

**ARE WIRELESS COMPUTERS A COST  
EFFECTIVE ALTERNATIVE TO  
FIXED BEDSIDE COMPUTERS  
FOR DOCUMENTING AND  
REVIEWING PATIENT  
CARES?**

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## **EXECUTIVE SUMMARY**

Most healthcare organizations have been developing electronic medical record systems. Gaining access to the patient's electronic record becomes a particular challenge in the hospital at the bedside. One way to give access is to put a computer at each bedside. Another option is to deploy wireless networked computers giving flexibility and potentially cost savings to the organization.

The following research was compiled to determine whether or not an organization could implement wireless computers for bedside documentation and review less expensively than installing a fixed workstation at every bedside. The study involved researching literature as well as conducting a survey of healthcare organizations. The survey asked questions regarding how long the organization had been using wireless and why they chose the technology. It also asked if they were able to justify the costs.

The results show promise. They indicate that the technology is being used with justifiable benefits. Healthcare organizations are finding the technology to be worth the cost and equal to or somewhat less expensive than putting a computer at each bedside when all costs are considered.

My recommendation is to encourage the use of wireless computing for bedside documentation and review but to proceed cautiously and do your homework. There are many variables involved in assessing the right configuration and set of processes. One size does not fit all as far as devices, technologies, processes, whether it makes sense to deploy wireless in a given area.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **Overview of the Research Project**

This research project involves results from a literature search regarding mobile wireless computing in healthcare as well as results from a survey taken from organizations having experience with wireless computing. The project is centered on trying to determine if an institution can deploy wireless mobile computing for bedside documentation and review and save costs as compared to fixed computers at each bedside.

#### **Research Goals and Objectives**

##### Background of the Business Problem

Over the past several years, health care institutions have been investing in electronic medical records software. One major endeavor involves documenting patient care at the bedside. Traditionally, paper records have been used to record and track patient's progress and care received but in the future, all records must be electronic to improve the efficiency of care. This is a costly process of not only physically moving the paper records but also keeping track of where the records are currently located. Quite often the records are needed by more than one location but with only one copy of the physical record, it is not possible to view it in two places at once. An electronic medical record allows for multiple people to document and view records simultaneously. An electronic medical record also allows for research and continuous

improvement through the querying of the database of clinical information that has been accumulated.

#### Research Problem or Opportunity Statement

The documenting of a patient's care is being transformed from paper to electronic. One of the major hurdles is giving caregivers access to the electronic record where and when needed. Many patient care units have several computers hooked to the network but the majority are located at desk areas or in hallways or conference rooms. Most documentation and viewing of patient cares are done in the patient's room using paper charts; therefore the question has been how should an organization give caregivers access to the electronic environment at the patient's bedside? One possible solution is to install computers at every bedside and/or fill the hallways with them away from where they are needed most. This quickly gets very expensive. Another option is to install a wireless mobile computing solution. This would allow caregivers access to a computer when and where they need it but not require a workstation in every room.

#### **Conclusion**

Most healthcare organizations could benefit from technologies like wireless mobile computing. This research should be beneficial for anyone considering providing access to electronic patient records. If wireless mobile computing proves to provide more cost effective benefits for an organization than fixed computers it will be prudent to pursue this method.

## **CHAPTER 2**

### **LITERATURE REVIEW**

Over twenty publications exist today that focus specifically on wireless technology. Some are specific to the technologies used such as wireless networking, personal data assistant devices (PDAs), and other variations of wireless computer hardware. Other journals and magazines relate to the use of the technologies such as *Wireless Integration* magazine. Many related publications exist to research healthcare-specific information for mobile computing. These journals and publications include *Health Data Management*, *Advance for Health Information Executives*, and *Healthcare Informatics*.

The literature research yielded four main areas of analysis: technology of wireless computing, costs, benefits, and case study examples. This section will summarize the articles relating to mobile computing and healthcare.

In 1999, the Healthcare Information Management and Systems Society (HIMSS) conducted a survey, which asked what technologies would organizations use over the next 12 months. Respondents selected wireless information technology as the top answer over six others, including e-commerce, voice recognition, and data mining (Irving, 1999).

Wireless networking is here to stay. Some believe it can replace most wired networking, but many see that at a minimum, there are places where it just makes more sense than hard-wired

networks. “The wireless LAN [local area network] is not a replacement for the wired infrastructure, but it can be a significant complement to what currently exists, according to WLANA [Wireless Local Area Network Association] (Irving, p.27, 1999).

### **Technology**

Many articles described the various technologies of wireless networking and wireless devices. Technology can provide caregivers access to a computer when and where they want it. In order for the technology to work, the network itself must be established. The wireless network configuration is quite simple and not much different from a wired network. With a wired network, each computer or network device is physically connected to a data jack/outlet in each room or hallway. From each data jack, the wire or fiber optic cabling connects to a data closet. In the data closet there is a device called a router that supports a number of computers. The router is connected physically to many other routers that connect to computer servers forming the organization’s network.

With a wireless network the setup is similar. The computer has a card in it with an antenna that communicates via radio waves to a router in a wall or ceiling that also has an antenna. The router/antenna assembly is able to support a number of computers for a geographical physical space. The router connects to the data closet as well to complete the connection to the organization’s network.

### **Technology : Network Standards**

The network for wireless computing is based on industry standards. There are two prominent standards: OpenAir, and IEEE (Institute of Electrical and Electronic Engineers) 802.3. OpenAir is the most widely established standard with forty vendors using it for their products. It is based upon Proxim’s “RangeLAN2” 2.4GHz frequency hopping spread spectrum (FHSS)

technology (Irving, 1999). This technology, as the name implies, sends data bits on multiple different frequencies in the 2.4 GHz range to reduce collisions and keep the data secure.

Another standard is IEEE 802.3 for Ethernet networks and 802.5 for Token Ring style networks with a variation being quickly created for high speeds, identified as 802.11. 802.11 is stated to run at 1 and 2 Mbps (megabits-per-second) but 11 Mbps was thought to be out by the end of 1999 (Irving, 1999). To be close to normal LAN Ethernet speeds, 10 Mbps is a minimum requirement. In the year 2000, 11Mbps was achieved and used by many organizations. This technology uses direct-sequence spread spectrum technology where the data is sent at one frequency but uses bit patterns to scramble the signal keeping it secure.

Data transmission speed of 11Mbps is just the start. Speeds as high as 22Mbps are also available for some devices, and there is room for higher speeds in the future. The 802 standard allows enough bandwidth for these higher speeds, which will enable more devices to communicate on the same transceiver. This standard will also allow more data to be transmitted such as dense images and even voice. Voice over IP, as it is referred to, allows organizations to consider a single network for all voice, data, and video transmissions. This is an enormous benefit for organizations if indeed it proves to be feasible (DeJesus, 2000).

According to Steve Flemig, director of new business development at LXE in Norcross, Georgia, "If you look at the history of 2.4Ghz technology, it was available in an affordable form factor in the 1996 timeframe. It has taken three solid years for the application to mature in the market and take advantage of the technology." (Irving, p.30, 1999). It has been taking a year or more for applications to adjust to changing technologies and really adapt to the point where truly beneficial software is available.

### **Technology : Network Costs**

Even though wireless costs have dropped, wireless systems are still expensive for some smaller healthcare facilities. A short-range transceiver that can reach 100 feet can cost as little as \$200-\$500. A longer distance transceiver able to extend computers as far as 300 feet can cost from \$500 to \$2000. Adding any costs to the cost of the devices makes it more difficult to get approval to implement unless there are assurances of a return on the investment. In addition, it is very difficult to estimate the total costs for a typical patient care unit because it depends on the number of computers and the geography, structural make-up of the walls and ceilings, and wiring capabilities of each site (Chin, p.80, 1998). The challenges are not easy, but with concerted effort, they can be justified.

### **Technology : Devices**

Computer devices for wireless use range from handheld devices that fit in the palm of the user's hand, also known as PDAs (personal data assistants), to complete desktop systems often connected to or integrated with a cart and special battery technology. There are also several hybrid systems much like clipboards or tablets. Microsoft Windows CE has enabled some of the devices allowing the user the familiar Windows user interface on a not-so-familiar piece of hardware. The hardware is now able to be quite lightweight, small, and versatile. Companies such as Data General, Sharp, NEC, Hitachi, Fujitsu, Symbol, Motorola, Wyse Technology, Telos Corporation, and Hewlett Packard have come up with devices like tablets that allow for a large screen and onscreen keyboards or membrane keyboards that allow for limited text entries.

