Wireless and Mobile Computing

ihealthreports

Acknowledgments

The **California HealthCare Foundation,** a private philanthropy based in Oakland, California, focuses on critical issues confronting a changing health care marketplace by supporting innovative research, developing model programs, and initiating meaningful policy recommendations.

The iHealth Reports series focuses on emerging technology trends and applications and related policy and regulatory developments.

Additional copies of this report and other publications in the iHealth Report series can be obtained by calling the California HealthCare Foundation's publications line at 1-888-430-2423 or visiting us online at **www.chcf.org**.

Contents

Overview

MOBILE COMPUTING IS BECOMING AN IMPORTANT part of health care's information technology (IT) toolbox. Technology advances and the proliferating health care applications indicate that mobile computing will find a secure place in both inpatient and outpatient care. It is not too early for organizations to investigate the benefits it can offer and how it would fit in with current information systems, workflow, and care practices.

Mobile computing is not a single technology, but a combination of three components (handheld computing device, connecting technology, and a centralized information system), each with different performance considerations, costs, and risks. Successful implementation of mobile computing requires employing all of these components in the way that best suits the work and environment of the end users.

The major benefit of mobile computing—connecting caregivers to clinical data and applications anywhere and anytime—is increasingly attractive in a health care environment where physicians work longer hours and see more patients. They are looking for a more efficient means to enter and retrieve data; they cannot afford the time required to locate an available desktop, log in, and then enter information into a system. On the nursing side, with a severe shortage of personnel, technology at the point of care can increase nurses' efficiency. Furthermore, new regulatory pressures for comprehensive clinical documentation point to the value of data recording and retrieval that is portable, accurate, easy to use, and reasonably priced.

Newer mobile computing applications not only provide clinicians with access to medical reference tools but also handle patient care and administrative tasks such as basic charge capture, prescription writing, clinical documentation, alert messaging, and general communications. Additionally, vendors of hospital information systems (HIS) are using wireless technology and teaming up with mobile computing vendors to provide portable solutions for their systems.

Further advancement of the technology is needed to address connectivity, performance, security, integration, and cost issues for more integrated applications. However, the rapid rate of development and maturity for wireless technology, combined with the appearance and promise of more powerful handheld devices, is expected to spur application development to create solutions that support the work of health care professionals in both inpatient and outpatient settings.

There are risks of implementing emerging technologies: Vendors and products are immature, with a limited record of success; mobile computing functionality does not currently compare with traditional systems; and integrating mobile computing applications with current systems is risky and expensive. Like any technology, mobile computing implementation requires careful planning, user involvement, executive sponsorship, and commitment from the organization.

Pioneering organizations are providing valuable lessons on how to successfully introduce mobile computing into the work setting to improve care delivery and workflow efficiency. Common themes from these organizations include:

■ Start with the business problem. What can mobile computing do that traditional applications cannot?

■ Set realistic expectations by understanding technology capabilities and limitations, costs, and risks. Because the applications are immature and many vendors are new to the market, factor additional time and resources into the decision-making and implementation phases.

■ Learn from the experiences of others; review case studies and take lessons from their successes and failures. Be aware that the technology changes may be easier to integrate than the work process and role changes.

■ Pilot the application. Mobile computing lends itself to pilot projects because there are low front-end expenditures for the devices and applications, and many can be piloted with simple interfacing requirements. Start small and build on successes.

Mobile computing and wireless technology solutions have entered the health care industry and are beginning to prove their worth to providers and hospitals, as well as patients. Understanding the technology and how it is used in health care are the subjects of a series of timely reports written by First Consulting Group and published by the California HealthCare Foundation. In addition to this primer, the upcoming series includes:

■ E-encounters

■ E-disease Management

■ E-prescribing

■ Diffusion

These reports, as well as other reports in the iHealth Report series, can be obtained by calling the publications line at 1-888-430-2423 or visiting our Web site at www.chcf.org.

Purpose

THIS REPORT IS INTENDED TO SERVE AS A GUIDE for health care clinicians and administrators who want to understand mobile computing and wireless technology concepts in health care. Geared toward non-technical readers, it provides a snapshot of the current marketplace with a view toward future developments. More technical information on capabilities, issues, connectivity, and coming developments are included in the appendices and referenced in the text for those interested in more detail. A vendor list and a basic glossary are also included. The following is an outline of the major areas of this report.

I. What Is Mobile Computing?

This chapter begins with a description of the basic components of mobile computing and how they work together to provide the portability that caregivers need. Following the description is a high level overview of the three ways data is transferred from the handheld to the patient care information system—data synchronization, wireless LANs, and the Internet. Information on the mobile devices, technology issues, best-fit scenarios, and future trends is included to give a full understanding of the components of mobile computing.

2. Applications: What Mobile Computing Does

Building on the understanding of the technology, this next chapter provides an overview of the major application products for both inpatient and outpatient settings. Characteristics of the current marketplace, including acceptance, barriers, trends, and future directions are addressed.

3. Implementation Considerations: Benefits, Issues, Risks, and Tactics

The third section provides some insights into how to address decisions on selecting and implementing mobile computing in health care. Understanding the problem, expected benefits, technology considerations, HIPAA compliance, and the impact on internal processes are factors that organizations weigh when considering mobile computing. Finally, lessons learned from early mobile computing implementations will help today's adopters set realistic expectations and glean value from this new technology.

I. What Is Mobile Computing?

Most mobile computing applications today in health care do not interact at all with the Internet.

RECENTLY THE TRADE AND POPULAR PRESS HAS been full of cover stories touting mobile computing and wireless technology as the linkage solution for personal communication and business transactions. Given all of the excitement about mobile computing and the frequent association with the Internet, it is not surprising that there are a number of misconceptions about what wireless is and does. Recent items in the press indicating widespread adoption of wireless include:

■ The number of wireless Internet users will reach 83 million by the end of 2005, or 39 percent of total Internet users.[1]

■ By the end of 2004 there will be 95 million browser-enabled cellular phones and more than 13 million Web-enabled personal digital assistants (PDAs).[2]

■ The wireless LAN market is expected to reach $1 billion in 2001; this figure will double by 2004.[3]

In fact, these items refer to different technologies. The first refers to the wireless Internet; the second is about Internet-ready devices, and the last refers to wireless LAN. All of these technologies will be discussed in this report.

Probably the most common misconception is that *wireless* means the Internet. Actually, wireless refers to the underlying technology that supports the transport of data between the mobile handheld computing device and the main computer system without a wired connection between them. The *Internet* is a global network that provides access to information and applications using a browser or Web navigating application. Most mobile computing applications today in health care do not interact at all with the Internet.

To unravel these misconceptions and understand what mobile computing *can* offer, it is important to recognize that mobile computing is not one technology. It is a range of solutions that enable user mobility by providing access to data anytime, from any location. For health care managers and caregivers, a high level understanding of wireless technology and mobile computing options is fundamental to sound decision-making on whether and in what ways to use them.

