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Nurse Digital Assistant
A Wearable Computing Device for Nurses

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Executive Summary

Nurses play a vital role in healthcare delivery within the ICU. Studies have shown that greater nurse hours spent on direct patient care were associated with decreased risk of hospital-related death and shorter lengths of stay. However, it is alarming that nurses spend a significant amount of their time in documenting their tasks and coordinating with team members in providing care for their patients.

Recent advances in computing technology such as image and voice recognition make it possible to automate activities of the nurse. In addition to that, the ever decreasing size of computers and increase in mobile computing power make it suitable for the nurses to carry computers with them to access information literally at their fingertips.

We designed a device which is worn like a watch and an optional lapel pin that can automatically read information from monitors and enter them into a medical record. A barcode scanner on this device allows automated entry and tracking of administered medications and used medical equipment into a patient’s electronic medical record. Voice activated commands allow the nurse to operate this device without occupying their hands. In addition to the above, the device also allows nurses to communicate with other team members and the patient’s family members easily. This replaces the traditional phone and cell phone usage within the ICU. Time saved by this device in the documentation and care-coordination process can be diverted to direct patient-care activities which are known to provide better outcomes.
Introduction

A great amount of evidence links the availability of more nursing time per patient-day with better patient outcomes [1][2][3][4]. However, increased nurse workload and the growing nursing workforce shortage reduce the amount of nursing time available for patient care activities [5]. In the face of all this evidence it becomes obvious that “How nurses spend their time” has a great influence on the efficiency of ICUs and is the key driver of bold changes in the hospital work environment[6][7][8]. Therefore, maximizing the efficiency and effectiveness of nurses is essential to the integrity of hospital function and the promotion of safe patient care.

According to a study by Kaiser and Ascension Health, nurses spend 35% of their time on documentation and in contrast 19% on patient care.

Figure 1: Average distribution of a nurse’s time during a 10 hour shift[10]
The results (Figure 1, Figure 2) demonstrate that nurses devote large proportions of their time to documentation, medication administration and lesser time to patient care activities. These findings illustrate the complex and demanding hospital work environment and suggest opportunities to improve the efficiency of nursing work. Changes to the process and technology of documentation, communication, and medication handling, could benefit nurses and patients greatly.

The documentation process takes significant nursing time one of the reasons for which is that current documentation input devices are not efficient enough (See Figure 3). According to the observation in Piedmont Hospital, nurses use different kinds of methods to input the data and complete documentation (see Figure 4). Information from different sources should go into the electronic medical system as documentation. Nurses have to manually input the
Figure 3 problem statement chart

Figure 4 Different sources of information that goes into documentation[11]
data on the chart and notes into the computer. At the same time, they have to use several different devices such as PDAs, smartphones and laptops to obtain information. Unfortunately, all these devices do not communicate with each other.

Currently there are different kinds of digital devices in the market to facilitate documentation process. However, each product has a different interface as well as a different workflow, which results in nurses spending additional time adapting to the them. PDAs are commonly used by nurses to perform documentation. In one study the researchers identified barriers of usage of PDAs that includes screen size, data entry mechanism, short battery life, perceived delicacy of the device and additional accessories needed to perform functions[12]. Also the PDA takes up nurses’ hands so that they have to place the device somewhere else while taking care of patients. Our interactions with the nurses at Emory Hospital revealed that nurses prefer single device to collect patients’ vital sign records, medical administration record (MAR) and to contact team members or patients’ family as well as to remind them of important schedules.

**Related Work**

Our work is related to several wearable mobile devices that makes communication easier for an active lifestyle(see Figure 5). Our solution is motivated by the existing “iwatch”, and “Vocera” technologies. The “iwatch” is a tiny Apple iPod Nano (6th generation) on a strap. The main screen, seen below, shows the time, or several icons selected by user(see figure6). The strap turns the iPod Nano into a technologically advanced watch. With mp3 & mp4
capabilities users can listen to music on their watch, watch movies, TV series & other media, all from the wrist.

Figure 5 Different kinds of wearable devices

Figure 6 Interface of "iwatch"
A second related work is “Vocera”, a communication system that allows mobile workers to instantly communicate with each other while keeping their hands free. Users can control them using simple spoken commands like saying the contact name, function, or group name of the people they want to reach (see Figure 7). It also helps clinicians stay connected to multiple alarm and alert systems in the patient environment.

![Figure 7 Interface of “Vocera”](image)

**Project Description**

To help reduce time spent by nurses in documentation and care-coordination, we designed a wearable computing device called the Nurse Digital Assistant (NDA). Pictures of the developed prototype are represented in Figure 8. Our device uses latest RFID, image and voice recognition technology to automate the documentation process and ease communication with other team members. The device is worn as a wristwatch and contains a touch-screen, camera, microphone, speaker and projector. An optional attachment is worn as a lapel pin and contains a camera and projector which communicates with the
device wirelessly. A user friendly interface allows nurses to intuitively operate the device. The projector can be used to project the interface on any surface whenever a larger screen is desired. The device is operated using the touch-screen or voice commands. The camera, when activated, uses image recognition technology to locate data values or barcodes and enters them automatically to the medical record of the patient.

Figure 8- Prototype of NDA

NDA includes many functions and related interfaces easing nursing activity and increasing the efficiency of nursing. A flow chart of the interfaces is represented in Figure 9. Each interface also has buttons to return home page and previous page, expand or narrow the screen. We will explain functions of NDA by using the screenshots of the interfaces.
Figure 9 Flow chart of interfaces
Below are the detailed descriptions of each interface page.