According to interviews in *Advance for Health Information Executives* magazine, several CIOs said that not being able to settle on one device for all was a problem. However, some believe that due to the differences in job responsibilities and roles it may always be impossible to

settle on one solution for all providers. In order for portable devices to be helpful for nursing, they must be small and easy enough to be able to input data. Physicians, on the other hand, need something large and fast to retrieve and view data. This is not easily matched in one device. This can lead to small handheld devices for data entry and laptops for text entry and viewing data (Mitchell, 1999).

Some providers believe that the size of the computer can be a hindrance to gaining acceptance by the patient. Having a smaller computer can help. One case described this. At Midwest Heart Specialists, a thirty-cardiologist practice in Downers Grove, Illinois, O'Tolle, a cardiac specialist stated, "We didn't want our interaction with patients to be altered by the presence of a large cumbersome computer" (Chin, p.88, 1998).

### **Technology : Device Costs**

Costs for the devices have come down dramatically, like similar high technology devices that catch on quickly. According to the Gartner Group, an IT research firm, "Right now, we've got a combination of very low cost wireless PC card and wireless PC form factors that can put a fairly capable mobile PC device in your hands for under \$1000" (Irving, p. 32, 1999). Personal data assistants are in fact now under \$500 for a scaled down wireless network version. Bruce Patterson of 3Com had noted that more than 20% of all physicians use palm-sized computers and also mentioned that this has occurred without IT staff trying to force them to use the technology. This suggests that it may be possible to gain acceptance through having beneficial applications that providers can see easily the benefits (Mitchell, 1999).

Another related technology involves putting special hardware and software together that puts the bulk of the processing and data storage on a remote computer within the organization, referred to as a "thin client." This allows the wireless device to be less expensive and potentially

less valuable to someone walking off with it since it couldn't function outside of the wireless network. Using software from Citrix Systems Inc., Coral Springs, Florida, the devices only need to display the screens that are being processed on another computer in a data center (Chin, 1998). Because most programs are not actually running on the computers but instead are simply being shown to the user through the use of the wireless computer, companies like MedicalLogic Software believe it will be easier for customers to deploy its software. Trying to keep laptops or other computers up to date with the correct software is difficult especially with an untethered wireless device. A "thick client," on the other hand, operates much like any other normal personal computer and requires a more expensive device to run programs.

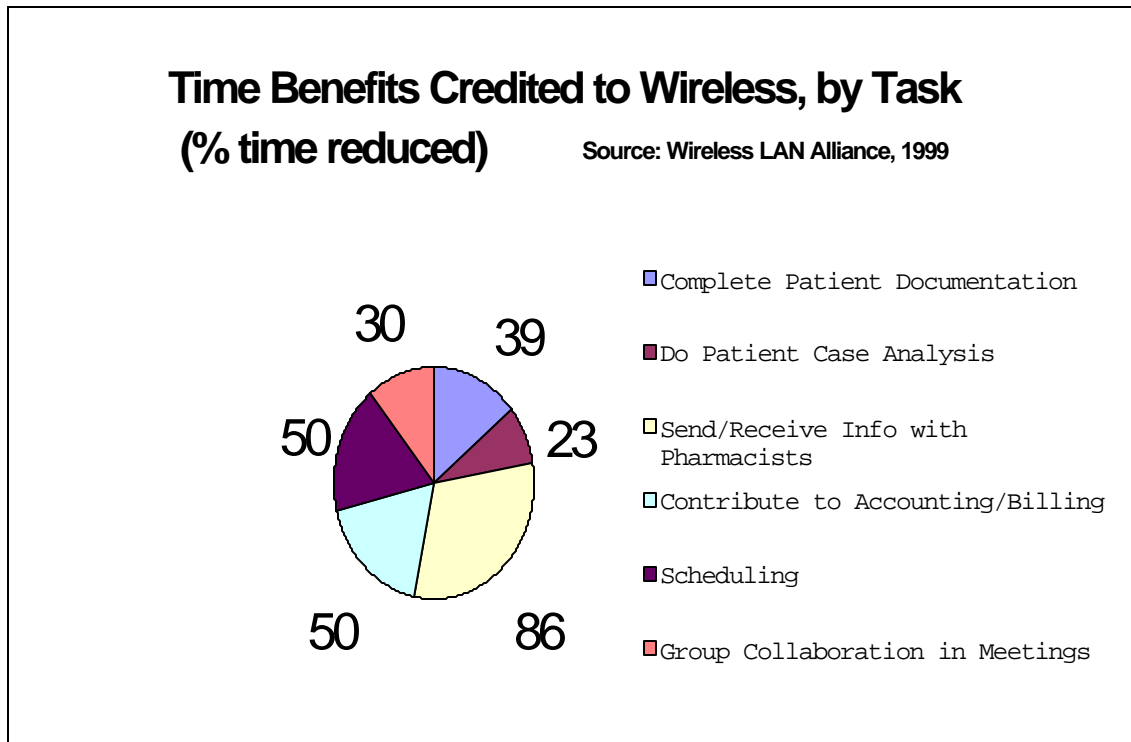
### **Benefits and Justification**

"Today, health care institutions are still dealing with the workflow changes that come with the paperless environment" (Irving, p. 30, 1999). Until the workflow changes are complete, it is possible that benefits will continue to increase. Overall benefits include improving productivity by providing access to patient information seamlessly, increasing patient satisfaction, reducing costs, and speeding up the time it takes to capture what was done when and by whom.

Safety can also be improved with wireless mobile computers and through the use of bar codes and scanners hooked to the devices. A patient's armband can be scanned as well as a barcode on a drug to be administered. If the unit and dose match for the patient's order, the medication can be given. This double check mechanism can greatly reduce the highly publicized errors that have occurred in some healthcare organizations (McCormick, 1999).

Improvements in patient care can also come from a decrease in the time it takes for a care provider to call for more care for the patient. Ordering a consult with a paper system normally involves writing an order on a piece of paper and getting it sent to a secretary who then transcribes the order into a computer system. This can create errors with handwriting interpretations as well as create delays. With an electronic ordering system entered directly by the care provider, delays are minimal and the accuracy of the order can be greatly improved. Care can then be given to the patient much faster (Finch, 1999). According to the Wireless LAN Alliance, time can be saved completing patient documentation, analyzing patient cases, communicating with in-hospital pharmacists, contributing to accounting-billing tasks, scheduling patients, and collaborating in meetings. See figure 1 below for an illustration of the percent of time that can be saved (Datavision-Prologix, Inc., 1999).

Figure 1. Time benefits credited to wireless by task.



One case citing timesavings as a big success factor was at Good Samaritan in Dayton, Ohio. Nurses had a very inefficient way of getting medication administration information into the computer. They would document the medication administration data on paper and at the end of their shift key it into a computer. Nurses were doing double entry and often lost or misplaced their notes. They would also often forget or not have time to enter in all of their data creating delays in communicating information to other caregivers. As of January, 1997, they now have wireless laptops on carts to capture the information at the time it occurs at the bedside. "The greatest benefit is we have patient records that are up-to-date at any given time now, and we've reduced the chances of making medication errors tremendously," Wasyk noted. They also estimated timesaving of 30-45 minutes per shift by eliminating the double entries and verifications done transcribing from paper. (Chin, p. 82, 1998).

The almost instant installation of wireless can also be of great benefit to an organization. Instead of having to wire each room or many different locations throughout a patient care unit, only a few sites in hallways or in a few rooms need to be wired. This can mean that patient rooms do not have to be blocked off while construction/wiring crews install power and network wiring. For organizations with few empty beds this is incredibly valuable (McCormick, 1999). Spartanburg Regional Healthcare System implemented a wireless system in January of 1997 and found that they were able to deploy six to eight workstations per patient care unit instead of one per bedside (20-30 rooms per unit). Charles Townson, Vice President of Information Services, said that when an organization reaches the point of reducing the number of workstations, then it can start seeing a payback (Evans, 1997).

