Accessible Home Vital Signs Monitoring System Proposal

By Jenna Sullivan, Robert Croce, and Mike Kapinos

Client Contact: Dr. John Enderle ● University of Connecticut, Bronwell Building, Room 217C, 260 Glenbrook Road, Storrs, Connecticut 06269-2247 ● Voice: (860) 486-5521 ● FAX: (860) 486-2500 ● Email: jenderle@bme.uconn.edu
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Executive Summary

This document is a proposal for an accessible home vital signs monitoring device. The introduction contains background information on our clients, the purpose of this project, and information on similar vital signs monitors that are currently on the market. The objective includes an overview of our device and the design features it must have to meet the needs of our clients. The methods section breaks down the accessible home vital signs monitoring device into parts and discusses the monitor, transducers, and secure website for transmitting vital signs. Included in this section are a computer drawing of our device, indicating its features, and a flow chart of how to operate the device. The budget for this project is listed in tabular form and is followed by the conclusion.

Introduction

Background

With the aging baby boomer population, home health care is a growing and changing industry. The advent of telemedicine and advanced communication technology has allowed patient monitoring to move from the hospital to the home. By monitoring patients’ statuses remotely, health care facilities can free up hospital beds and doctors’ time for more critical patients. An integral part of remotely monitoring a patient’s condition is the home vital signs monitor.

Our three clients that are in need of an accessible home vital signs monitoring system are Mat, Sani, and Dolores. Mat is a 52-year-old male in good physical condition. He is blind and works as a radio commentator. Mat just had a small stroke, and his doctor wants to monitor his vital signs from home for the next 90 days. Mat does not like devices that are very technologically advanced, but lives with his vision-impaired wife who loves the internet. Sani is a 31-year-old female who recently experienced a head injury from an automobile accident. This accident left the right side of her body paralyzed (her dominant side). Sani is a lawyer and is now working part time from home. She must sleep in a hospital bed, and she administers pain medication to herself using an infusion pump. Her doctor monitors her vital signs by a computer system that is installed in her home. Sani does not want to appear sick to her family and friends. She would like a vital signs monitoring device that blends in with the other furniture in her home. Our last client is Dolores. She is an 86-year-old female who lives with her son, his wife, and their son. Dolores is deaf and has severe arthritis. She also has heart problems that cause her to receive infusions at home. These infusions are normally administered by one of her family members. Dolores’ grandson Tyler is 11 years old, and he likes all kinds of electrical gadgets. He loves to help his grandmother collect her vital signs and send them to her doctors on the computer.
Purpose of Project

The purpose of this project is to create an accessible home vital signs monitoring system. Although there are already similar devices on the market, it is our goal to design a monitoring system that meets our clients’ specific needs. This device will improve our clients’ quality of life by allowing health care professionals to monitor them from home, rather than from a bed in a hospital or nursing home. Our clients want to stay in shape, not appear sick to their friends, and continue to live with their families. The device we design will allow them to do these things. It will be accessible to the vision and hearing impaired, and it will be cost effective. Most systems available today are very expensive, and our purpose is to make an affordable device that is also accessible and easy to use.

Previous Work and Products

Previous work on home vital signs monitors can be seen in current monitors in hospitals and homes. There are many different types and brands on vital signs monitors currently on the market. They range in size, function, and price. Most are very expensive, costing patients or healthcare providers upwards of $2,500 per system. Below are the descriptions of a few select monitors.

The monitor shown below (Fig.1) is the Welch Allyn Vital Signs Monitor 300 Series.

![Figure 1. Welch Allyn Vital Signs Monitor 300 Series](image)

This device is small and lightweight. It is 6.6 inches tall, 10 inches wide, has a depth of 6 inches, and weighs 5.4 pounds. Some of its features include: an easy to read LCD screen, blood pressure monitor, built in memory for up to 99 sets of measurement data, thermometer, pulse measurement, blood oxygen level measurement, and a printer for record keeping. This device also comes with an optional wheeled stand making for easy transportation. The Welch Allyn system also has an alarm that will go off if patients forget to take their vital signs at the specified time. With all of the above features, the Welch Allyn Monitoring system is approximately $3000.
The Philips SureSigns VS1 Vital Sign Monitor includes non-invasive blood pressure (NIBP) and pulse rate. It weighs 8 pounds and is 9.3 inches tall, 9.4 inches wide, and 9.8 inches deep (Fig. 2). It can store up to 400 sets of vital signs and has a battery life of 6 hours. A bright LED display displays the latest vital signs readings, and a backlit LCD screen displays historical trend information. With these features and to monitor only two vital signs, this device costs approximately $2000.

Figure 2. DRE Philips SureSigns VS1 Vital Sign Monitor

Both of these monitors lack audio output and obvious buttons. Though both have internal memory, neither have the option to save vital signs off of the monitor.