Figure 1. Mobile Computing Components
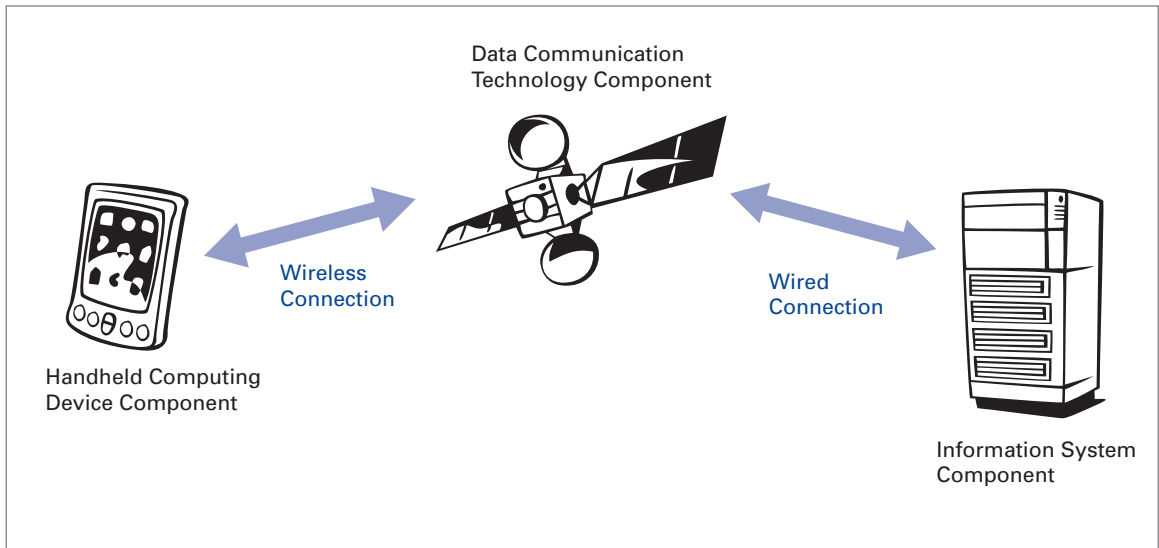
As shown in Figure 1, mobile computing has three components:

1. Handheld, mobile computing device
2. Connecting technology that allows information to pass back and forth between the site's centralized information system and the handheld device and back
3. Centralized information system

Here is how mobile computing works:

- The user enters or accesses data (such as vital signs, charge information, clinical notes, or medication orders) using the application on the handheld computing device.

- Using one of several connecting technologies, the new data are transmitted from the handheld to the site's information system where system files are updated and the new data are accessible to other system users, such as the billing department.

- Now both systems (the handheld and the site's computer) have the same information and are in sync.

The process works the same way starting from the other direction. For example, a physician may want to have access to all new laboratory results for today's clinic patients. This information is stored in the site's information system and now needs to be transmitted to the handheld device. Again, the connecting technology delivers the data to the handheld and the physician can roam around, accessing the appropriate information from the handheld device.

The process is similar to the way a worker's desktop PC accesses the organization's applications, except that the user's device is not physically connected to the organization's systems. The communication between the user's device and the site's information systems uses different methods for transferring and synchronizing data, some involving the use of radio frequency (RF) technology.

Three Data Transfer Options

In today's market, the three most commonly used wireless data transfer methods are:

1. Wireless local area network (Wireless LAN)

2. Wireless Internet or wireless Web

3. Data syncing or "hot syncing." This is not a wireless data transfer method, although it is often referenced as "wireless." Data syncing uses docking cradles or docking stations that are connected to a LAN to transfer data from the device to the organization's information system.

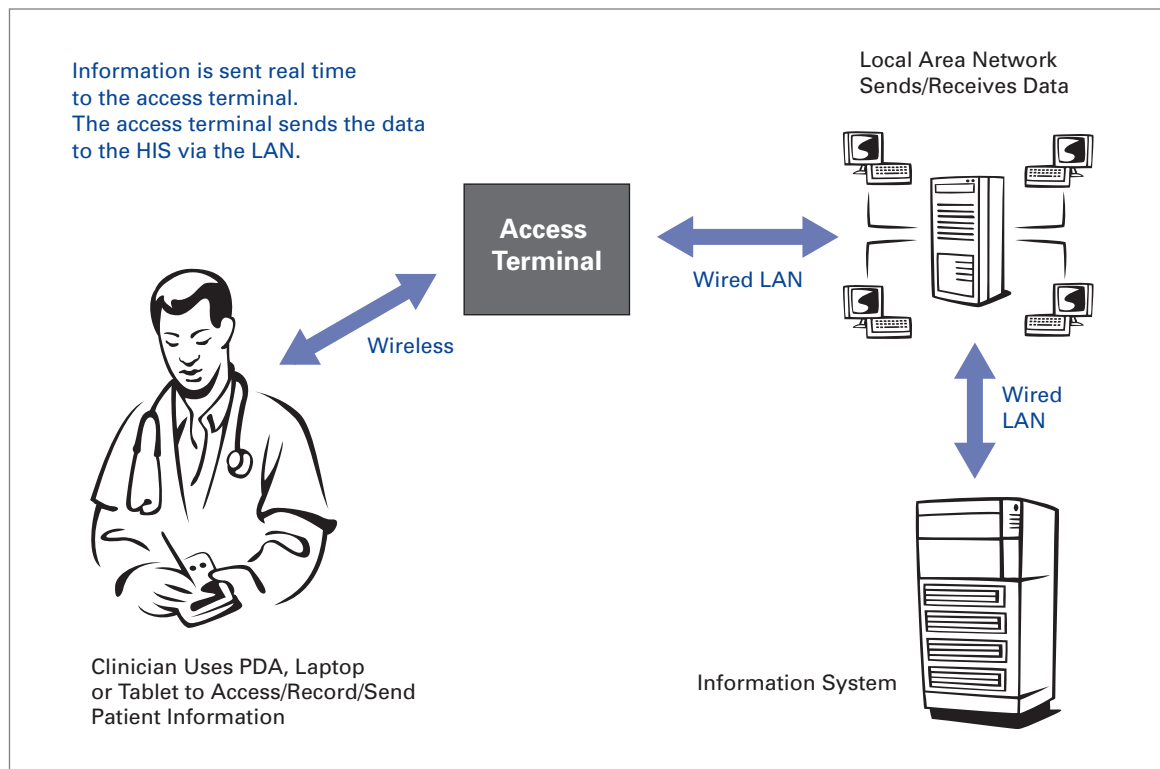(For a complete picture of the mobile computing landscape, refer to the diagram in Appendix A.)

Wireless LAN

Wireless LAN is a flexible data and communications system used in addition to, or instead of, a wired LAN. Using radio frequency (RF) technology, wireless LANs transmit and receive data over the air, minimizing the need for wired connections and enabling user mobility. Unlike some technologies such as infrared, wireless LAN is not a "line-of-sight" technology. Therefore the handheld device can operate anywhere within the coverage area.