There are also several locations where computers are needed but space is limited, such as in pre or postoperative areas or in emergency room areas where several beds lay in one large

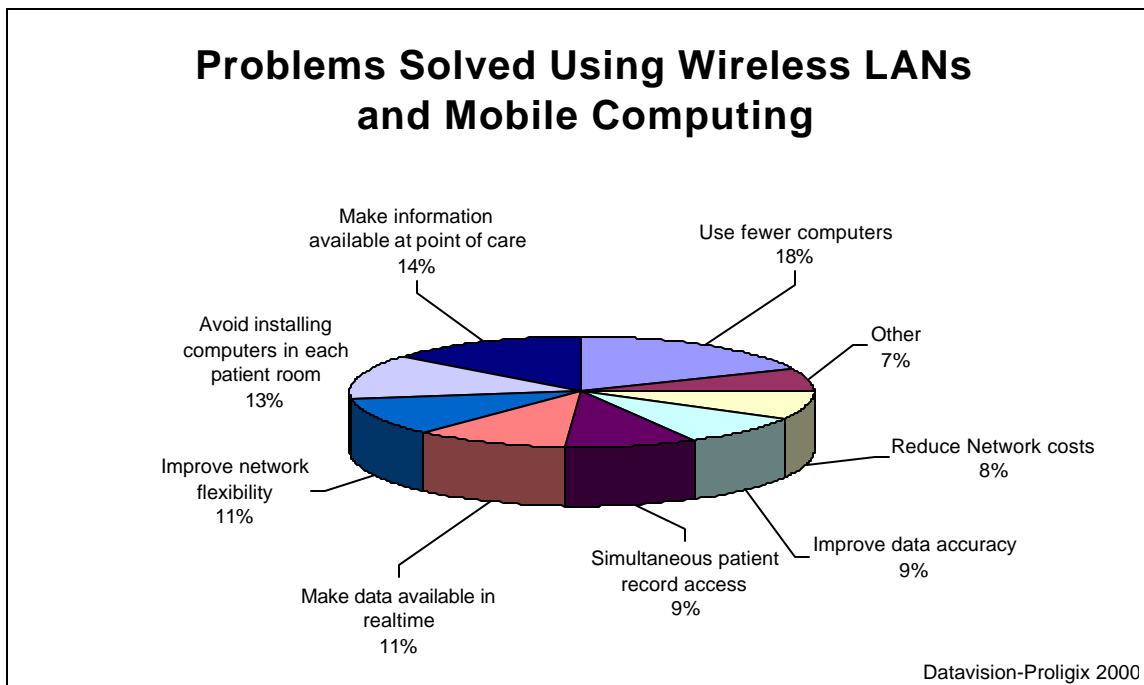
room without walls. The only solution is to use wireless with computerized carts or some form of portable device. Martin Memorial Health Center in Stuart, Florida installed such a system with great success (Anonymous, Health Management Technology, 1999). Space is not permanent either, so that as medical devices such as ventilators or infusion pumps are moved into the patient's room, the wireless computer can easily be moved out of the way.

Voice over IP can be another great benefit of wireless. Voice over IP allows wireless phones to be used which run on the same 2.4Ghz frequency not interfering with other equipment. There is no additional charge for using the phones and this gives even greater access for care providers to a patient's status (McCormick, 1999).

Because the caregiver has access to the patient medical record most anywhere, there exists the ability to have a more accurate record and more timely documentation of cares. This can lead to a more positive audit by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). It can also mean better support during any litigation because the care provider can show what was known when and by whom through this more complete and accurate documentation (McCormick, 1999).

Dr. Saravanakumar from the VA Hospital in Iron Mountain, Michigan, spoke positively about the technology, "The wireless technology installed...is a tool that enables us to perform more efficiently and, thereby...provide optimal care to our patients" (<http://www.symbol.com/solution/045SS.htm>). Care providers can get information immediately entered as well as review how the patient is doing every few hours within a shift instead of just once each day. The paper reports that would get generated by hand or by computer once each day can now be eliminated now that users look on-line for up to date details. (Mitchell, 1999).

Figure 2. Problems solved using wireless LANs and Mobile Computing.



Cited benefits, (see Figure 2) according to Datavision-Prologix, Inc., a vendor of wireless products and services, include enhanced productivity, complete and accurate clinical documentation, more accurate billings, streamlined operations, time and cost savings, improved cash flow, and increased patient satisfaction (<http://webone.datavision.com>, 1999). Wireless LANs frequently augment, rather than replace wired LAN networks, often providing the final few meters of connectivity between a wired network and the mobile user (<http://webone.datavision.com>, 1999).

## **Cost Savings Benefit**

For a significant return on investment with wireless, the computers need to be used by multiple departments for multiple applications. It has been estimated that the cost of installing a wired network per computer is about \$350. Once all of the benefits are added such as not having to find the paper medical record or go to a hallway computer and then go back into the room, the minor additional costs of wireless become worthwhile (Irving, 1999).

MacNeal's Health Network in Illinois conducted an implementation of wireless mobile computers and discovered that three of four physicians were able to see 13.6% more patients per day. This was attributed to being able to get rid of the chart through a wireless implementation (Rhodes, 1997). More than \$1000 per month was saved on file room supplies. Savings per patient amounted to \$1.50 for existing patients (those who have existing paper records that were scanned in) and \$4.27 for new patients. They also claimed floor space previously used to store medical records (Rhodes, 1997).

Another cost savings effect comes in the form of improved cash flow. Savings can occur with more accurate and timely billing due to the ability of capturing what happened to the patient at the point of care. This can result in an increase in the organization's accounts receivable and also frees the clinician to spend more time with the patient and less time with accounting (Finch, 1999).

Some articles mentioned the overall costs of their implementations. One such case was at Ohio State University Hospital (OSU). OSU uses laptops equipped with wireless cards. Executives view the increasing use of wireless technology as "the best way to support the move to patient-centered care, increase administrative efficiencies and streamline clinician communication." (Chin, p.80, 1998).

The 1,000 bed facility considered fixed personal computers at each bedside but executives believed the costs would have been prohibitive. They expect to spend \$900,000 over three years on wireless technology and estimated fixed computers would have cost from \$2–3 million. They expected to spend over \$400,000 in 1998 on the wireless network from Aironet Wireless Communications Inc. They also expected to spend \$1,000,000 on wireless computers (ibid).

Still another example is Duke University's implementation of wireless mobile computing. Duke University Medical Center located in Durham, N.C. has over 1,000 beds and use laptops as thin clients. They considered but rejected wiring each of its patient rooms with a PC because PCs would take up too much space and cost millions of dollars to implement. "The expense is too high and the utility and benefits of having a PC in every room are too marginal," said David Kirby director of Duke's Center for Information Technology Innovation (Chin, p. 89, 1998). "We think the industry has reached that conclusion, and that's why you don't see a lot of in-room computing" (ibid).

Most articles reported that overall, the use of wireless has been a success. One article was positive about the prospects for the technology but felt that it was too early to talk about return on investment. Donald Jacobs, president of Inteck Inc., Denver, Colorado, and a member of the HMT Vendor/Consultant Advisory Board stated in July of 1999, "I don't believe anything meaningful is being done with wireless on a return on investment (ROI) basis at this time. When you talk about the ROI for wireless it's to improve quality of care" (Jacobs, 1999). Return on investment comes when productivity is increased but because there are many process changes that need to occur when using wireless and because wireless is still in its infancy, it is too early to refer to ROI with wireless. Mr. Jacobs prefers to refer to wireless as a way to improve the

quality of care and sell it as such to the caregivers. He felt that by pairing wireless with cost reduction it might not be well received by providers.

Reducing errors is another often-cited reason for doing wireless. Symbol, a hardware vendor of wireless devices, states on their web site the importance of error reduction using wireless. They claim repetitive operations induce errors 3-5% of the time when dealing with human processes. With computers doing error checking and verification of the data entered, there is much more promise that data will be entered (<http://www.symbol.com/solution/045SS.htm>). According to the Department of Pharmacy Care Systems at Auburn University, well known for researching medication errors, there is one error per patient per day in every hospital (<http://www.lattice.com/mobwebwp.htm>).

