Home Health Nurses' Initial Experiences with Wireless, Pen-Based Computing

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Abstract Eight home health nurses from the Visiting Nurse Service of New York participated in a focus group discussion after their initial experiences using wireless, pen-based computing in the inner-city, home care environment. Transcripts of the nurses' responses to open-ended questions were analyzed and central themes were found, following the method of concept analysis described by Strauss and Corbin (1990). The central concepts were "Readiness," "A thousand pounds on my back," "Call for support," "Problems with transmission," "Using the computer as an assistant," "Nurses discovered glitches," and "Everybody has to have a computer." These themes reflected the nurses' initial experiences with the wireless computers and also revealed their concerns. This article will describe these themes and will discuss the implications of current improvements in wireless computing for health care. The focus group themes aided in understanding how this group of experienced home health nurses began to transition from handwriting on several different forms to checking-off items on a small, hand-held computer screen, from innovating methods to communicate when telephones were not available, to using a wireless computer to send and receive data involved in the patient admission process

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INTRODUCTION

Wireless computing, also referred to as point-of-care technology, is increasingly playing a role in hospitals and home care and is expected to be widely used in healthcare in the next few years (Jacobson, 1997). Point-of-care systems, based on a central database and portable terminals, increase the accuracy and efficiency of caring for patients (Hughs, 1995). A key feature of wireless computing is that it enables nurses to conduct two-way communications without relying on telephone line access. Wireless computing is an extension of the existing wired network environment used in local and wide area networks (LANs and WANs) (Georgia, 1977).

In a wired network, computer modems are used to transmit data over telephone lines and both analog or digital technology may be used. Analog technology transmits voice and electronic data by making an electronic waveform analogy of the frequencies and volume of the original sound (Witherspoon, Johnson, & Wassem, 1993). In places where the newer digital format is available, the spoken word over the telephone line is usually switched from the older analog format to digital format by the telephone company so that the message will be transmitted more efficiently (Georgia, 1997). Integrated Services Digital Networks (ISDN) enable local phone companies to convert a variety of data (voice, writing and video) into digital format, so that data travel through a single channel simultaneously to be sorted out at the receiving end (Witherspoon, Johnson, & Wassem, 1993). Digital technology has improved data transmission speed and has played an important role in the progression to voice, video and written data transmission over wireless computers (Georgia, 1997). Digital coding, somewhat like the old Morse code, is a

process of encoding information by turning the power on and off, sending a stream of bits of information as zero or one (Witherspoon, Johnson, & Wassem, 1993).

The implications for health care delivery are profound. For example, a radiologist is able to send or receive an x-ray or magnetic resonance image (MRI) to be viewed on the screen of a wireless computer that can fit in the palm of a hand. Nurses are able to communicate with patients or caregivers while in the home, and not be dependent upon available telephones or even public pay phones in the neighborhood. Home health nurses' dependence upon available telephones, especially in poor, inner-city neighborhoods, has led to missed contact in the field (Wilson & Fulmer, 1997). The use of wireless computing enables data to be transmitted to multiple agencies simultaneously and helps overcome these problems.

In order to understand home health nurses' transition experience from paper to paperless, and from wire to wireless communication, a focus group was held with eight home health nurses from the Visiting Nurse Service of New York (VNSNY) after they had used wireless computers for approximately 10 weeks. Themes analyzed from the focus groups offer the reader insight into this experience. The nurses expressed their satisfaction that wireless computing had met their expectations, but also pointed to the new problems created. Wireless computing technology and methods of telecomunications have progressed since the home health nurses identified their concerns (Howard, 1997; Jacobson, 1997; Koegler, 1997). The purpose of this article is to describe the themes from the focus group, increase readers' familiarity with the application of wireless computing to home health care, and suggest future possibilities for this important technology.