Patent Search Results

There are many different types of vital signs monitors, and so many patents of vital signs monitors exist. One such patent is a blood pressure and heart rate monitoring method and apparatus (U.S. patent number 4,967,756). This system uses a microprocessor-based circuit to record blood pressure and heart rate. It also uses a new method to measure blood pressure without unnecessary constriction of the patient’s limb. U.S. patent number 5,613,495 is for a high functional density cardiac monitoring system for ECG data. It is a very small device that is lightweight and worn on the wrist. It uses dry skin electrodes that come in contact with the patient’s skin to take readings. U.S. patent number 5,553,609 is a remote visual monitoring system for home health care services. This device is a way for a health care professional to monitor a patient in their home from a remote location. This is done through normal telephone lines and uses two main databases for storing and sending information.

Project Description

Objective

The objective of this project is to create vital signs monitoring device for home use that measures blood pressure, heart rate, blood oxygen saturation, and body temperature. In designing our device, we must keep in mind the specific needs of our clients. The accessible vital signs monitoring system will be easy to use for a wide range of ages and abilities (from children to geriatric adults). The device will be accessible to those with hearing impairment, vision impairment, partial limb paralysis, and low
strength and dexterity levels. The device will also be lightweight and home friendly. In addition to being able to withstand small falls and small amounts of water, the device will be visually unobtrusive. Its casing will be designed to allow it to blend in with the home as another piece of electronic equipment, rather than a medical monitoring device.

Because we have vision-impaired clients, the device must incorporate some type of Braille system so that buttons being pushed can be identified. Screens displaying vital signs should be large and well lit. Also, there needs to be an audio output of the vital signs being measured. Our clients span all ages and levels of technological savvy, so our device must be easy to operate for anyone. Buttons on the device should require only little force to depress, so as to be operable by our clients with paralysis and arthritis. Finally, the device should be aesthetically acceptable, if not pleasing. It needs to blend in with the home surroundings as another piece of electronic equipment.

The accessible vital signs monitor will have a simple three-button design and large, well-lit screens to display acquired vital sign data. To measure blood pressure, an adult-sized blood pressure cuff will be used. A commercial pulse oximeter probe will be used to measure both blood oxygen saturation and heart rate. Body temperature will be measured by a commercial vital signs monitor probe. Once collected, the vitals signs will be stored on a USB flash drive. This will allow the client to upload the vital signs data to a secure website where a health care provider will be able to access them.

**Methods**

The accessible vital signs monitoring system has three main parts: the monitor, the transducers, and the secure website. The front of the monitor will consist of four LCD screens on which will be displayed the vital signs as they are measured. Labels for the readings being show by each screen will be painted on the monitor casing. Also on the front of the monitor will be two buttons. A large, raised “Record/Stop” button will be pressed to start and stop recording data to the USB flash drive. Another button will be located next to the blood pressure readings LCD screen. This button will be pressed to start the inflation of the blood pressure cuff. This blood pressure button is a necessary safety measure. It will prevent the cuff from inflating before the client is ready and has the cuff in the proper position on the arm. All buttons will be printed with either Braille or a universal symbol, so as to be identified by the visually impaired. A large, raised “on/off” button will be on the side of the device and will also be printed with Braille or a universal symbol for the visually impaired. Also on this side of the device will be the USB port and the three ports for the transducers. On the lower back of the monitor will be a power cord jack, to monitor’s battery or operate on A/C power. A handle on the top of the monitor will allow for easy repositioning and handling. A red light will be on top of the monitor which will activate if vital signs being measured are outside of healthy parameters (to be decided). A speaker will be located on the front of the device for audio output, and a bag or holder will be located on the side of the device to hold the transducers (Fig. 3).
Figure 3. Microsoft Visio image of the accessible vital signs monitor indicating the locations of different components. A) Front of the monitor, B) Left side view, C) Back view.
As signals enter the monitor, they will be amplified and filtered. Through the use of a microprocessor, the signals will be displayed on the LCD screens. They will also be announced aurally once a satisfactory signal has been acquired. For continuous signals (pulse rate and SpO2), the measurements will be announced for every change in value during the measurement time period. For blood pressure and temperature, the measurement will be announced once for each time it is taken. If no signal is received from a transducer, the device will continue to function and measure other vital signs. This allows the user to choose what vital signs they wish to monitor at any given time. When the “Record/Stop” button is pressed, the current vital signs values will be written to the USB flashdrive.