In 1991, the Harvard Medical Practice issued a report showing 4% of all patients suffered in some way due to medical areas. 14% of these mistakes resulted in death (<http://www.lattice.com/mobwebwp.htm>). Only a small fraction of errors are published, therefore it is difficult to ascertain the amount of errors that occur. Errors relating to medications may be able to be stopped at the pharmacy but drug interactions can be checked right at the bedside. This is additionally beneficial when the point of care device is equipped with barcode or similar technology with the nurse scanning the patient and the medication (<http://www.symbol.com/wp/stwp0012.htm>).

Another time when errors can occur is when capturing laboratory test information at the bedside. One article stated that one in every 10,000 nuclear medicine procedures results in a mistaken patient identification or dosage error (<http://www.lattice.com/mobwebwp.htm>). Bringing the computer as close to the point of care as possible as with wireless computing can help reduce the potential errors in misidentifying the patient or mislabeling a specimen.

Security is another reason health care facilities sited for going mobile and wireless. By moving the device in and out of the room when needed, the user does not have to log on and off the computer (less hassles) but they also can remove the temptation of patients and family members wishing to investigate what's online (Chin, 1998).

Ultimately the greatest benefit to this type of technology is for the patient through increased care. Portland, Oregon had an implementation that was very successful for the patient. The 451-bed Providence Portland Medical Center in Portland uses pen-based tablets and notebooks from Toshiba Corporation to access CareManager software with Proxim networking. "Our whole outlook is, if we can collect information at the bedside, we can distribute it more readily with greater accuracy and we can use that information to provide better care," the organization's manager reported (Chin, p.84, 1998). Because the computer can audit and edit the data while it is being entered, the provider can get more accurate data entered into the system. The provider can also be coached into asking questions or finding out specific information if the computer is programmed to prompt the provider. This is something paper based records simply cannot do effectively, if at all (Chin, p.84, 1998). "The wireless LAN's ability to ensure more accurate, consistent, and timely clinical documentation has been shown to improve the hospital's position in the event of litigation, in addition to improving audit results by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO)" (<http://www.symbol.com/wp/stwp0012.htm>).

According to the WLANA or Wireless Local Area Network Alliance, a non-profit industry trade association, it takes 8 or 9 months to get return on one's investment in wireless. In addition, 97% of the customers said that their wireless network gave them what they expected and 48% of that payback was in productivity improvements. These organizations felt that the

ability to work with patients untethered gave them the ability to see more patients and at the same time increases patient satisfaction (McCormick, 1999).

### **Constraints and Limitations**

There are some constraints or limitations to wireless technology. Most articles that described the drawbacks mentioned battery performance on the top of their list. The portable devices consume battery power far too quickly with some sites quoting that perhaps the radio transmitter draws 25% alone. Care providers also have to remember to recharge the devices so that their two to four hour lives can be sustained (Essex, 1999).

Remembering to charge the wireless devices is not the only change in work style for caregivers. Many sites mentioned that the whole process of caring for a patient must be adjusted for the technology. Instead of signing on to a computer outside the room, reviewing the patient's data, logging off and then entering the room to see the patient, one can now bring the computer to the bedside and review and document before, during, and after the patient examination. Most sites eventually are able to adjust to accommodate this process.

Speed is another factor for some caregivers. Even with higher data speeds comparable to wired devices, there can still be contention. Brian Ralson, MD, from the 30-facility MacNeal Health Network of Chicago, said he has to get used to getting smaller pieces of information and to be more specific when asking for information. He states, "You've got to learn to read and get a page at a time – you can't flip pages" (Essex, p. 40, 1999).

Another concern noted in some articles was security. There were two areas of security written about: loss or theft of the wireless computers and access to the organization's information through radio waves. Because wireless computers are untethered, there is always the possibility that they will be lost or stolen. If the device were secured on a cart, this would be less likely.

Depending on the applications and type of device, this could lead to loss of not only hardware but potentially also of patient information. Most organizations solve this by not storing patient information locally on the devices – ever. Thin-client technology makes protecting information simple because the device itself doesn't save patient information – it only displays it on the screen from a central server/computer (Chin, 1998). Some devices do not have any local storage capabilities and are simply emulating the activities off another remote computer. The other security concern was that people might have easier access to the organization's network with wireless technology. With the latest communication protocols, the possibility of this happening is very unlikely since the short range of the transceivers is about 200 feet.

### **Summary**

The literature appeared to conclude that now is the time for healthcare organizations to take advantage of mobile wireless technology. Implementing mobile wireless computers can benefit patient care, require fewer computers to support, reduce errors in documentation, reduce redundancy in documenting and transcribing. These are just a few of the many benefits noted in the literature.

The caregiver's workflow will have to change with technology. This was quite surprising initially. If an organization merely mocks the current paper flow with mobile computing, not as many benefits will occur. To take full advantage of the benefits of an electronic medical record, organizations must actually find ways to adapt work processes with technology so that caregivers begin to think about how they can best document and review a patient's cares. If a caregiver does not have to stop in the hallway to document or review a chart after each patient exam, they can do other things such as visit another patient. If most of the patient's record is on the computer, processes that exist today getting the paper chart for the clinician are no longer needed.

It was interesting that the literature did not explain how organizations came up with their cost savings and cost justifications. Most institutions appeared to assume they were saving money rather than actually going through cost-benefit analysis.

There were no reasons cited in the literature not to use wireless. There were situations where it may be less cost effective such as in critical care areas and places where there is a one-to-one ratio of patients to care providers. Where there are fewer people needing access than there are patients, going wireless appears to be a better approach than a fixed computer at each bedside. There were still some big challenges such as adapting processes for mobile computing, allowing for recharging batteries, keeping enough computers so that if one breaks there are still enough to care for patients, etc. If these hurdles can be overcome, the wireless implementation will not only be successful but also well received by all.

## **CHAPTER 3**

### **METHOD**

#### **Statement of Purpose**

##### Research Question

Are wireless computers a cost-effective alternative to fixed bedside computers for documenting and reviewing patient cares?

##### Alternatives

- Are fixed bedside computers more cost effective than mobile computers for documenting and viewing patient care at the bedside?
- Are there other wireless devices such as handheld computers or other hybrid computers that might be more cost effective for documenting and viewing patient data at the bedside?

##### Criteria

Use of wireless computers will be evaluated based on relative cost, efficiency of use for clinical staff, and ease of maintenance and support. Fixed workstations will be compared to mobile ones for the research.

Benefits that will be examined will include the flexibility of being able to move the computer wherever needed, less wiring costs due to using wireless Ethernet technology, which allows for fewer wiring data jacks hooked to antennae in ceilings.

One assumption is that the benefits of an electronic medical record outweigh a paper record. An assumption will also be made that there will need to be a significant difference in price or benefits in order to consider the wireless computer method superior to fixed workstations at the bedside.

## **Data Collection**

### Data Collection Procedures

Research will involve surveying at least twenty hospitals that have used wireless computers in patient care units. The survey will ask each site to give some general information about their role with wireless, the cost and type of computers they use, and how they determined their costs, benefits, and limitations. They will also be asked about their organization's use of fixed bedside workstations.

### Analytical Tools and Tests

The survey results will be compiled for a simple set of tabular results that will be averaged and analyzed.

## **Conclusion**

The conclusion should yield data indicating whether or not organizations should pursue wireless bedside computing. Ideally organizations will have enough convincing evidence to know that wireless bedside computing is indeed a necessity that yields better care for the patient and will reduce costs of care. If mobile computing can be less expensive than fixed devices, then mobile computing options should be pursued.

**CHAPTER 4**  
**RESULTS AND ANALYSIS**

**Findings**

In order to find people with experience in wireless mobile computing experience, three main sources were used: the HIMSS (Health Information Management Systems Society) email list server and printed membership listing, a nursing focused AMIA (American Medical Informatics Association) email list server, and LINX (Lastword IDX user group) list server. In addition to these list servers, the author was also able to contact some sites through normal telephone directory searches after having read articles or heard about their site having experience with the technology. Emails went out to the list servers asking who has had experiences with mobile wireless computing. A total of 57 people responded to the survey. Of the 57, 39 had some experience with wireless and therefore are included in this evaluation.

First, the participant's demographics will be described and then the details about their experiences will be described, including general questions from the survey, technology aspects, and performance results from the sites.

Figure 3. States Represented.