In a wireless LAN, as shown in Figure 2, the caregiver enters data into a handheld device such as a personal digital assistant (PDA), laptop, or tablet (see Table 1 and Figure 5 for descriptions) that has a special wireless LAN card. This card has an antenna that transmits the data in real time using radio frequency technology to an access terminal, usually connected to a ceiling or wall. The access terminal is connected to the local area network and sends the data received—or requests for data—from the handheld to the patient care information system. Conversely, data from the site's information system can be sent to the handheld using the same technology.

Figure 2. Wireless LAN Diagram

Information is sent real time to the access terminal.
The access terminal sends the data to the HIS via the LAN.

Local Area Network Sends/Receives Data

Access Terminal

Wired LAN

Wireless

Wired LAN

Clinician Uses PDA, Laptop or Tablet to Access/Record/Send Patient Information

Information System

Currently wireless LANs work best in health care settings where (1) the area of mobility is confined to a campus or building; and (2) the need for up-to-date patient information is immediate.

If the caregiver is using a small handheld device like a PDA, the small screen size is suited to only limited data viewing and data collection functions such as lab order entry, single results display, and clinical notes entry. Laptops and tablets provide more processing capabilities, more data storage, and larger displays so users can access entire patient records and view results in a number of graphical formats. Ambulatory and inpatient medical record applications work very well in a wireless LAN environment with larger user devices. (See Table 1 and Figure 5 for more specifics about devices.)

Case in Point: The Children's Health Fund Mobile Clinics

Medical staff working from The Children's Health Fund mobile health van now have access to the organization's electronic medical record (EMR) system while traveling to homeless shelters and inner-city areas. The organization, which is affiliated with Montefiore Medical Center in the Bronx, did careful research before introducing (in January 2000) wireless LAN technology using handheld pen tablets for recording and displaying patient information. The tablets are equipped with wireless LAN card antennae to communicate with computers mounted in the van.

Unlike the old paper-based process, the tablets provide immediate access to patient information including medical concerns during previous visits and all the details from past interactions, regardless of the location. If a child shows up in one shelter at one time and then in another years later, the caregivers have all of the patient's information. And they can print out any information during the visit so patients can leave with printed prescriptions and instructions.[4]

Wireless Internet

Wireless Internet, also known as the wireless Web, provides mobile computing access to data using the Internet and specially equipped handheld devices as depicted in Figure 3.
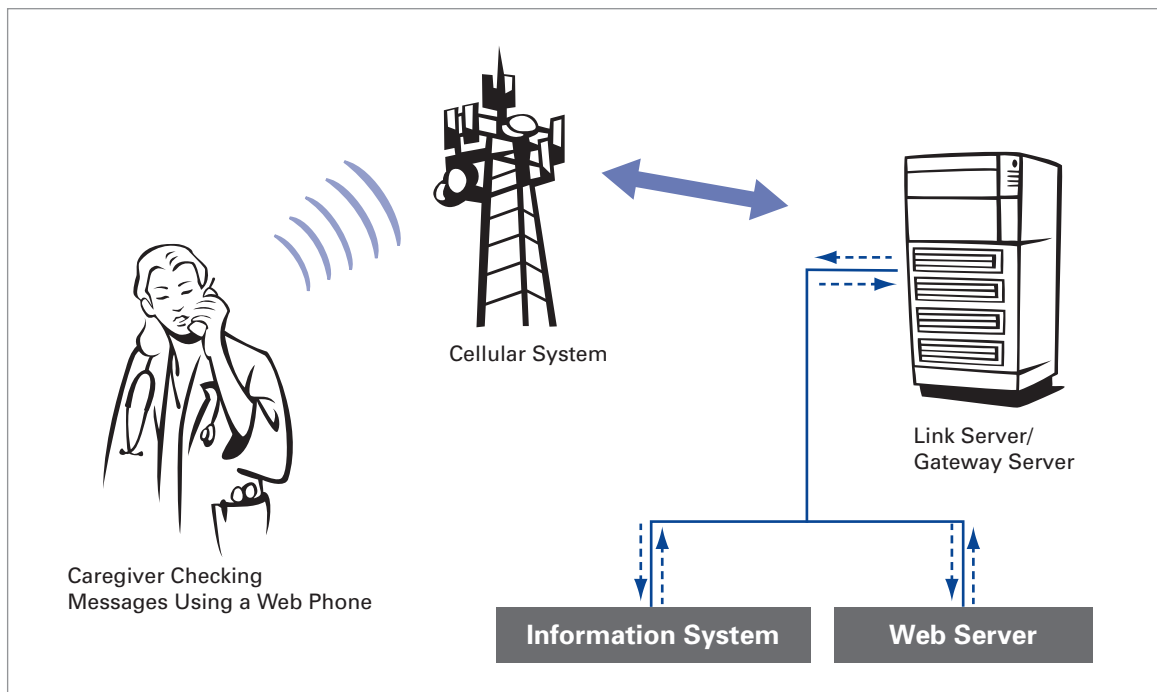
Using a Web phone or the latest PDA phone (see Figure 5) with a micro Web browser, the user can display data accessible from the Internet. Technically speaking, the mobile device connected to the cellular system sends the request to a computer link server. This server acts as a gateway that translates signals from the handheld device into language the Web can understand, using an access and communication protocol. One of the leading protocols is called WAP (Wireless Application Protocol). The server also forwards the request over the Internet to a Web site, such as Yahoo or AOL or the organization's site information system.

The Web site responds to the request and forwards the information back through the link server. Again the response is translated into a Wireless Markup Language (WML) so it is viewable on the small cell phone screen. This translated response is then sent to the cellular system and finally to the Web-enabled mobile computing device.

Examples of the current uses of wireless Internet include accessing short emails, quick look-up capabilities (stocks, weather, flights, directions, movies, restaurants), retail transactions, and alert messaging in health care.

Wireless Internet has not been widely used in health care at this point. Some pioneering sites are beginning to pilot solutions aimed only at reading emails, alert messaging, and viewing very limited patient data such as an admission notice. These users have found that wireless Internet works best in health care settings where (1) the access area for mobile users is wide, usually outside of traditional care delivery settings; and (2) the need for current information is immediate.

Figure 3. Wireless Internet Diagram

Cellular System

Caregiver Checking
Messages Using a Web Phone

Link Server/
Gateway Server

Information System

Web Server

Data synchronization

Data synchronization ("data syncing") provides many of the benefits of mobile computing without the cost of installing wireless LAN equipment or needing access to the Internet. Information is *periodically* downloaded from the hospital information system (HIS) to the handheld device and then uploaded from the device to the HIS. The major drawback of data synchronization is that it does not provide real-time access to data.