BACKGROUND

Two groups of nurses from the VNSNY (16 nurses) had participated in focus groups held one week before the introduction of the wireless, pen-based computers into their practice. Focus groups were held with the home health nurses before their experience with wireless computing in order to identify their perceptions of how the wireless, pen-based computing would affect their practice. The qualitative approach had been selected to interpret and describe the visiting nurses' views of patient care needs in the home and to describe the nurses' expectations of how wireless pen-based computing could be used in home health care (Wilson & Fulmer, 1997). Central themes analyzed from these earlier focus groups were "Missing contact in the field" (in the patient's home or en route), "Consumption of time writing on forms," "Using the computer to help with the practice of home health nursing," and "Home health nursing is a lifeline"(Wilson & Fulmer, 1997).

After the initial set of focus groups, one of the groups (eight nurses) used the computer for the patient admissions process during a 10 week period before participating in the follow-up focus group. The follow-up focus group themes will be described in this article. A summary of themes derived from analysis of the focus group discussions before the computers were introduced, the nurses' expectations of how the oncoming technology would be useful, and their actual experiences are listed in Table 1.

This study was part of a larger study, funded by the National Telecommunications and Information Administration (NTIA), to evaluate the potential of remote, wireless telecommunications, and wireless, pen-based computing to support patient care in the home, streamline the flow of patient information between agencies, and assess the impact of these technologies upon patients and providers of care (Hripsack, 1994).

The Wireless Computer

The computer weighed 3.5 pounds and had been used by the nurses for patient admissions. The nurses, most of whom were novice computer users, had received three one-half day training sessions with an in-house technical trainer before using it in the field. The nurse admitted the patient in the home, assessed the patient and checked-off vital signs, medications and activity level with a customized pen onto an on-screen menu. The nurse could immediately send this updated information to the VNSNY database. Similarly, the nurse could download assignments remotely from home, and send information without having to travel. Travel time, redundancy in filling out paper forms, and missing contact when phones are not available, have improved with wireless computing (Hughs, 1995, Simpson, 1996). An impetus to automating systems in home care came when the Health Care Financing Administration (HCFA), the agency involved with Medicare expenditures, launched an electronic claims transaction initiative in 1991, with a goal of having providers submit Medicare bills electronically by the year 2000, thus reducing costs (Klein, 1993).

How Data Are Sent Over the Wireless Computer

The Fugitsu 500® pen-based computer, used by the nurses at the time of this study, contained a wireless external modem that plugged into the computer. The nurses dialed-up and reached the newly installed Bell Atlantic-Nynex Mobile cellular digital packet data (CDPD) network, that connected them to the VNSNY mainframe computer with the agency's central database. The home based computer at the VNSNY utilized a frame relay connection (a type of wired phone line, that connected into the wireless network) to move data back and forth. The VNSNY sent

TABLE 1.

[a]Concepts describing home care needs	Concepts describing expectations for wireless computing	Concepts describing initial experience with wireless computing
Missing contact in the field Doing whatever it takes The cost of doing whatever it takes	Using the computer to help with the practice of home health nursing	Readiness Problems with transmission Everybody has to have a computer Call for support
Consumption of time writing on forms How nurses deal with being stuck on a treadmill You have to work a very long day	Using the computer to help with the practice of home health nursing Access and control over information Using the computer as an assistant Sharing information, time saver, little monster	Using the computer as an assistant Nurses discover glitches Access and control over information Sharing information, time saver, little monster
Home health nursing is a lifeline Compelled to make the right decision You made the right decision	Internet access, medication information and printouts	Using the computer as an assistant Sharing information, time saver

[a]From Wilson & Fulmer (1997)

data from the central database over the phone lines, Bell Atlantic-Nynex sent the data out via their wireless network, and the nurse received the data remotely in the patient's home (Fig. 1).

There are several ways to send data sent over wireless systems. The method used in this study relied on a telephone company wireless network. Some wireless systems, such as those in hospitals, use radio-based signals over LANs and WANs to transmit data throughout a facility, so the nurse is able to go to any unit and have access to current patient information and communicate without any physical connection (Simpson, 1996). The system used by the VNSNY at the time of the initial phase of this project was the first in New York City to transfer patient data over CDPD wireless technology using a newly installed wireless network by Bell Atlantic-Nynex. In this way, both voice and written information was sent by the nurse in the field to VNSNY and back again, over the same network that handles cellular phone connections for voice communication in New York City.

