noncompliance, and lack of knowledge and skills for competent self management [6-8].

Telemedicine approaches will be useful in patients with CHF for several reasons. First, telemedicine will improve disease monitoring through more frequent assessment of symptoms. Second, use of patient self-management plans will accelerate treatment in the setting of CHF symptoms and thus decrease the utilization of health care resources [8]. Home Automated Telemanagement (HAT) is a telemedicine system designed to assist health care practitioners treat patients according to current clinical guidelines, to assist clinicians in educating patients, to assist providers in monitoring patients, and to assist patients in following individualized self-care plans [9-14]. Our aim was to design a low cost telemanagement system for CHF patients and to perform an initial assessment of patient acceptance of such a system. This paper reports the success of design and implementation of the Home Automated Telemanagement system in patients with CHF.

Materials and Methods

System Design

The HAT system is based on Wagner's model of chronic disease care [15] and supports patient self-management, comprehensive patient-provider communication, and multidisciplinary care coordination. The CHF HAT system comprises a home unit, a decision support server and a web-based clinician portal. The HAT home unit consists of a notebook computer and an electronic weight scale. CHF patients answer questions regarding symptoms, side effects, adherence, and receive disease-specific education using the home unit. The home unit automatically transmits the results to the decision support server after each self-testing session. Data transmitted from patient's home are de-identified and encrypted. The data transmission can be carried out via Internet or direct modem-to-modem communication. For subjects without an active phone line, a cell phone is provided to transmit self-testing results over a secure wireless network to the server in a similar manner. The web portal provides an interface for the collected patient data. The web-based care management portal is used to set up customized clinical alerts and individualized action plans based

on patient disease severity and other individual factors. The care management team individualizes alerts and action plans for each patient on-line whenever warranted. The updated action plans are automatically transmitted to patient home units. If certain clinical conditions are met, email alerts are sent to the nurse coordinator. The coordinator reviews the information and if necessary consults the medical provider and the patient for management changes.

The HAT server runs Internet Information Services (IIS) which collects the patient's data and integrates it into a website which can be accessed by the patient's primary care management team. IIS is one of the most widely used web servers and provides a stable and compatible system for receiving and editing patient information. The web page was developed using Microsoft's .NET framework. This is a framework for developing dynamic websites which offers extensive built-in functionality and is supported by most browsers. The system is designed so that each patient has an "Action Plan" approved by their care management team. The action plan defines what a patient's actions should be based upon their self-test data and can be viewed on the HAT home unit and the clinician website. Prior to beginning home unit use, the patient has an action plan approved by their care management team. The action plan accounts for the possible cases of good, fair, and poor health; respectively corresponding to a green, yellow, and red 'zone'. An example of yellow zone of CHF action plan is shown in Figure 4. The patient responses from the self testing portion and weight measurement are used as a gauge for determining the action plan zone in which the patient currently belongs. At any time the patient may view their current zone or review the other zones on the home unit. CHF HAT action plan information flow can be seen in Figure 1.
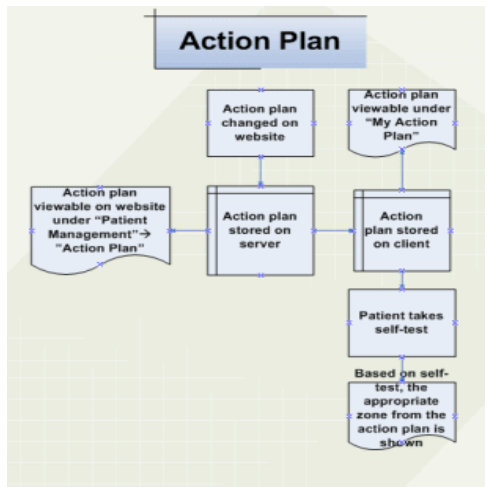

Figure 1- Action plan information flow

The HAT home unit allows a patient to complete a disease diary which asks the patient a series of questions, records their weight, and sends the information to the server, then gives the patient instant feedback on their current action plan zone, based upon their symptoms and weight measurement. This test provides the patient with immediate information on their condition and appropriate action steps for self management and provides their care management team with daily updates. Once a report has been sent to the server it can be viewed by the patient's care management team through the CHF HAT website.

On the server, the alert generator runs every night and uses the information from the self-test reports to send e-mails to the care management team when appropriate. Alert parameters are defined by a nurse case manager and can be set to generate alerts under various situations. Alerts can be generated if a patient's total score on the symptom questions falls above a specified number. They can also be generated if the patient's recorded weight falls above a specified threshold for the mean weight, percentage of last weight, or absolute change. Finally, if the patient is in a specified zone or has changed to a specified zone, an alert may also be generated.