Data syncing is not a *wireless* data transfer method because data are transferred from the mobile computing device to the site's information system through a docking (or syncing) cradle wired to the LAN. It is commonly grouped under the general term of "wireless," because the user's device is physically attached to the LAN only during the batch data transfers.
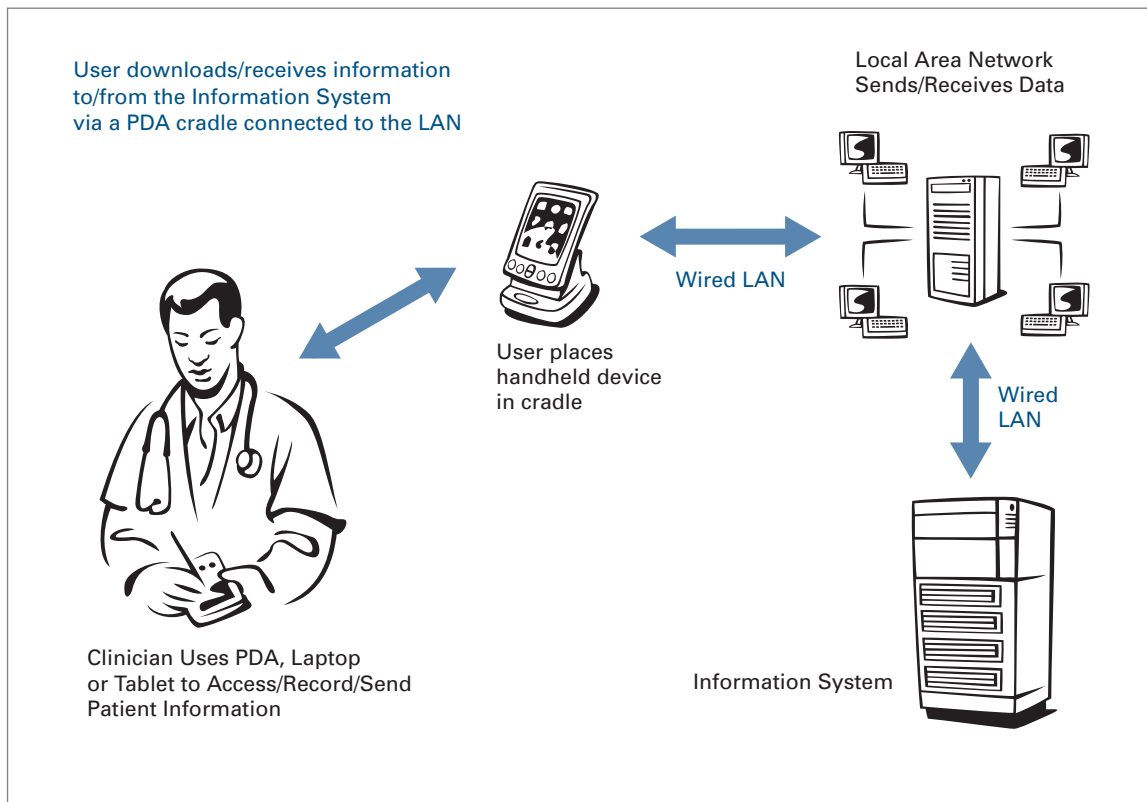
As an example to illustrate the process, consider a caregiver who uses a handheld device to record brief clinic notes.

■ The caregiver downloads the patient information for today's outpatient visits into the device by placing it in a docking cradle connected to the site's local area network (LAN), then pressing a "sync" button.

■ For each patient visit, the caregiver selects the correct patient name and enters the clinic notes into the handheld device.

■ At the end of the day, the caregiver uploads the notes into the HIS by again placing the device in the docking cradle and pressing the "sync" button.

This process and the supporting technology components are illustrated in Figure 4.

Data synchronization solutions have been used widely in health care and are typically the first use of wireless because of the low cost to implement and the wide range of applications that deliver real value to the organization. These include point-of-care charge entry, notes entry, ordering, prescribing, and formulary reference. Generally, data syncing solutions work best in health care settings where (1) mobile users have access to the LAN for periodic data updates; and (2) the work being performed does not require access to the most current information.

Figure 4. Data Synchronization Diagram

User downloads/receives information to/from the Information System via a PDA cradle connected to the LAN

Local Area Network Sends/Receives Data

Wired LAN

User places handheld device in cradle

Wired LAN

Clinician Uses PDA, Laptop or Tablet to Access/Record/Send Patient Information

Information System

Mobile Computing Devices

Some of the mobile computing devices have already been mentioned in order to describe the different wireless data transfer options. Following is a closer look at the range of products, functions, and uses in health care. Although there are many products on the market, handheld devices fall into several categories, each with specific capabilities and options. Because the handheld device is the link between the caregiver and the data, it is important to understand its functionality, limitations, and expected enhancements to set current expectations and plan for future growth.

Table 1 and Figure 5 provide high-level summary data on each device type. Current differentiating characteristics are in bold.

Several distinctions about devices and their uses in health care can be drawn:

■ Web phones and smart phones provide general-use functions but have not yet played a role in health care mobile computing applications.

■ PDAs and handheld PCs are the devices of choice for single-function applications, as well as browser-based applications when portability is critical. These applications run on either the Palm or Microsoft's Windows CE (now Pocket PC OS) operating system. While Palm OS is far more widely used for today's applications, it is designed for basic text storage and retrieval. Microsoft's operating system has more powerful processing capabilities and is easier to integrate with Microsoft's desktop applications. For more information on the two operating systems and when an organization needs to make a selection decision, please refer to Appendix B.

■ Tablets and laptops are capable of handling multiple integrated data functions with more complicated processing capabilities.

■ Future application development using the latest PDA phones could provide solutions that blend the best features of Web phones and PDA health care application functionality, but currently no commercial solutions are available.

Table 1. Comparison of Mobile Computing Devices

Device Type	Product Features	Health Care Application Support Examples
Web Phone: Cellular phone with Internet access	• Internet browser functions • Limited email, calendar, appointment scheduling, and directories	No health care specific applications but email and alert messaging
PDA Phone: Combination of a Web phone with PDA functionality	• Internet browser functions • Email, calendar, appointment scheduling, and directories	Single functions; e.g., charge entry, prescription writing plus Internet access
Personal Digital Assistant (PDA) or Pocket PC: Handheld computerized information organizer; examples include Palm Pilot, Handspring Visor, Compaq iPaq	• Email, calendar, appointment scheduling, and directories • Some desktop application functions; e.g., Word and Excel • Pen-based system for data entry • Bar coding	Single functions; one or more basic functions; e.g., charge capture, prescription writing, lab results. Multiple functions using browser technology with wireless LAN.
Handheld PC: Small hand size personal computer with a keyboard	• More powerful than a PDA device • Some desktop application functions; e.g., Word and Excel • Keyboard for data entry • Voice recognition and recording options • Bar coding	Single functions; one or more basic functions; e.g., charge capture, prescription writing, lab results. Multiple functions using browser technology with wireless LAN.
Tablet/Laptop: Tablet is a flat paneled PC; laptop is also known as PC notebook	• All desktop functionality • Tablets use pen or touch-screen technology	Multiple integrated functions; e.g., full Electronic Medical Record (EMR) capabilities.