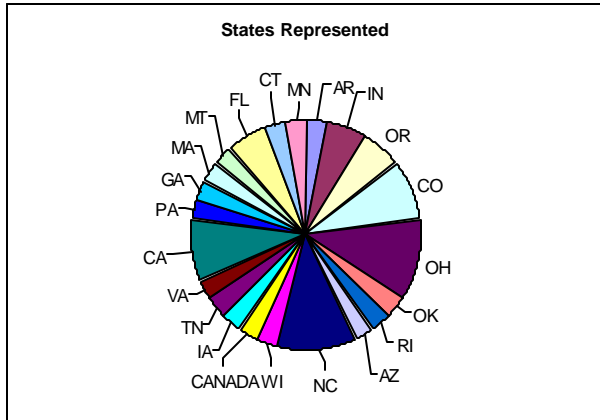
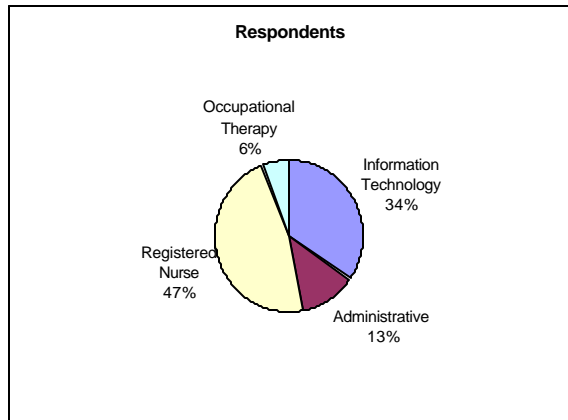
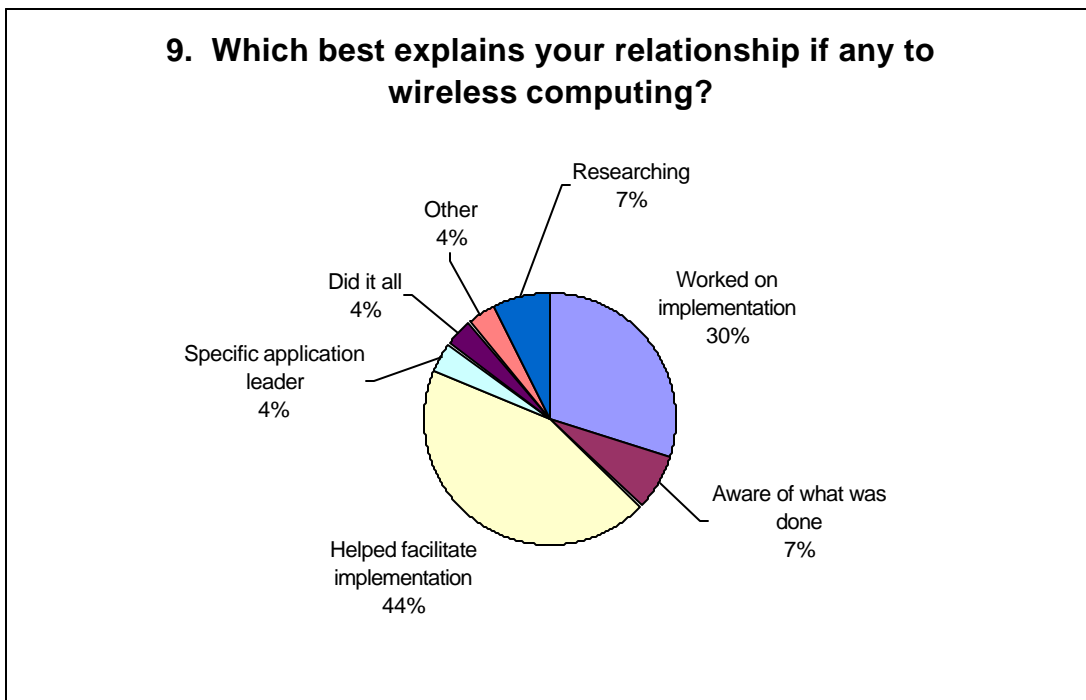


Figure 4. Respondents.



The demographics of the participants show a cross section of respondents from across the United States (Figure 3). Individuals in 21 states plus Canada responded to the survey. Participants consisted of 47% registered nurses, 34% in information technology, 13% in administrative positions, and 6% in occupational therapy (Figure 4).

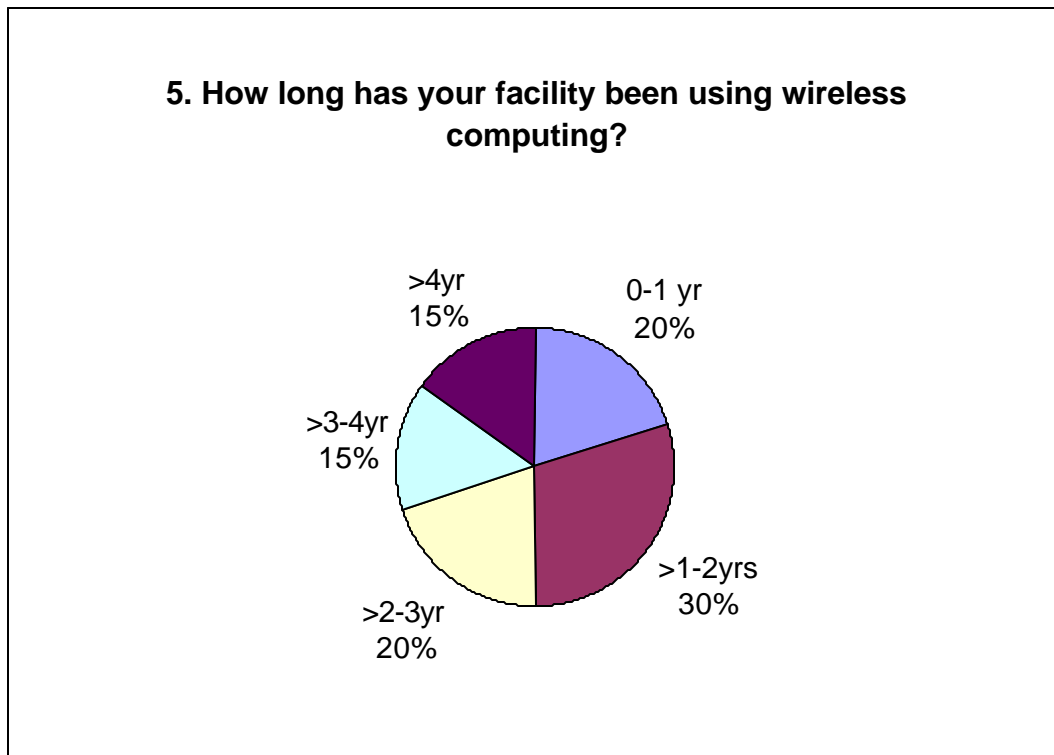
Figure 5. Respondent's relationship to wireless computing.



The survey also included questions to determine just how involved the respondent was in the wireless implementation and use of wireless. Question 9 asked for this and the results show that 44% either helped out facilitating the implementation and 30% were actively working on the implementation (Figure 5). This should put more weight on the accuracy of the information gathered because most respondents were directly involved in wireless activities.

The results revealed that half of the respondents are currently using wireless and half are not. Of the half that is not, 93% said they were planning on using the technology.

Figure 6. How long facilities have been using wireless.