The transducers to measure blood pressure, heart rate, blood oxygen saturation, and body temperature will be commercially purchased and integrated into the accessible vital signs monitoring system. To measure blood pressure, a vital signs monitor compatible standard adult blood pressure cuff and hose will be used (Fig. 4). An adult-sized SpO2 finger probe will be used to collect blood oxygen levels and heart rate (Fig. 5). An oral vital signs monitor temperature probe will be used to measure body temperature (Fig. 6). These three probes will be removable (from the device) and will attach to it via ports on the side of the device (Fig. 3B).
The Health Insurance Portability and Accountability Act (HIPAA) is a set of guidelines enacted by congress to ensure patient privacy. This privacy rule, which took effect in 2003, establishes regulations for the use and disclosure of Protected Health Information. In accordance with this rule, we are going to implement a secure, encrypted web site through which our patients will be able to send their health information to their healthcare facility. To protect our patients’ data, HTML encryption software will be used to encrypt the contents of the password protected website to which the data will be uploaded. Theses encrypted pages prevent the information stored on them from being hacked or viewed by anyone without the proper password. This ensures maximum patient privacy. A website using the UCONN Biomedical Engineering server will be created, and then encrypted with the appropriate encryption software. We will use encryption software such as TagsLock Pro v 2.22 to hide the source code of our HTML documents.

Procedure

To begin gathering the client’s vital signs, the machine has to be turned on via the on/off button located on the left side of the monitor. Once this button has been turned on, the client’s vital signs will be displayed on the front panel of the device. To collect each vital sign, the instruments will need to be inserted into the corresponding instrument ports on the side of the device. To record these vital signs, a record button placed on the front of the monitor will be pressed. This record button is used to record and send the information to the USB port on the left side of the machine. The recording is stopped when the button is pressed again, stopping information from being sent to the USB port. A flowchart of this process is seen in Figure 7. Once the desired amount of information is recorded (the length of time for which the vital signs are recorded, to be decided by the user or their health care provider), the USB stick is removed and inserted into the computer. The user then logs onto the secure website with the appropriate user name and password to upload their vital signs. The client’s physician or healthcare facility will access the same website with a different password to download the vital signs data.
Figure 7. Flowchart of accessible vital signs monitor operation
Budget

Below is a table containing the cost of the supplies we expect we will need to construct our accessible vital signs monitoring system. This budget is subject to change as we change and update our design. Our expected total cost for the product is $700 which is 35% of our total budget of $2000. This is also significantly less than the cost of current vital sign monitoring devices.

<table>
<thead>
<tr>
<th>Product</th>
<th>Cost</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Casing</td>
<td>$30</td>
<td>Mouser</td>
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<tr>
<td>Microprocessor</td>
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<td>Mouser</td>
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<tr>
<td>Circuit Board</td>
<td>$204</td>
<td>PCBexpress</td>
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<td>Power Cord</td>
<td>$3</td>
<td>Mouser</td>
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<tr>
<td>Rechargable Batteries</td>
<td>$13</td>
<td>Amazon</td>
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<tr>
<td>LCD Screens</td>
<td>$7</td>
<td>Mouser</td>
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<tr>
<td>Electrical Components</td>
<td>$40</td>
<td>Newark in One</td>
</tr>
<tr>
<td>USB Port</td>
<td>$7</td>
<td>Newark in One</td>
</tr>
<tr>
<td>Buttons</td>
<td>$6</td>
<td>Happcontrols</td>
</tr>
<tr>
<td>Computer Software (Security)</td>
<td>$30</td>
<td>TagLock Pro.</td>
</tr>
<tr>
<td>Alarm</td>
<td>$15</td>
<td>Epill</td>
</tr>
<tr>
<td>Transducers (BP Cuff, thermometer, SpO2 probe)</td>
<td>$200</td>
<td>DREMed</td>
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<tr>
<td>USB Flashdrive</td>
<td>$60</td>
<td>SanDisk</td>
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<td>Speaker</td>
<td>$16</td>
<td>Newark in One</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$700</strong></td>
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</table>
Conclusion

As healthcare moves out of the hospital and into the home, reliable technology for monitoring patients is needed. Monitoring patients’ vital signs is an important part of home care. Vital sign monitoring systems currently on the market are very expensive and not always accessible. Most are designed for hospital use and so have complicated interfaces and do not blend in with the home environment. More devices specifically for use in the home, by the patients themselves and their families, are needed.

It is our intention to design an accessible vital signs monitoring system that is relatively inexpensive and meets the needs of our clients. The accessible vital signs monitoring system that we design will be easy to use and include audio output and prompts and buttons with Braille or universal symbols, something that most current models do not have. Our secure website system is also unique in that it provides direct communication between the client and the physician or health care provider. By using a secure website, the “middle man”, often a paid monitoring service, is taken out of the line of communication. Also, because our system uses a USB flashdrive on which to store data, the clients need only any computer connected to the internet, rather than a separate installed system, to transmit their vital sign readings. Through this design, we hope to improve our clients’ quality of life while closely monitoring their health.