VNSNY Wireless Computer System Used in this Study

The computers used in this study were equipped with two-way communication so that the home health nurse could transmit and receive, as well as store and retrieve, admission information while in the patient's home. The wireless

Figure 1. The wireless transmission of data. The nurse inputs data with a customized pen onto the computer screen. Data is then transmitted from the nurse's computer via a CDPD modem to a wireless network carrier (such as the Bell Atlantic/Nynex CDPD wireless network). The data are uploaded to the central database located at the VNSNY. If the nurse wants to download information from this central data base, a frame relay connection at the VNSNY allows the data to be transmitted to the CDPD wireless network so that the nurse can download it with the wireless computer, from the patient's home.
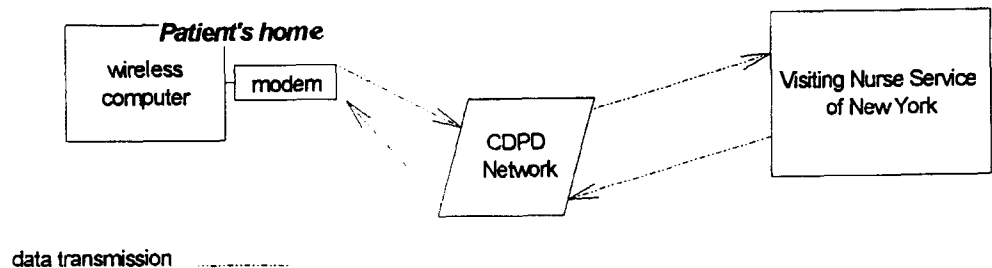
computer system used in this study was expandable so that it could accommodate applications such as the Internet and automated patient management protocols that will enhance decision making support for nurses and others involved in the patient's care, according to Dr. George Hripsack, Principal Investigator (Hripsack, 1994). These will be added in a future phase of the larger study. During this phase, data entry and E-mail functions were utilized.

The software used in this phase was designed to enable the nurses to input most of the patient's admission data onto a form on the screen by pressing appropriate boxes with a pen designed for the computer, or handwriting comments directly onto a comment window on the screen with the computer pen. The nurses were also able to type onto a soft keyboard template on the bottom of the computer screen. Figure 2 shows the upgraded Fugitsu 1000^{tm} computer (the computer used in the pilot study was a Fugitsu 500^{tm}) displaying an MRI of a patient's head on the computer screen. This figure illustrates the size and clarity of images which are possible.

METHODS

Two groups of nurses had participated five months earlier in focus groups held before the introduction of the computers into their practice. Informed consent was obtained, and all participants had received an orientation to the study prior to the focus group interviews. Semi-structured questions for the before and after focus group interviews had been developed in partnership between the faculty from the New York University Division of Nursing and the VNSNY.

A sample of eight home health nurses from the VNSNY was equipped with wireless, pen-based computers for patient admissions in the home. Another eight visiting nurses continued their usual admission practices with paper charts and admission forms. After using the wireless computer in home health care for approximately 10 weeks, focus groups were held with each group of nurses: with those who had used the wireless computer, and with those who had not used the computer. The focus groups were facilitated by the authors and audio taped for later transcription. The data were analyzed following the method of recognizing themes by open coding, described by Strauss and Corbin (1990). The concepts were repeatedly compared with the raw data in an inductive/deductive process of asking questions and making comparisons. Open coding is the analytic process by which concepts are developed in terms of their properties and dimensions (Strauss & Corbin, 1990). This article will report the results from the data collected from the nurses' group who had used the computer.