Figure 5. Mobile Computing Devices

Laptop   Tablet   Handheld PC   PDA   PDA Phone   Two way Pager   Web Phone

Meets Most Requirements ← Meets Few Requirements

Processor Power
Screen Resolution
Ability to Support Business Application
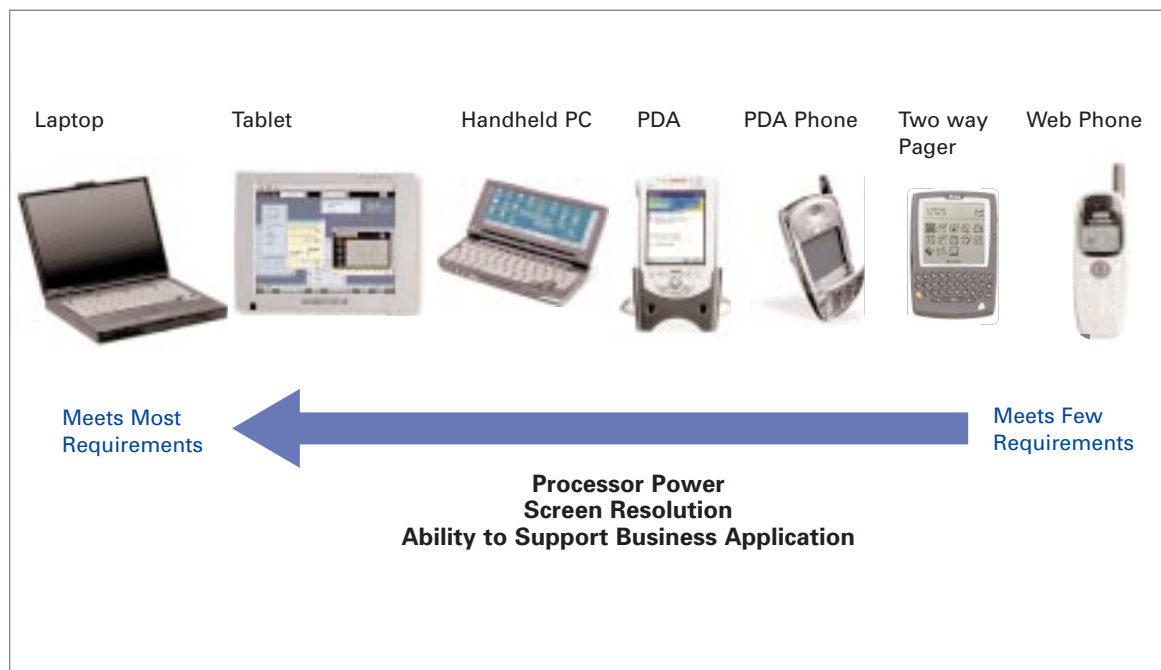
Current Technology Issues and Limitations

Although wireless technology is maturing rapidly, several limitations stand in the way of widespread adoption. Good decisions about technology need to be based on a realistic understanding of current performance and how limitations can be addressed.

Technology Selection Considerations

Three important technical aspects to consider when selecting a mobile computing application are:

1. Infrastructure requirements

2. Mobile computing device capabilities

3. Integration with existing systems

Infrastructure requirements

Data access and the area of mobility are the two infrastructure factors to consider. Real-time access to updated data can only be supported by wireless data transfer technologies; *near* real-time access can be accomplished through wired data synchronization using the LAN. The other important factor is the mobility range of the end user while using the application; depending on the technology used, the range can encompass one department, a single building, a campus, or the world.

Key questions to consider are:

1. What is the expectation for access to data? Real time? Near real time? Batch?

2. Is there an existing LAN or wireless LAN?

3. What connectivity protocols are used?

4. How good is the network coverage?

5. How fast is the transmission speed?

6. What support staff skills are needed?

Table 2. Current Technology Issues and Limitations

Technology	Current Issues and Limitations
Mobile Computing Devices	Handheld devices such as PDAs and Pocket PCs have small screens, short battery life, limited processing power, and rudimentary data integration capabilities.
	Laptops and tablets provide greater processing, battery life, and data viewing power, but are considerably larger and heavier, with limited data interfacing capabilities.
Wireless LANs	Data transfer speed (throughput) is currently slower than traditional LANs.
	Real time interfaces between mobile computing and LAN-based applications are custom developed for each site and therefore expensive to create and maintain.
	Use of wireless LANs with some medical equipment may cause electro-magnetic interference. (See page 27.)
Wireless Internet	Wireless Internet technology faces similar issues with data transfer speed and medical equipment interference.
	Additional problem of multiple connectivity standards.
Data Synchronization	Same device limitations as described above plus the need for application-specific cradles wired throughout the service area.
	Supports only batch data updates.

Mobile computing device capabilities

With mobile computing devices, the selection decisions are limited. In many cases, the vendor will have already made the device decision, with only a small range of customer-specific options. However, it is important for new users to understand what they are getting in terms of current and add-on capabilities. Two considerations are:

- **Expandability.** Most users do not want to carry several devices; i.e., one for charge entry, one for ordering, and one for notes. Can the handheld device support today's application needs as well as plans for the future?

- **Special features.** Having a color display or voice recognition capabilities may be very important for some caregivers but not others, depending on what they must use the device to accomplish. What are the special functions needed for the handheld to support the application and enhance ease of use? Is it available now? What are expected changes for next year?

Key questions to consider are:

1. What device(s) and operating system(s) does the application use?

2. What is the screen resolution of the device?

3. What are the general specifications for battery life, weight, processing power, and potential add-ons?

4. What is the capability of the handheld application itself? What is the future direction for development?

Integration with existing systems

The integration of a new application with the existing systems is always a challenge. Besides identifying the data, it is necessary to consider data formatting, coded data value, update capabilities, ownership, and access rights for all users in the process. Careful examination of the workflow, end-user data needs, and functionality of the systems will require technical resources (both vendor and IS) and process experts (both vendor and end user) to create a workable, effective solution.

Key questions to consider are:

1. Will the application integrate with legacy systems?

2. What data needs to be received, updated, and sent?

3. How does the system distribute and synchronize files?

4. How is data ownership established?

5. What methods are used to maintain data security?

See Appendix C for more information on the prevailing issues and technical considerations with each data transfer technology.

Future Directions for Wireless Technology

Over time the distinction between the wireless Internet and wireless LAN will blur as current limitations are overcome. Bringing access to both data and voice communication through the same technology—the industry calls this "convergence"—is the direction of the future. However, data synchronization solutions will remain in practice as a logical entry point for mobile computing and as a low-cost solution when immediate access to updated data is not required.

Devices are becoming much more robust and multi-functional. For example, voice has come to handhelds, including speech recognition applications. Other emerging device capabilities that may be useful include:

■ Video conferencing

■ Imaging

■ Voice browsers

■ Digital camera attachment

■ Language translators

■ Location based services; i.e., the ability to track location of user

Expect to see continued growth in wireless technology, device capabilities, and application development that takes advantage of both wireless Internet and wireless LAN.