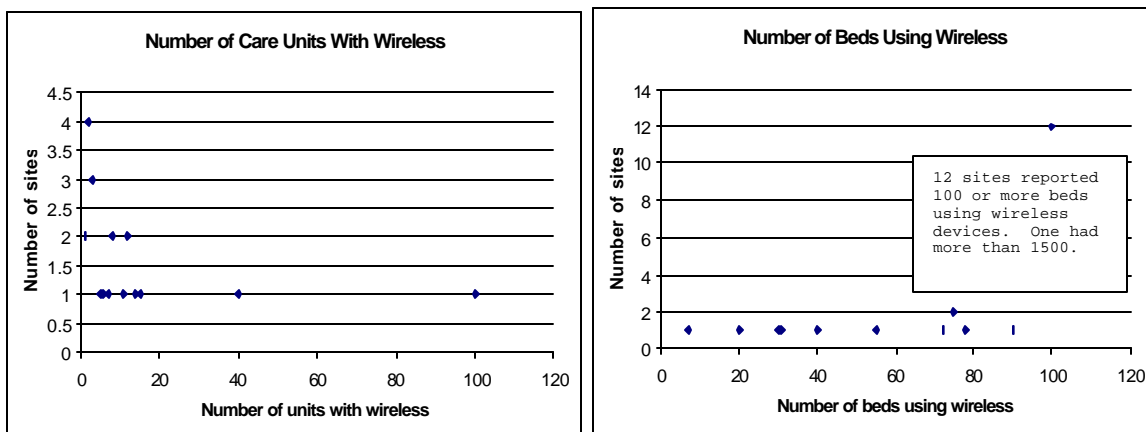


The survey also questioned how long people have used wireless technology. The expectation was that since this was relatively new technology not many respondents would have used it for several years. The results, shown in Figure 6, show that about half have been using

the technology for two years or less and the other half have been using it for more than two. Three sites had actually been using some form of wireless for more than four years.

Questions 7, 8, and 13 attempted to gauge how many wireless devices exist compared to fixed computers at the bedside. From examining the results, it is clear that there is a wide range of numbers of users of wireless technology for patient care from just a few beds receiving care from the devices to several hundred. As shown in the XY scatter graphs below (Figure 7 and 8) that there are not many care units using wireless in each facility but there are many beds affected/benefited by mobile wireless computing. Most of the sites had fewer than 20 units with wireless.

Figure 7. Number of care units with wireless. Figure 8. Number of beds using wireless.

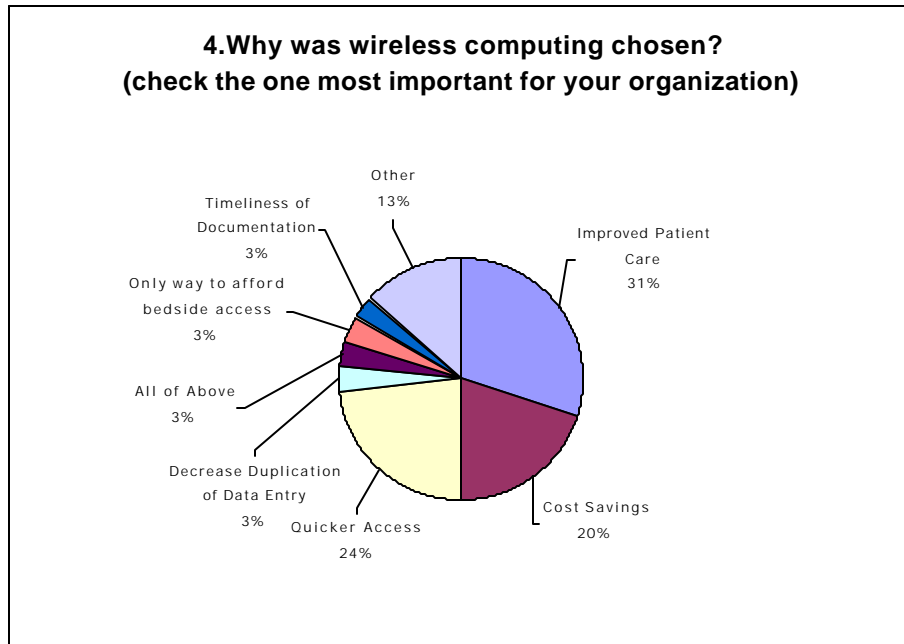


wireless but the number of beds varied greatly from less than 20 beds all the way to 12 sites reporting having more than 100 beds equipped with wireless devices.

Question 4 targeted reasons why people chose to use wireless technology. Results show that 31% of the organizations are using wireless to improve patient care, followed by 24% for quicker access to information and 20% for cost savings. Other reasons include the timeliness of information and decrease in duplication of data. These reasons also may indirectly save on costs (Figure 9). One site, Immanuel St. Joseph’s Hospital in Mankato, Minnesota said, “It’s the only

way we could afford bedside access. It would simply cost too much to put a computer at each bedside” (E. A. Weydt, personal communication, January 2001).

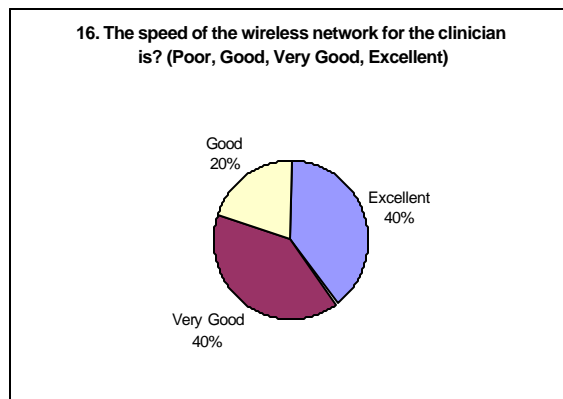
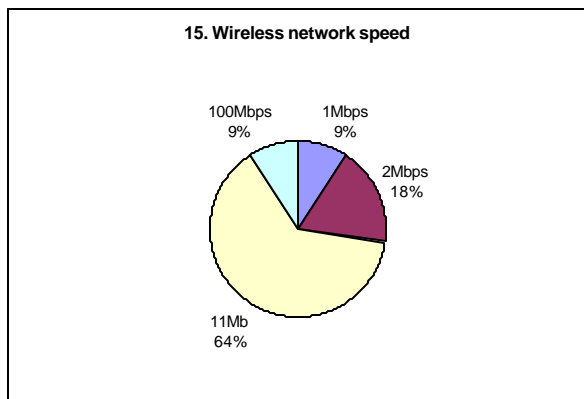
Figure 9. Why wireless was chosen.



Question number 6 asked if the site was using the wireless technology specifically at the bedside. The results show that 78% are. This supports the literature that wireless computing is well suited for bedside charting and review and that is what most facilities are using wireless for.

Figure 10. Wireless network speed.

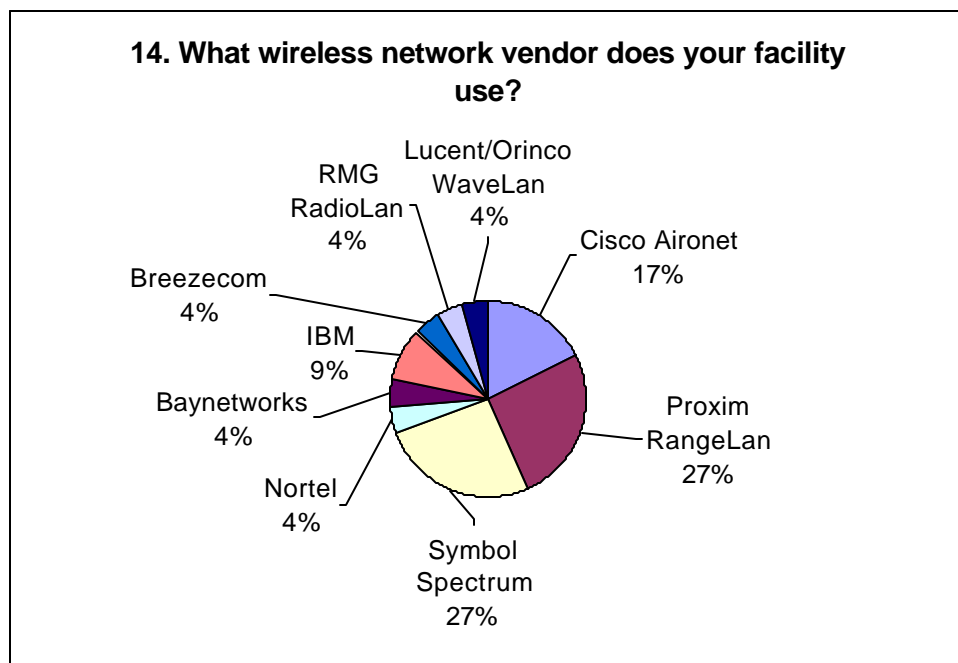
Figure 11. Performance of wireless network.