RESULTS

The nurses' experiences with the pen-based computers included documenting patient symptoms, treatments and vital signs from standardized on-screen lists with their pen, sending and downloading the information between the wireless computer and the central database at the VNSNY main-
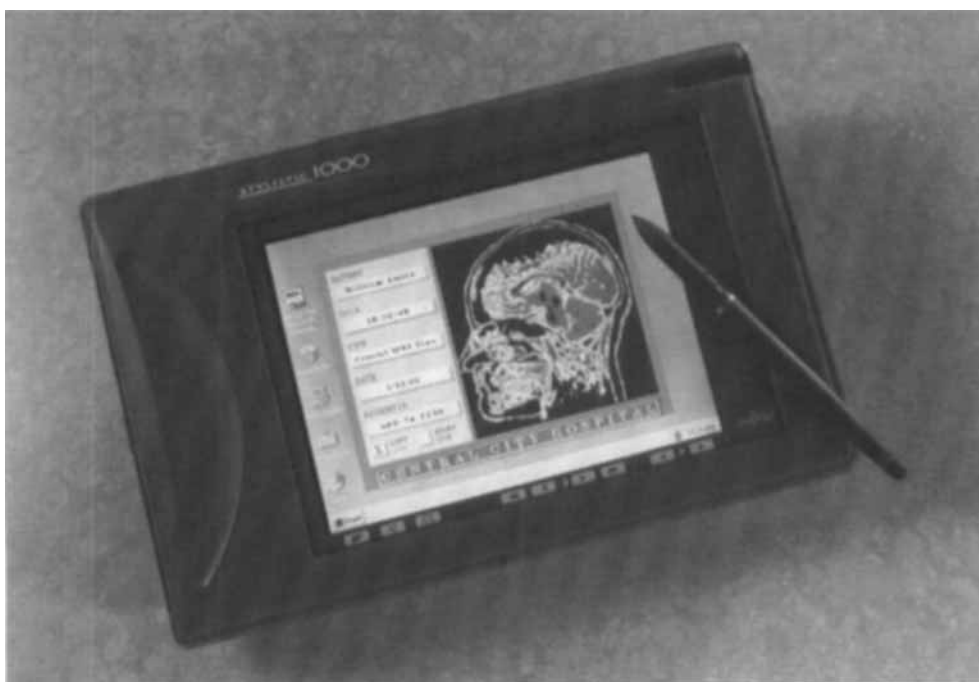

Figure 2. Displayed in this photo is the Fugitsu 1000 model pen-based wireless computer, an upgrade from the Fugitsu 500® which was used by nurses in the current study. The on-screen menu drops down and the nurse may either select functions, write with the pen, or type on the keyboard template. The computer screen displays a patient's MRI which had been transmitted and received for viewing.

frame, and using the small mobile computer's organizer capacities. These experiences piqued the nurses' imagination about the future uses of this technology for patient care in the home. Some of the nurses expressed their interest in using the wireless computing for Internet, Medline, and pharmacology information even as they were initially using the computers for data entry and transfer. This was interpreted as the nurses' "readiness" for wireless computing and will be described first. The other concepts which developed from open-coding of the data were "A thousand pounds on my back," "Problems with transmission," "Call for support," "Using the computer as an assistant," "Nurses discovered glitches," and "Everybody has to have a computer." These concepts revealed aspects of the transition to wireless computing as experienced by this group of home health nurses practicing in the inner city. Comparisons with their earlier expectations of the technology are shown in Table 1.

The nurses who had used remote computing in the patient admission process wanted to continue using the computer. They found ways of "using the computer as an assistant," a key strategy identified by nurses in earlier focus groups, before their introduction to wireless computing. They found ways to increase access and control of information and discovered ways the computer could enhance their practice. However, the new technology also presented problems. The nurses experienced disruptions in transmission of data over wireless connections. This occasional experience was reminiscent of their earlier regularly occurring experiences with "missing contact in the field," when the nurses were dependent on wired telephone technology, described in the previous set of focus groups. "Nurses discovered glitches" referred to problems experienced when they typed on the small keyboard (the computer was 7.2″ by 10.7″) and when the system misread their handwritten notes. The nurses wrote information on the small screen, when the form did not provide a box and simple check-off.