In health care there will also be growth in the number of products and in their usage. Although serious mobile computing development with smart phones or PDA phones using the wireless Internet is unlikely in the near future, some in-house-developed niche functionality pilots will be testing the limits of the latest technology advances coupled with Internet access. On the commercial vendor side, the number and complexity of applications supported by handheld PCs, tablets, and PDAs using wireless LAN and data synchronization technologies will continue to increase. There will be significant growth in browser-based computing applications using wireless LAN technology because this solution meets the data access, response time, and data security requirements for health care providers.

II. Applications: What Mobile Computing Does

Seven Applications of Mobile Computing

Mobile computing applications for health care began with reference tools that allowed clinicians easy access to guidelines, medical literature, and drug information databases. Then came transaction-based systems, which automate specific clinical and business tasks. The next evolutionary step—currently underway—is to provide multiple integrated applications on a single device.

The other avenue of development is use of mobile computing as an extension of a hospital information system (HIS) or practice management system, with the mobile device providing both HIS access and specific functionality. For purposes of this report, the application descriptions are focused on mobile computing functionality, but examples and case studies highlight uses as both single-function applications and extensions of HIS solutions.

Given the immature application market and continually advancing technology components, today's most effective applications are those focused on tasks that require data access at the point of care but do not require sophisticated infrastructures to transfer data between the device and the organization's computer system. These include prescription writing, charge capture and coding, clinical documentation, and lab order entry and results viewing. (See Appendix D for representative vendors in each application category.) The versions currently on the market are discussed below.

Prescription writing

Using a PDA or pocket PC instead of a prescription pad, physicians generate prescriptions by clicking on the patient, medication, and dose. Many "e-prescribing" tools can also check prescriptions for drug interactions and potential allergic reactions and transmit completed prescriptions directly to the pharmacy. Products on the market today differ in almost every step of the process, from how patient data are obtained, to where processing occurs, to how scripts are sent to the pharmacy, making this a crowded and confusing vendor field. Advancements for e-prescribing tools are likely to develop rapidly as problems of integration with patient data and data transmission are overcome.

Some reported numbers on prescription writing:

- 22.2 percent of handheld devices being used today are used for prescriptions.[7]

- 4 percent to 7 percent of online physicians are electronically prescribing medications; 25 percent are interested in e-prescribing in the future.[8]

Charge capture and coding

These popular tools for both inpatient and outpatient care enable caregivers to record information at the point of care instead of after the fact. The handheld computing application replaces the antiquated index card system for recording charges. It includes coding tools for translating increasingly complex payer rules, especially in the ambulatory setting. These applications can have a positive financial impact by capturing more accurate and complete information about diagnoses, procedures, and other care-related services. In the future, charge and coding functions will likely be integrated with other clinical computing tools, thus capturing financial information as part of the automated care documentation process.

Lab order entry and results reporting

Most often found in the inpatient setting, these applications allow users to order lab tests and view results at the point of care. Most focus first on one aspect of the process and then move to the other. For example, one vendor decided to start with result-viewing because of the limited handheld processing and customization required, and then moved toward a total ordering and result viewing application. Lab order entry streamlines the ordering process; results reporting allows access to often-critical patient information anytime and anywhere. Because these functions require real-time interface with existing ordering and results systems, success has been limited to a few vendors who have either partnered with well-known traditional vendors or added integrating tools to their products. As the technology advances, allowing for better integration of applications, lab order entry, and results reporting tools will likely become common.

Clinical documentation

Litigation, accreditation, payment requirements, and regulatory compliance are increasing the need for clinical documentation systems. Tools with a wide range of functionality from basic notes templates on PDAs to images that can be displayed on a laptop help clinicians quickly document clinical activities, as well as organize and track patient information from one encounter to the next. Most products supporting inpatient care are focused on nursing documentation; applications for physicians in the ambulatory setting are currently supported by only a few vendors. As more physicians and other providers begin to participate in disease management, which requires increased data collection and monitoring, tools that enable providers to cope with the volume of data at the point of care will become increasingly valuable and will be accessible through mobile computing.

Alert messaging and communication

Gaining ground in inpatient care are tools that go beyond the pagers long used by on-call physicians, often allowing them to receive test results and send messages. The biggest challenge for these products is the ability to deliver secure, non-interrupted messages. As electronic interactions between ambulatory physicians and patients become more common, devices may be able to deliver messages and alerts to physicians in that setting as well.

Clinical decision support

These capabilities assist the clinician in determining the correct intervention for a given patient based on a combination of patient-specific information and knowledge bases. Common offerings are stand-alone reference tools, such as medical computations or drug databases, which have gained popularity on mobile devices. The real power is when access to clinical knowledge is integrated with other functions and patient data and can generate alerts and reminders as clinicians perform routine tasks such as ordering and note writing. Decision support on mobile computing applications is expected to increase, although it will not be as common as on applications that can better integrate with multiple data sources and process multiple functions.

Medication administration

Mobile computing to support patient medication processes can be found in both the outpatient and inpatient settings. In the inpatient setting, wireless LAN-based applications provide real time medication alerts, as well as documenting medication administration information. Some applications have incorporated bar coding technology for positive patient and medication identification prior to medication administration.

Inpatient Care Solutions

Although generally applications can be used in both the inpatient and outpatient settings, most are designed initially for one environment and then modified as needed to be useful in the other.

In hospitals, mobile computing is used in one of two ways:

- Multi-function wireless LAN solutions are implemented throughout the campus, usually with pocket PC, tablet, or laptop devices.
- Single functions are automated via handheld devices used by caregivers and administrative staff.

In the first case, these solutions support complex processing, a high level of integration, and real-time access to data from multiple sources. They are mobile extensions of the traditional HIS. Some of the most popular inpatient applications are bedside charting, emergency room documentation, and remote access to data for physicians.[10]

Barriers and outlook
for inpatient solutions

This kind of extensive wireless technology can
be complex and expensive to implement.
Transmitters connected to the HIS must be
placed all around the building to send and
receive signals from the mobile clinicians.
Some applications require further investments
beyond the wireless technology. For example,
medication administration systems that use
bar-coding technology require the caregiver to
use a portable scanner to read a bar code on
the medication and patient ID bracelet. The
system checks to ensure that the correct patient
is receiving the proper medication, dose, time,
and route. In order for the system to work, hos-
pitals must not only be able to generate bar codes
for patient bracelets and unit doses of medica-
tions, it must also have a system to track them
and integrate order information and patient data.

For many hospitals costs are too high to jump
right into a high-end wireless solution. Many opt
for mobile computing applications that support
single functionality (such as charge entry or
reference data access that have little integration
with the HIS), which usually only require a PDA
and periodic synchronization. An important
drawback is the proliferation of devices supporting
unique functions and the lack of data-sharing;

providers do not want to carry a different device
for each of the applications they need to use.
Therefore these applications are best viewed as
introductory or pilot solutions that build accept-
ance and provide value if implemented as part of
a plan to migrate toward a more integrated
approach.