**MAIN MENU**

**Patient Record**: see the list of patients assigned to the nurse

**Scan Patient**: activate the camera to scan the barcode of the patient

**Contacts**: connect with the other team members

**Alarms**: set individual alarms as reminders

**SCAN PATIENT**

Camera allows nurses view the Patient Records Page automatically by scanning the barcode
PATIENT RECORD

View the list of patients assigned to the nurse and select by name to view the Patient Record Page or to open the camera in the patient room.

CONTACTS

See a list of other team members (family, primary physicians, primary nurses, labs, pharmacy) to contact by sending voice, text messages or directly calling.

Voice recognition function of NDA allows nurses to call the other team members by only saying the ‘call Family‘ or “call Doctor Franks” voice commands.

PATIENT RECORD PAGE

After scanning the barcode Patient Record Page is opened.

Scan Data: activates the camera to record vital signs, given medication, used medical materials, calculate the dosage of medications

Display Vital Signs: view recorded vital signs

Contacts: connect with the other team members

Prescribed Medications: view the prescribed
SCAN DATA

Camera is activated; image recognition and RFID function of NDA allows nurses to document vital signs, administered medication and used medical materials automatically.

For instance, when nurse wants to record heart rate of the patient, nurse just should press Scan Data, go near to heart rate machine and direct the camera of NDA to the machine. NDA recognizes the record type and value.

SCAN VITAL SIGN

In the previous interface, camera recognizes the heart rate machine and the heart rate of the patient, and then a message that show the value pop ups. Nurse clicks on save to confirm and record the value or clicks cancel. When nurse clicks save, data is directly recorded to the main data warehouse via wireless technology. So, records can be reviewed on any computer connected to the healthcare software infrastructure.
MEDICAL MATERIALS

Nurses keep track of medical materials used for the patient. Scan Data interface also can lead to Medical Materials page, if the barcode of a material is scanned. As shown in the picture, a message that shows the feature of the material pop ups. If nurse click on Save, it means that “I have used a needle with size 0.5 mm and keep in records”. Or, nurse can click on Cancel, if the material is not used for the patient.

PRESCRIBED MEDICATION

Giving accurate dosage of medication is important for the quality of the care, so nurses should be careful in administering the accurate dosage and keeping records. Scan Data interface can be used to determine the dosage of medication automatically, when the barcode of a medication is scanned, appropriate dosage is calculated by using the patient records (age, weight, acuity etc.) and national dose standards. As seen in the picture, a message that shows the accurate dosage pop ups. Nurse clicks YES, if the calculated dosage given; clicks NO, to enter any other dosage due to specific conditions of the patient; clicks on Cancel, if the medication is
DISPLAY VITAL SIGN

Allow nurses to view the recorded vital signs of the patient. When they are not able to see the records or charts in detail, they can use the projection function of NDA to view the records clearly by projecting the screen to any surface.

PRESCRIBED MEDICATION

View the administered medications for the patient. Click on the name of the medication to follow the records, to see the next time to give medication or to know the accurate dosage.
Based on demand from healthcare providers and managers, different functions can be easily integrated into our device. Our device is very flexible and can be integrated into any system easily. NDA is also able to communicate with other devices. Furthermore, this device can be used by any healthcare provider to add different functions.

We believe that NDA will impact the future of the ICU. Our project differentiates itself from other projects by its promising power. Our aim is to use advanced existing technologies and

**ALERTS**

When nurses do their regular work, they can receive messages related to lab results of the patients assigned to them. They do not need to go nurse station or any computer to check the situation of lab results. Also, they receive messages when there is an emergent situation in patient room.

**ALARM**

Avoid delay because of forgetting. Nurse can set alarms by adding txt or voice notes. For instance, nurse can set alarm as a reminder of:
- Call a patient’s family at 9:45
- Attend to meeting at 10:50
- Check room 12 at 18:00
integrate them into one device. Furthermore, according to our interviews with health providers and responses from people during the open house, we can conclude there is a certain demand for such kind of a device.

**Reflections**

All of us really enjoyed working towards every aspect of this project. Working with students from different majors, backgrounds and experiences allowed us to consider multiple points of view during our design process. This helped us uncover and resolve issues using the most beneficial solutions which may not have been possible while working within a single discipline group.

Given more time we would work on the following things which would clarify information for those interested in adopting our system. Firstly, we would like to mention that even though we designed a system which can replace current systems and their interfaces used by hospitals to access electronic medical data, the benefits provided by our system can also be easily integrated with existing systems. Our Automated Documentation System which scans data and automatically creates the appropriate entry into the medical record of the patient can be used by nurses in any hospital without the need to replace the entire software infrastructure of the hospital. Thus, all hospitals have the opportunity to benefit from our design.

Like every other secure software product, we would like to make appropriate failure recovery mechanisms which will be activated if any component of our system fails for any
unforeseen reason. We would decouple our Automated Documentation System from the healthcare information system so that in case of any error the manual documentation system can still be used to enter data. This would prevent any disruptions in the hospital until the issue is resolved.

Several people at the Open House were interested in learning the cost of each device we designed. This is something we never estimated during our design process. However, given more time we would definitely like to research the market prices for each component of the appropriate size and deliver an estimate for each device. This would help interested parties in estimating the hospital-wide costs of adopting our system.


10. Landmark findings on how nurses spend their time guide process improvement at Kaiser, Ascension: Nursing Executive Watch, June 2008