Readiness

"Readiness" was a concept that described where they were in the process of transition from paper to computer. Although these nurses were novice computer users, they made comments such as "we knew in our heads it was a trial . . . but I wish I could do something more with it . . . to take me away from my regular work." This reflected the nurses readiness for future applications, such as accessing information on a certain diagnosis or generic medication, or having access to a decision support system to help guide their interventions with complex problems while in the patient's home. Using the new technology was, not surprisingly, seen as different from their regular work. "When it goes agency wide . . . it will be ready for everything . . . progress notes, admission notes."

Nurses who used the computer did not want to return to paper and pen. "No, no we don't want to give it back . . . we want it to go forward." The nurses were especially interested in whether they could look up a generic medication or dosage on the Internet and then have a printout for use in patient education, "so that if we are with a patient and have a question on a medication, we could say hold on, and click into that Internet and have the screen come up with that medication or that diagnosis . . . I don't carry my medication book because it's too heavy. What I have to do is go home, look it up in the book, and then come back, tell the patient the side effects, and write them out." The nurses also wanted to be able to inventory products, such as a contour bed. One nurse wanted to have access to evaluation tools, such as mental status exams, to assist with assessing the patient's level of function.

A Thousand Pounds on My Back

"I've been trying to utilize it as much as I can; I don't want to carry all that extra stuff." The computer, which came with an instruction book and bag, added weight to papers the nurses still carried, since wireless computing had not yet been implemented agency wide. Nurses were caught between using the computer for admissions and carrying paper to write items that had not yet been automated. The nurses perceived the computer would be "an assistant" with patient care, yet felt that they were still carrying papers that were reminiscent of the past burdens of their job. This added up to the feeling among some of the nurses that the 3.5 pound wireless computer felt like "a thousand pounds on my back."

Nurses also complained that the computer "didn't save time because it was a double thing. The patient service managers still had to read us the information over the phone." "We had that frustration because we came into it all excited, this is gonna be great . . . then we realized we were using it so little. It was a trial and eventually would be fine . . . we hoped for . . . forgot . . . and wished it would be different. . . ."

The 3.5 pound computer felt as if it was a thousand pounds while in transit as well as in the patient's home. "I can't take it out in the street to check an address, I have too much to hold . . . I completely streamlined it." Some nurses introduced the computers to their patients. "I showed it to everybody, they kind of looked at it from a distance . . . no one got too close . . . some of them liked it, thought it was nice that their name was on the screen." Fears about losing the computer, a theme heard in the earlier focus groups before the computers had been introduced, were repeated. For example, some nurses did not

carry the computer during snowstorms for fear of "dropping it in the snow and losing it."

Call for Support

The nurses agreed that they had been well prepared for the computers. They observed that a simulated admission before going out with the computer would have been helpful. While the nurses were no strangers to challenge, their early introduction to wireless, remote computing presented them with some new obstacles. Under the conditions of nurses' awareness that they were a pilot group of visiting nurses who would be testing out these computers in the field, and were for the most part novice computer users, the nurses' previous strategy of "doing whatever it takes" (Wilson and Fulmer, 1997) now included calling the user support desk to solve computer related problems. One nurse commented "some know a lot about the computers, but other people were afraid of the program, afraid of messing it up, afraid of deleting something. My philosophy is: so what if at this point you mess up the program, you delete out a file . . . let the programmers know what happened. That happened to one of my cases and they did find a glitch in the program."

Problems with Transmission

The nurses occasionally missed contact when there was interference in the network or when transmission was hindered by the building's construction materials. One nurse commented "I couldn't transmit until 1:00 or 2:00 in the afternoon. Now, I know I've got an admission, I've got the computer, I want to see where the patient lives and figure out my schedule, but I'm not getting the information."