Mobile solutions for inpatient clinical computing
are likely to be offered by traditional HIS ven-
dors who will partner with wireless technology
providers and mobile computing vendors. Wire-
less LANs will become common as the cost of
deploying them decreases and integration across
applications improves. Adoption will be driven
by increased documentation requirements,
concern over patient safety, and the proliferation
of wireless LAN technology in general. Organ-
izations such as the Medical Center at Ohio State
University will become the norm. The big
winners in this field will be the applications that
allow mobile clinicians to enter, view, and take
action on cross-continuum patient data.

Outpatient Care Solutions

Physician use is the primary focus of mobile computing in the outpatient setting. Mobile computing devices are well-suited to the physician practice because physicians often spend their whole day moving among exam rooms and offices, and need continuous access to clinical data. Mobile computing also avoids the cost of hardwiring many physician offices and exam rooms. Other mobile health professionals, such as home health nurses, are poised to take advantage of handheld computing devices for documentation and charge capture.

In the physician office, mobile devices that use batch synchronization of data are most common. As mobile computing catches on, physicians—particularly those in large practices—are beginning to invest in wireless LANs. A snapshot of the current market reveals the following:

- Mobile computing applications to automate specific point-of-care processes such as prescription writing and charge capture.
- Basic functionality and little integration with other systems.
- Partnerships and acquisitions among mobile computing and traditional vendors.

- New business relationships among software vendors, pharmaceutical firms, health plans, and other health care organizations to sponsor mobile or handheld computing for physicians.
- Low but increasing adoption rates among clinicians.

In addition to reference tools, handheld applications are focused largely on high-stake individual processes such as charge capture or prescription management. Besides mobility, potential benefits include decreased paperwork, increased revenue and collections, less rework, easier communications, and access to administrative (for example, formularies and schedules) and medical information. (See also Table 3.)

Adoption of current mobile computing product offerings is difficult to gauge, given the limited research and rapid growth of the market. One medication reference application vendor, however, says more than 350,000 health care professionals have downloaded its current product. To persuade more physicians to use their products, many vendors are sponsoring studies to prove the value of the applications. One electronic prescribing vendor showed savings of as much as $3.20 per prescription when comparing paper and electronic prescriptions.[18] In another instance, an orthopedic practice showed a 577 percent return on investment by using a charge capture application.[19]

Vendors are also teaming up with other players in the health care industry to offset the initial cost of these solutions for physicians. Established vendors are partnering with start-ups to offer mobile solutions to existing clients. More complicated relationships exist among mobile computing vendors and other sponsors such as health plans, pharmaceutical companies, and pharmacy benefits management concerns. (Figure 6 shows the various relationships that are forming.) The difficulty with some of these models relates to the uneasy relationship physicians traditionally have had with managed care organizations and pharmaceutical companies. Many of the prescription-writing vendors are looking for sponsorship from the pharmaceutical industry, which is enthusiastic about gaining access to the physician and aggregated prescribing data. However, some models require physicians to accept advertising and messages from pharmaceutical companies on their devices and possibly share aggregated patient data with a third party.

Figure 6. A Growing Network of Business Relationships
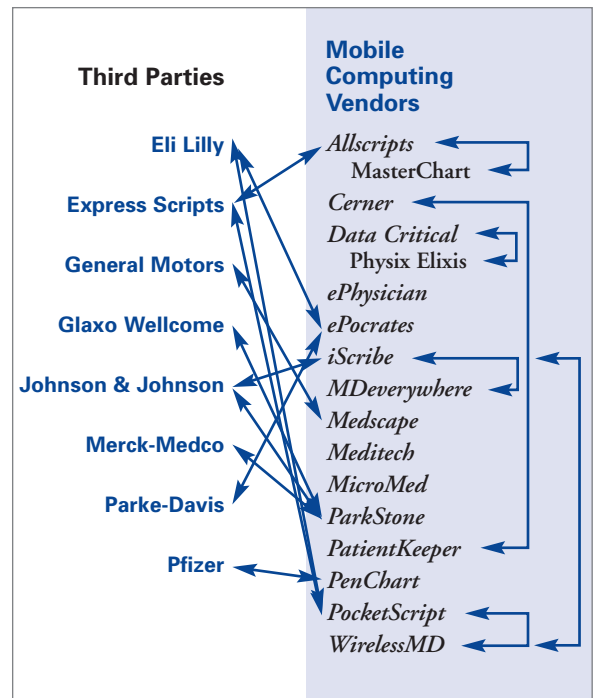
Theoretically, physicians would have to carry multiple devices, each with a different formulary and pricing structure, if each plan offered them a tool for their covered patients. It remains to be seen which models will be durable and sustainable and to what extent physicians themselves will invest in these tools.

Barriers and outlook for outpatient solutions

Cost and lack of integration with legacy systems are major barriers to widespread adoption of advanced forms of mobile computing in ambulatory care. Other factors include confusion over the large number of products on the market; impact on the work environment; worry about the learning curve associated with new technology; concerns over data security and confidentiality; and reluctance to invest in leading-edge solutions.

Despite the barriers, the number of clinician users is increasing and is expected to grow. Vendors will address integration issues and increase functionality through internal development and by building business alignments with strong partners from among more traditional ambulatory medical record vendors who have established clients. Thus wireless technology will provide the mobile extension of electronic records, providing physicians with documentation and access to patient data at the point of care.

Because acceptance of clinical computing tools has been relatively low in ambulatory care, with only about 20 percent of physicians keeping any kind of electronic records, single-function and stand-alone mobile solutions are not expected to fade out.[22] In fact, studies from e-health vendor WebMD suggest that many of the physicians using handheld devices to support patient care do not have access to good practice management systems or electronic patient records.[23]

The other area that shows high potential for outpatient mobile computing is home health, where visiting nurses could use mobile computing applications to record patient charges, document clinical findings, and get access to medical reference information.

III. Implementation Considerations: Benefits, Issues, Risks, and Tactics

CURRENTLY, THE MAJOR ADVANTAGE OF MOBILE computing over traditional systems is the mobility it affords—access to data and functions anywhere. Mobile computing cannot duplicate all of the functionality of traditional systems. It is not a solution that supports the entire care process; rather it targets one or more tasks within the process. Therefore, if the workflow and the information requirements dictate the need for this type of targeted processing portability, then mobile computing may make sense.

These limitations of currently available technology should factor into decisions about whether and how to adopt and implement wireless solutions. The first question to ask is: What can mobile computing applications do that traditional applications *cannot* do to solve a particular business problem?

The Benefits of Mobile Computing

To answer this and the many questions that must be addressed in the decision-making process, it is important to understand how the mobile technology solution solves a particular business problem and fits into the workplace. In fact, addressing the *how* determines the people, process, and technology changes that will make the introduction of mobile computing successful. And, like any other technology, mobile computing requires careful planning, executive sponsorship, and end-user commitment.