Results of more technical nature show most sites were running wireless mobile devices at speeds of 11Mbps with over 64% stating this as the speed. Sites using older technology able to transmit slower speeds of 2Mbps and less comprised 27% of the results (Figure 10). Surprisingly, even though 27% of respondent systems run at less than half the speed of the majority's faster systems, all respondents said the speed was at least good. No one rated system speed as fair or poor. A surprising 40% of respondents rated system speed as excellent, including several whose systems run at 2Mbps (Figure 11). Depending on the application being run the slower speeds may be acceptable as long as there is not much data needing to be transferred at one time [Note 100Mbps represents wireless transmissions from one building to another, not for mobile devices].

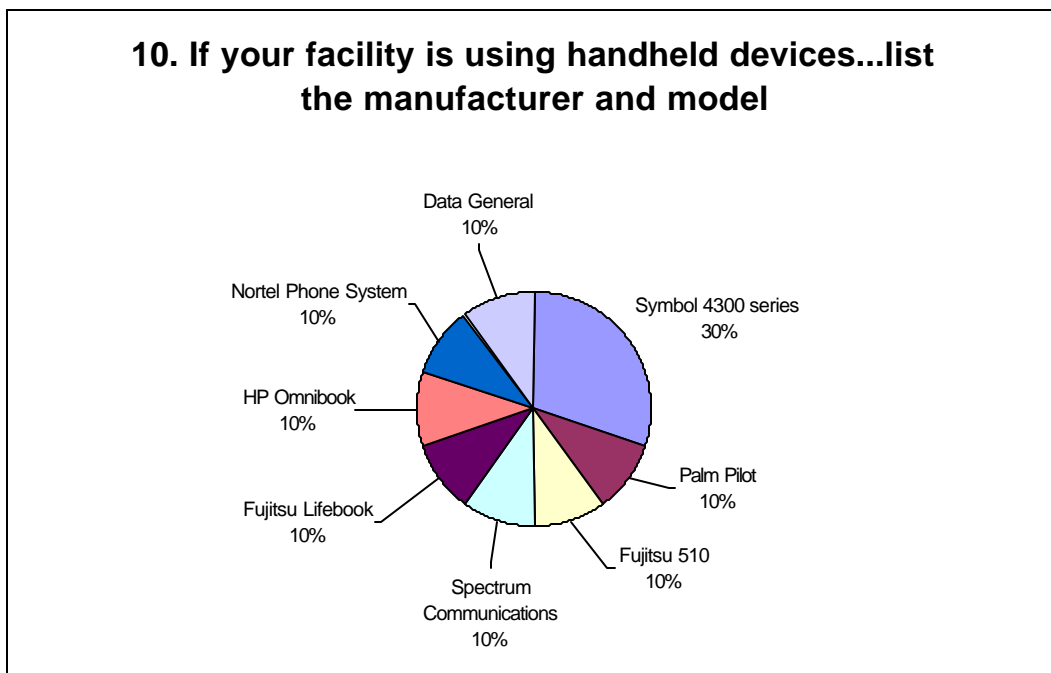
Vendors of wireless networking hardware and software varied. Figure 12 illustrates that there were three primary vendors used, plus a handful of others. Symbol, Proxim, and Cisco appear to have good market shares with 27%, 27%, and 17% shares respectively.

Figure 12. Wireless network vendors.



The remaining vendors however still comprise 20% of the remaining sites network vendors. Three different questions sought information about what hardware is being used for wireless applications: what manufacturer and model are used for handheld devices; what manufacturer and model if laptops are used; and, what manufacturer and model of any hybrid devices. The survey asked about the cost and quantity of the devices as well but didn't get enough responses worth summarizing. The responses were quite varied. Handheld devices came from Symbol, Palm, Fujitsu, Spectrum, HP Omnibook, Nortel, and Data General according to the respondents (Figure 13). Symbol was mentioned more than the others, but most of the others were only mentioned once.

Figure 13. Vendors for handheld devices.



When sites listed their laptop manufacturers, again none of the vendors stood out from each other as being the best for wireless applications. Since a wireless card that fits in most any laptop is all that is needed, it was not surprising to see a variety of manufacturers including Dell, Gateway, Toshiba, and IBM Thinkpads being used in wireless sites.

Hybrid devices (devices that were not exactly handheld and not laptops) were listed from Fujitsu, ScanTouch, and Wyse. The Fujitsu was listed as a handheld; therefore the definition of a hybrid device may not have been clear to the participants.

Battery performance was cited in the literature search as one of the major hassles with wireless devices. The survey results appeared to indicate otherwise. Surprisingly, 74% said that battery performance was adequate. There were a few comments regarding the subject. One participant from Montana noted that educating the users to regularly recharge the devices was a never-ending battle. Another confidential survey respondent stated it this way, “You can tell them a million times to keep the laptop plugged in when not in use and they still forget.”

Speed was not a factor. Answers to question 16 indicated surprisingly that 80% of respondents using wireless with speeds of 1Mbps to 11Mbps found the performance to be very good or excellent. The remaining 20% still said the performance was good. It may be that either the applications being used are not very demanding of the transmission speed or for many, the speed simply does not impact performance for clinical users (Figure 11).

One of the most interesting results more specific to the research question was in regard to cost justification of the wireless technologies. 50% of respondents said they had to cost justify and 50% said they did not. Of the 50% that said they did, one said they could not justify wireless, therefore they did not implement yet. That site was going to do more workflow analysis and time studies to see if they could find a way to justify the technology in other ways. Another respondent said that if an organization includes all the costs of a dedicated system with the mounting of the hardware and all the network costs, it would be cost prohibitive and that is how they were able to justify the costs. Bill Bollig from Martin Memorial Healthsystem in Stuart, Florida commented in this research survey, “Our justification was in five areas:

information accuracy, patient care, patient satisfaction, nursing satisfaction, and timesavings. I don't believe it can be justified by only one type benefit.”

### **Implication for the Research Question**

The survey results show that one can justify wireless but not much differently from fixed workstations at each bedside. Most of the benefits are going to come from having access to a computerized medical record for patient care. These same benefits would be present with a fixed computer at each bedside. The main cost savings item revealed in the survey is that organizations did not deploy as many computers when using wireless. Depending on the cost of the devices and network costs of wireless, this should have been a savings as compared to fixed workstations, but it could not be unequivocally ascertained from the data collected. Rather, it was communicated in question 4 as one reason why the organization chose wireless computing.

## **CHAPTER 5**

### **CONCLUSION**

#### **Recommendations**

Many healthcare organizations, surprisingly, do not have to justify their wireless efforts – at least not in terms of wired costs versus wireless. Organizations have been able to show the complete benefits of wireless or an electronic medical record and sell the solution to administrators.

The question was, “Are wireless computers on carts a cost-effective alternative to fixed bedside computers for documenting patient care?” From the literature and surveys the answer becomes a resounding, “Yes, but not always” and “It depends upon many factors such as the number of caregivers, number of beds, etc.”

Among the key reasons why wireless computing may be more cost effective is first that it can be much faster to deploy the devices. If a patient room has to be blocked for installation of a fixed system, it may take weeks or months before a fixed computing device can be installed in a patient room.

Second, there can be fewer workstations. If the number of care providers needing access to the system on a given patient care unit is less than the number of patient rooms, then there may be savings from deploying wireless simply because there would be fewer workstations to deploy.

Another reason that is more difficult to assign dollar savings to is the flexibility of wireless computing. Because a wireless workstation can be anywhere anytime, savings occur when a provider can carry or wheel a device from room to room without logging on and off and review a patient's chart or document as needed. There is no delay in trying to locate a computer or wait until someone else is done charting.

Better use of space was another potential cost saving reason for wireless. With rising healthcare costs and smaller areas in which to work, wireless offers another benefit of not having to try and find a place to mount a computer on a wall or table.

In order to assess the costs of wireless mobile computing for bedside charting and review, an organization should analyze each care unit. If an organization were to choose either fixed or wireless computers for a patient care unit, it would be prudent to do the following:

- Examine the costs of fixed workstations and all of the indirect costs including getting cables pulled and power to each room as well as the cost of mounting fixtures to secure the computer in the room such as a movable arm.
- Assign a cost if the organization has to block a room and not allow a patient in while the installations are being done.
- Compare fixed bedside computers with the costs of wireless devices including the access points for the antennas and routers cable pulls for the network and power to each router. Include any additional parts needed to be kept on hand in case a device breaks down (batteries, additional devices, wireless network cards if using laptops, mice, keyboards, battery chargers, etc.).
- Include the cost of carts because they can be surprisingly expensive depending on the configuration, battery setup, etc. Computer carts come in all shapes and sizes each with its

own benefits and limitations. Try several for each area to survey and pilot and expect to have to support many flavors.