The nurses also had fears about what might happen to data in cyberspace. "They could E-mail a signed thing back and have it be part of the record. What makes me nervous, things get lost in cyberspace . . . if you send an order to a doctor . . . and it never comes back . . . it isn't going to be making my life easier . . . when you send out an intramodive, you have a copy. With the E-mail you won't, not unless you save it." "If things get lost in cyberspace . . . there is going to be a transmitted thing floating around somewhere."

Using the Computer as an Assistant

The nurses' view of "using the computer as an assistant" to help with the practice of nursing, a theme heard before they had the computer, persisted after they had used the computers. The computer was an organizer. "I've been relying on the computer most of the time . . . not so much that I need it for medications, as I need it for doctors and clinical numbers, emergency contact people . . . social workers . . . so I know which home health aide services

to use." The computer retrieved information that was essential to the patient's care. "The computer gave me the person who did the referral, the social worker and their phone numbers, which you don't get a lot of times over the phone . . . and social security numbers . . . and all the other doctors that may have been involved. All of that information was contained in the comment sheet." "I called and told someone at the hospital that I was on the pen-based computer and asked them to be explicit with the comment section. I was getting a lot of information . . . about family . . . and that was nice, these were not given to you by phone." The nurses found that the comment section was important in fields that could not be anticipated on the check-off. "If there would be a way we could add comments from the hospital, that would save somebody a lot of trouble . . . Mrs. Jones is at the Senior Center every day; she will not come home for your visit, if you want her, go to the Center. . . ." "I think that the computer in the future . . . is going to help us enhance the family involvement. . . ."

The nurses anticipated that the computer would also help them to communicate patient's needs to nurses who covered on their weekends or days off. The weekend nurse needed the case file and the primary nurse needed the weekend nurse's note describing treatments, medication and patient condition updates. Nurses described their previous elaborate preparation to communicate patient needs to the covering nurse, when they were to go off duty. "I know I have to start a week ahead to get all my records ready. Maybe there's a way that they would print out all your cases, . . . you would highlight your whole caseload . . . who needs to be seen, on what days and frequencies . . . . and that whole, updated record would be ready. The nurse could download to the nurse who is covering, and take their pen-based out in the field to see their eight to 10 people. Then when they come back . . . plug it in to the terminal . . . the information loads back up, and you are able to retrieve the information onto your pen-based when you get back . . . You would automatically get new medications . . . you wouldn't have to wait to come in the office." These approaches were already possible and awaited the nurses' use.

Computer as "a time saver" was as an important theme. "We could have a life actually, a real life . . . like other normal people do at night when you go home. After dinner and dishes, you don't have to sit and do the paperwork, you can have it done. . . ." "It gives us hope..for the future . . . just to get away from the paper . . . that's something. . . ."

Nurses Discovered Glitches

When the nurses could not find a check-off for information they felt was important, they wrote on the computer screen with the customized pen. Sometimes their penmanship

could not be deciphered by a handwriting recognition system, so the nurses typed these comments on the small keyboard. Some nurses complained that it was difficult to type on the screen template because of it's size.

Everybody Has to Have a Computer

The nurses were still concerned about missing contact, and looked forward to a solution. This was reflected by the statement "everybody has to have a computer." "If we send the 485 through the computer and it comes back on the computer with whatever changes the doctor makes, that would be helpful . . . the doctor needs a computer too. That's what Im saying . . . everybody has to have a computer, the social workers, the physical and occupational therapists. . . ."

DISCUSSION/IMPLICATIONS

Chick and Meleis (1986) conceptualized transition as characterized by process, disconnectedness, perception and awareness. These focus group themes support this conceptualization of transitions. The nurses demonstrated a process of readiness. The nurses made the distinction between the former state of dependence on phone lines and paper and current remote computing; they perceived themselves as a select group of nurses who had the opportunity to pilot a new technology. They realized that their observations would provide a basis for understanding the impact of this transition agency wide, and they demonstrated a consciousness that they had crossed into a new arena of communication in home care and did not desire to go back. They continued to "do whatever it takes" to overcome obstacles, such as accessing the help desk. Wireless computing was to become part of the nurses' usual practice, yet the nurses had developed a knowledge base of ways to overcome communication problems in an environment that depended on paper forms and telephones connected to a wall outlet by wires.