The system also aids in medication compliance. The home unit can display a list of current medications with their dosages and frequencies. This can be updated by a nurse care manager on the website and will update on the home unit the next time it connects.

The HAT home unit also features a progress chart, which displays a graph of the patient's weight measurements or action plan zones on the most recent self-tests. The 'Frequently Asked Questions' section allows a quick access to general CHF educational information. The advanced features section on the home unit allows the patient to send a message to the server at any time. There are stock messages for the user to choose from or they can type their own messages. Upon receiving the message, an email is sent to their care manager, allowing for computerized patient-clinician communication. The message is also stored on the server and can be reviewed on the website by the care management team. The care management team may also send a message to the patient through the website. The message will be received by the patient the next time they connect to the server.

Pilot Study

A pilot study of the system has been conducted in ten CHF patients with no prior experience in using computers. Semi-structured qualitative interviews and cognitive walkthrough were used to assess patient acceptance of the CHF HAT system. In the study the patients received a twenty minute introduction and demonstration of the patient home unit and self-testing procedure. After the demonstration, the patient was asked to complete the self-test on their own and comment on the system as they performed the self-test. Once the self-test was performed by the patient, we administered a qualitative interview to get patient feedback on the system. Because

African Americans are disproportionally affected by CHF [1-3] we assessed feasibility of CHF HAT in this population.

Results

The HAT system was successfully designed and implemented on a notebook computer running Windows 2000/XP connected to a Lifesource 321P digital scale through the serial port. Information was successfully sent and received from a remote location to the IIS server using an active landline and cell phone connection. The website was successfully launched and provides full functionality. The home unit runs the HAT program when it starts up and the user can navigate through the menu using the labeled arrow keys and the enter button. The text is large and easy to read while all the instructions are kept as simple as possible. The home unit options are broken into six sections. The first section is self-testing. In this section the patient will begin with a self-testing portion where they answer a series of questions pertaining to their chronic condition. A symptom diary question screen is show in Figure 2.
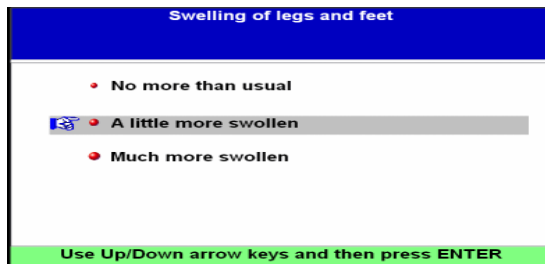

Figure 2-Symptom diary question

The responses are used to gauge the overall health of the patient, as well as to raise flags when the patient may be experiencing congestive heart failure symptoms that require immediate attention and treatment. After answering general symptom questions the patient is prompted by voice and text to correctly mount a weight scale in order for the CHF HAT software to weigh the patient. The scale instructions are shown in Figure 3.
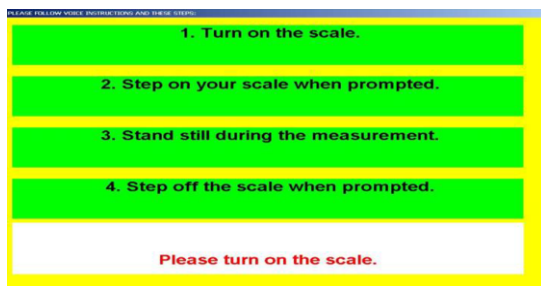

Figure 3-Weight scale instructions

The current patient's action zone is then immediately calculated and displayed. A screen displays weight and an absolute weight change from the previous day. The zone of the action plan is determined using the information provided earlier in the self-test. A sample action plan is seen in Figure 4.

Figure 4-Sample "Yellow Zone" action plan

After completion of the self-testing portion the patient is given an educational "Tip of the day." Each successive educational portion will end with a question about the previous day's tip. The question will be repeated each session until the patient is able to answer correctly. Then a new question is offered during the next self-testing session. At the end of an educational section, the patient will be asked several questions from the specific section. Upon completion of the educational portion, the symptom diary responses as well as the results of weight monitoring are stored for transmission. The system connects to the server using an active landline or wireless connection and relays all stored results/messages. This is shown in Figure 5. After transmission the main menu is displayed.
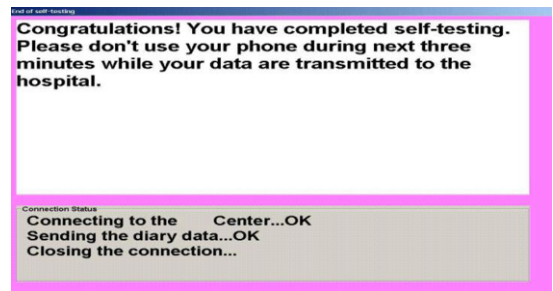

Figure 5-Data transmission screen

The HAT home unit also allows the patient to access their Action Plan. The patient can view their current action plan and their other plans for different zones. They can also view a graph of their recorded weights or action plan zones and the medications currently prescribed to them. The patient can also send either a personal or pre-written message to the care management team.