- Determine the number of caregivers needing access to a computer at any one point in time and compare that to the number of beds. If the organization has more providers needing access than the number of beds, the organization can probably figure that it will be just as expensive to use wireless as it will to put a fixed computer at each bedside.
- Plan for multiple devices. Don't assume devices for one area or one patient care unit or one specific user group will work well for everyone. The consensus appears to be that to do the best job of analysis, an organization really should survey each area separately. This may cause greater challenges for an organization that may wish to standardize devices. It may be necessary to have a choice for each area from a selected set of few that have been proven to be compatible and supportable. Giving caregivers choices might also make them more receptive to document and view electronically.

Palm-sized computers are very popular today. From the survey, it appears not many sites are using them for bedside documentation and review. It may be that organizations' electronic patient record systems have not yet been adapted yet for such devices. It could also be that applications have too much information to display at one time for a caregiver and therefore it is more difficult to give the provider what they need on such a small screen.

There is much growth in hand-held or palm-sized devices, and many people discussing the issue on email list servers are talking about the wealth of applications for caregivers. In the future many different applications will be able to port some pieces of their applications for portions of the available data. These small devices are not likely to work for a whole electronic

patient record view but certainly are viable for many more quick reference pieces of information such as laboratory entry and review and/or medication administration.

An area very similar to palm-sized computers that is gaining more acceptance is the tablet-sized computer. Fujitsu and Symbol, for example, are becoming very popular because within each device weighing less than six and often under four pounds is a full functioning mobile computer. Devices like this cannot only be held and used, but can also be equipped to mount on a cart and/or pop into a docking station when a user wants to do more keyboard entry of a clinical note or similar information. Organizations should look seriously into this area of devices if they have many existing applications and do not want to have to redesign their applications to fit on a smaller device's screen.

### **Implementation**

The implementation, just like the selection of wireless devices, is a challenging process. Because an organization is introducing new hardware and software at the same time, there will most likely be issues that were not expected. Organizations should expect to find many process issues in implementations that were not planned for. It is important to do an evaluation and pilot with select users before everyone takes a device into their daily workflow. Plan ahead of time for the following procedures:

- Document and train users where to find a device.
- Establish procedures for when and how to recharge the devices.
- Assign someone to regularly examine the devices for wear and tear and plan to have extras available as backup systems in case a device breaks down.
- Do a thorough audit and scan of the physical area to be sure all areas have coverage and are accessible using each device to ensure no loss of data.

- Develop a hardware support structure so that the devices are maintained properly and are not lost or stolen.
- Study the areas expected to benefit from the project and develop metrics to compare before and after the implementation. Administrators may want to see proof that the costs are outweighed by the benefits.
- Brainstorm other similar functions and plan for how to handle each of these scenarios.

Many healthcare organizations surprisingly do not have to justify their wireless efforts – at least not in terms of costs. Organizations are able to show the complete benefits of wireless and sell the idea to administrators.

The question was, “Are wireless computers on carts a cost-effective alternative to fixed bedside computers for documenting patient care?” This researcher concludes that the answer is, “yes”. It is not a simple “hands down” yes, but with the proper research and considerations noted in this research an organization can benefit from the technology.

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**APPENDICES**  
**A SURVEY FORM**

The screenshot shows a Microsoft Internet Explorer browser window with the title bar 'Mobile Wireless Computing Survey2 - Microsoft Internet Explorer'. The address bar contains 'http://www.geocities.com/lhpakrat/mobilesurvey.htm'. The main content area features a large heading 'Wireless Computing At The Bedside' followed by a horizontal line. Below the line is a paragraph of text: 'My name is Andrew Galbus. I am a lead analyst programmer working with clinical computer applications in Rochester, MN. I am also pursuing my master's degree in Business Administration at Cardinal Stritch University. For my thesis research I am investigating wireless computing *at the bedside*.' This is followed by another horizontal line and a request: 'Please answer the following questions based upon your facility's experience with mobile wireless computing.' Below this is another horizontal line and a section header 'Demographics Information' in green. The form includes three text input fields: 'Your Name:', 'Email address:', and 'Healthcare Facility/Organization Name:'. A question '1. Are you a(n):' is followed by six radio button options: 'RN Registered Nurse', 'RT Registered Therapist', 'MD Medical Doctor', 'IT Information Technology Professional', 'Administrator/Hospital Management', and 'PT Physical Therapist'. There is also an option for 'Other (indicate below)'. At the bottom of the form is a 'Comments:' label and a large text area with a vertical scrollbar. The browser's status bar at the bottom shows 'Done' and 'Internet'.

Mobile Wireless Computing Survey2 - Microsoft Internet Explorer

File Edit View Favorites Tools Help Address <http://www.geocities.com/lhpakrat/mobilesurvey.htm> Go

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## Wireless Computing At The Bedside

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My name is Andrew Galbus. I am a lead analyst programmer working with clinical computer applications in Rochester, MN. I am also pursuing my master's degree in Business Administration at Cardinal Stritch University. For my thesis research I am investigating wireless computing *at the bedside*.

---

Please answer the following questions based upon your facility's experience with mobile wireless computing.

---

### Demographics Information

Your Name:

Email address:

Healthcare Facility/Organization Name:

1. Are you a(n):

RN Registered Nurse                       RT Registered Therapist

MD Medical Doctor                               IT Information Technology Professional

Administrator/Hospital Management               PT Physical Therapist

Other (indicate below)

Comments:

Done                      Internet

Mobile Wireless Computing Survey2 - Microsoft Internet Explorer

File Edit View Favorites Tools Help Address <http://www.geocities.com/lhpakrat/mobilesurvey.htm> Go

## General Questions

2. Does your healthcare facility currently use wireless devices for viewing and/or documenting patient care?  
 Yes (go to question 4)  No

Comments:

3. If not, are you investigating such an endeavor?  
 Yes  No

Comments:

4. Why was wireless computing chosen? (check the one most important for your organization):  
 Cost savings  
 Improved patient care  
 Quicker access to information  
 Other (comment below)

Comments:

5. How long has your facility been using wireless computing? :  
\_\_\_\_\_ years | \_\_\_\_\_ months

6. Are wireless devices used for *bedside* charting or reviewing?  
 Yes  No

Done Internet

Mobile Wireless Computing Survey2 - Microsoft Internet Explorer

File Edit View Favorites Tools Help Address <http://www.geocities.com/lhpakrat/mobilesurvey.htm> Go

6. Are wireless devices used for *bedside* charting or reviewing?

Yes  No

Comments:

7. If yes, for how many nursing units?  and for how many total patient beds?

8. How many people might need access to a wireless device at the time same?

Comments:

9. Which best explains your relationship if any to wireless computing:

Assisted with the implementation  Am aware of what took place at our site  
 Helped facilitate the implementation of wireless  Other (comment below)

Comments:

---

### Technical Questions

10. If your facility is using **handheld devices** connected to a network via wireless technology  
Please list the **manufacturer** and **model** of these devices:

Done Internet

Mobile Wireless Computing Survey2 - Microsoft Internet Explorer  
Address http://www.geocities.com/lhpakrat/mobilesurvey.htm

---

## Technical Questions

10. If your facility is using **handheld devices** connected to a network via wireless technology  
Please list the **manufacturer** and **model** of these devices:   
Please tell me the approximate cost of **each** device: \$   
About how many did you purchase?: \$

11. If your facility is using **laptop computers** connected to a network via wireless technology  
Please list the **manufacturer** and **model** of the laptops:   
Please tell me the approximate cost of **each** device:   
About how many did you purchase?:

12. If your facility is using a **hybrid device** (not a fully compatible PC)  
Please list the **manufacturer** and **model** of the hybrid devices:   
Please tell me the approximate cost of **each** device:   
About how many did you purchase?:

13. If you have fixed computers at the bedside in any nursing units:  
How many nursing units have them?   
How many patient beds have them?

14. What wireless network vendor does your facility use?  
 Proxim  
 Aironet  
 BreezeCOM  
 Symbol  
 Other (list below please)

Done Internet