The needs, expectations and initial experiences with wireless computing provided insight into what would be needed to support home health nurses on a larger scale. Today 400 nurses at the VNSNY use the wireless, pen-based computing and it is anticipated that by the end of the year over 1,000 nurses will be using the pen-based systems. The themes help to understand the transition and guide planning for wireless technology.

Since this study, the technology for an internal CDPD modem has become available. The external modem used in the pilot phase of the study weighed one pound. The updated computer, the Fugitsu 1000[tm.] uses a PC-MCIA slot for an internal PC-MCIA modem card, which weighs only a few ounces. The nurses' fear of the computer getting wet or lost has since been addressed with a customized carrying case. The new carrying case has a vinyl cover

which protects the computer from solution spills that might occur during home care.

The help desk at the VNSNY is currently staffed with two to three people during the day and operates 24 hours, seven days a week. At night, mainframe operators are available to answer calls from nurses. For example, if the nurse omitted inputing the duration of a medication, the computer was programmed not to accept or transmit data. The help desk, familiar with the requirements of home health nursing, would identify the cause of the failure to transmit data. Training programs are ongoing to help support the nurses' computer use. According to Simpson (1996), training and computer support are very important. Point-of-care computing requires vendors to give the kind of support and service needed. An agency considering wireless computing will need to compare a vendor's service and training support, in addition to hardware, software and telecommunications.

"Problems with Transmission" reflected times that the nurses could not transmit data to the VNSNY from the patient's home. Using a pen-based computer that relied on cellular communication resulted in interruption of transmission similar to cellular telephone use. Since the pilot study, Bell Atlantic/Nynex has increased their signal strength and in general the technology required for seamless wireless computing is vastly improved (Georgia, 1997). Nurses might still find that they need to move to a window in order to transmit data in certain building structures.

"Nurses discovered glitches" referred to problems with handwriting recognition. Most of the functions of patient care are to be incorporated in the menus and lists which drop down and are checked-off with the pen, according to Rick Stazesky, Director of Systems Analysis and Development at the VNSNY. The small keyboard continues to be a problem. However, voice recognition and handwriting recognition will eventually supplement the keyboard in the near future according to a recent article in PC Magazine (Howard, 1997). Voice and signature recognition is improving because of the developing ability of the computer to understand contextual phrases (Howard, 1997). Patient security, concerns addressed by the nurses in an earlier theme "Computer as monster" require an encryption system to safeguard privacy.

The nurses identified an underlying reality when they described "Everybody has to have a computer." Access to information systems is required in order to realize the potential of technology. The availability of wireless computing depends upon cost considerations for hardware, software, training and on-going support as well as available telecommunications. This is also a national concern. The High-Performance Computing and Communications (HPCC) program, a multi-agency effort supported by federal funding, seeks to advance computing and communica-

tions nationally to lay a basis for the National Information Infrastructure (NII). The goal of the NII is to provide access to high performance computing and communications to vast areas such as health care and education (Lindberg & Humphreys, 1995).

In studying the knowledge of experienced nurses, Benner (1984) found that expert nurses possessed intuitive knowledge. Such intuitive knowledge was embedded in the remarks of nurses participating in the focus group. These experienced nurses used their intuitive knowledge of the complex needs of patients in the home to describe and anticipate what they needed from wireless technology to overcome the challenges of home care.

This study helped to understand the transition experience from paper, phone wires and pay phones, to paperless and wireless computing among this group of nurses. Their experiences help to guide the introduction of wireless computing in similar home care contexts. Future experiences with expanded applications for wireless computing will provide a context for understanding transitions to telecommunications via Internet, to professional chat rooms, and to automated decision support systems. Follow-up focus groups with this group of home health nurses will deepen understanding of the ongoing nature of these transitions.

ACKNOWLEDGEMENTS

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