The CHF HAT website is hosted on our servers and can be accessed securely by the care management team using any computer with a web browser and an internet connection. The care management team can also view a monthly report which displays graphs and statistics of the patient's information collected over the past month. A section of a sample report is seen in Figure 6.
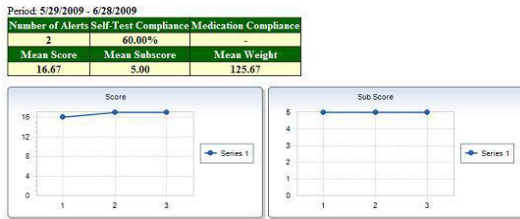

Figure 6-Sample monthly report data

The website also shows any current alerts for the patient and allows the care management team to log their response to the alert as shown in Figure 7.
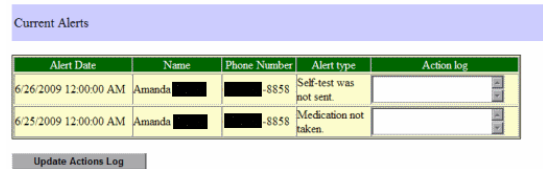

Figure 7-Current Alerts

The care manager can change their alert parameters for the patient, send a message to a patient, or view a list of the messages sent from the home unit to the server as seen in Figure 8.

Figure 8-Messages from the patient

Pilot study

After successfully using the system, patients were asked to complete demographics, attitudinal survey and qualitative interview. Average age of patients was 56 years, and they completed an average of 13 years of education. 60% of subjects were females, and 100% were African Americans. About 50% reported that they had moderate heart failure symptoms, and 50% answered that their heart failure had been about the same during the last 12 months. 60% and 70% never used the

computer and internet respectively, and 30% reported that they never used ATM machine.

Table 1 – Attitudinal Survey Results

Questions	%
1. How complicated was the self-testing process?	
Moderately complicated	10.0
Not complicated at all	90.0
2. How difficult was it to use the weight scale?	
Slightly difficult	10.0
Not difficult at all	90.0
3. How difficult was working with the computer?	
Not difficult at all	100.0
4. How difficult was answering the symptom diary?	
Not difficult at all	100.0
5. Did you get all the necessary information about self-testing including the first introductory meeting?	
All information	80.0
Partial information	10.0
Very limited information	10.0
6. How much of your time did the self-testing take?	
Considerable	10.0
Very little	90.0
7. Would the self-testing interfere with your usual activities?	
No	90.0
Little	10.0
8. Would you feel safer while monitored by the system?	
Significantly safer	80.0
Moderately safer	10.0
Same as usual	10.0
9. How important for you is it to know that the results of your self-testing can be reviewed by the study staff immediately after the test?	
Extremely important	80.0
Very important	20.0
10. How often would you review the test results?	
Once a week	80.0
Occasionally	20.0
11. Would you like to use this self-testing program in the future?	
Certainly Yes	90.0
Maybe	10.0

Patient overall response to the system has been positive (see Table 1). All patients were able to complete the self-testing procedure by themselves with little or no difficulty. 100% of

subjects responded that they didn't have any difficulty working with the computer and answering the symptom diary questions. Also patients reported that length of self-testing was appropriate that it would not interfere with their usual activities. All the patients we have interviewed so far did not consider themselves computer literate and did not own a computer. Overall we have concluded that the interface is sufficient for people with no history of computer use. Patients responded favorably to the educational portion of the self-test, indicating a desire to learn more about their condition. The content and interface also received positive feedback in patient responses. Patients commented that they believed the CHF HAT system would help them better manage their congestive heart failure and reduce their amount of hospital visits.

Discussion

The CHF HAT system's ease of use and convenience can provide reluctant patients with an easy way for care management teams to receive daily feedback from the patient. While care management team visits would still be important to the patient's care, allowing the patient to monitor their health frequently and educating them on their condition will hopefully increase their condition awareness, self management, and quality of life. The CHF HAT system can successfully provide support to patients in following their CHF action plans and to aid them in being adherent to their treatment regimens. We are also looking toward expanding the HAT system to other computer platforms. Mobile computing is becoming smaller, faster, and cheaper, creating more potential environments for the HAT disease management system. Systems such as the Apple iPhone, iPod Touch, Blackberry, and mobile phones are becoming viable options for the CHF HAT platform.

Conclusion

The Home Automated Telemanagement system is a viable system to test in the management of congestive heart failure patients. This system can be efficiently implemented for congestive heart failure, as well as other conditions, and is recommended for future use and expansion.

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