Here is an example of a busy family practice clinic that is considering mobile computing. This clinic is having problems with timely charge capture, high volume of lost charges, and claim denials based on inaccurate visit coding. Physicians use pre-printed check-off forms to indicate visit services and handwrite in anything that is not on the sheet. The forms are dropped into a box at the front desk and then keyed into the billing system by the administrative staff at the end of the day or whenever there is free time. In reality, the charge forms may not get entered for days.

A potential solution for this clinic would be a charge capture application on a PDA or pocket PC device. Physicians would enter information during their patient visits, eliminating the need for paper and administrative support for charge entry and checking for coding accuracy and completeness. The system would alert the user when charges have not been entered. While the physician's workflow would not change, the clinic would stand to benefit financially.

Other benefits have been identified in recent mobile computing implementations in the areas of improved workflow, decreased manual tasks, shorter patient and clinician wait times, and better clinical documentation. (See Table 3 for details.)

Once a business case for mobile computing has been made, specific technology and risk considerations must be addressed and integrated into the implementation plan.

The Problem of Electromagnetic Interference (EMI)

Now that more clinicians, other staff, and visitors to the hospital are using wireless devices, there is concern that the signals from these devices may interfere with those of telemetry equipment that uses radio frequency (RF) technology to transmit information from the portable monitor to the central display station.[24] Interference could cause malfunction of devices and potentially harm patients.

Table 3. Potential Benefits from Health Care Mobile Computing Applications

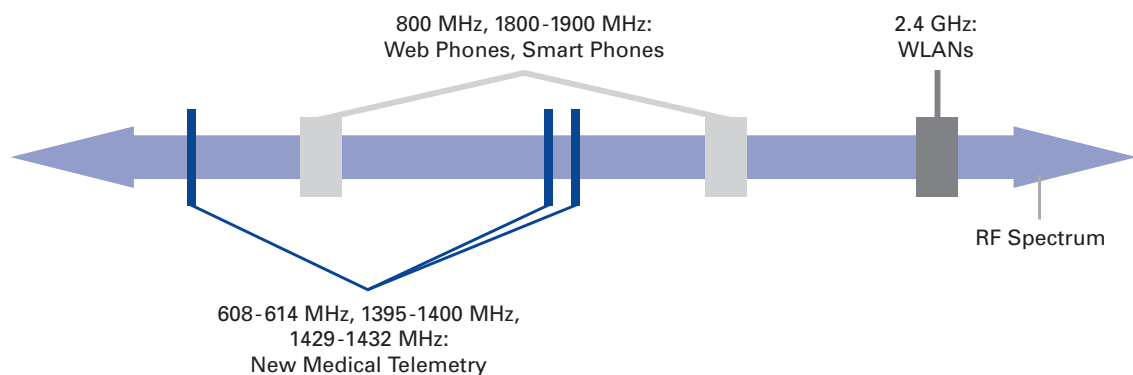| Mobile Computing Application	Positive Financial Impact	Improved Documentation and Coding	Decreased Wait Times for Patients	Decreased Wait Time for MDs	Improved Workflow	Decreased Number of Manual Tasks/Phone	Improved MD Satisfaction	Decreased Variation/ Improved Care Quality
Alert Messaging / Communication			X	X		X	X	
Charge Capture and Coding	X	X			X	X		
Clinical Documentation		X			X	X		
Decision Support	X						X	X
Lab Order Entry and Results Reporting			X	X		X	X	
Medication Administration		X			X	X		X
Prescription Writer	X		X	X	X	X	X	

While different radio frequency devices used in the same area *can* cause interference and malfunction; the likelihood of interference is based on the closeness of the two frequency ranges and the physical distance between the devices. For example, many wireless LAN-supported devices (such as wireless laptops supporting an electronic medical record) operate in the 2.4 GHz frequency range as shown in Figure 7. Cellular and smart phones operate in the 800 MHz and 1800-1900 MHz frequency ranges. Finally, telemetry and monitoring devices operate anywhere in the range set aside for medical equipment, but most operate in the lower end. Therefore, the most likely problem with EMI is between cellular phones and medical equipment, but there is always a potential for interference between monitors and wireless LAN access points that are in very close proximity.

Currently, the best way to address the EMI problem is for an organization's biomedical engineering department to conduct controlled tests with the specific devices and RF medical equipment in a lab setting. These tests can measure the level of interference and determine the safe distances between the devices. One study from the Mayo Clinic in Rochester, New York, for example, indicated that EMI in this case is only a problem when cellular telephones are within 60 inches of their monitors.[25]

The longer-term solution to the EMI problem is to separate the frequency ranges for the different devices and have guidelines for electromagnetic compatibility (EMC). The FDA and FCC are working with vendors to set up such frequency use standards. Last year the FCC set aside particular frequencies for primary or co-primary use by wireless medical telemetry systems. Once these standards are adopted as shown in Figure 7, patient care monitors, telemetry equipment, wireless LAN devices, and cellular phones will operate in different portions of the radio frequency spectrum and will be less likely to cause interference. It will take some time, however, for vendors to migrate their telemetry products to the new frequencies, so organizations should always test for interference in a lab setting and establish written policies to cross-check any new RF devices before they can be used in areas supported by telemetry equipment.

Figure 7. Future Radio Frequencies to Mitigate EMI in Health Care Facilities

800 MHz, 1800-1900 MHz:
Web Phones, Smart Phones

2.4 GHz:
WLANs

RF Spectrum

608-614 MHz, 1395-1400 MHz,
1429-1432 MHz:
New Medical Telemetry

HIPAA and Other Regulatory Considerations

Organizations adopting mobile computing must address the security and patient privacy requirements of the Health Insurance Portability and Accountability Act (HIPAA) of 1996 in a way that is consistent with the technology, policy, and procedures for patient-identifiable information delivered electronically by any other device. The biggest HIPAA-related issue for mobile computing is also its biggest advantage—portability. Unlike fixed desktop workstations, small wireless devices are at high risk for theft and loss—taking with them confidential patient data. While vendors are responsible for requirements related to code sets, encryption, privacy, and audit trails, user organizations need to manage the devices. Appropriate property management controls and turning off device storage cache settings are current measures used to manage mobile devices. Many vendors are solving the patient data security issue by using only browser-based applications on the mobile computing device. In this approach, the data reside only on the server and cannot be accessed by the mobile computing device once it is outside the wireless LAN coverage area.

Key HIPAA questions to ask

Privacy: What measures does the system take to ensure that only appropriate users can view patient information? Are there gradations of access privileges for different types of users? Is the system capable of recording audit trails of user edits and access to patient information?

Security: What level of encryption can the application support for wireless transmission? Where does the data reside? What security measures are guarding it? How is access to computing devices handled?

Other: Will the system be able to accommodate the provider, employer, and health plan identifiers? Will the vendor commit to accommodating the patient identifier? Does the system comply with the HIPAA standards for EDI transactions and code sets?

There may be other regulatory requirements to consider. Because HIPAA does not preempt more stringent state laws governing medical privacy, organizations must take into account these laws as well. For information on HIPAA administrative simplification rules, see the U.S. Department of Health and Human Services Web page (http://aspe.hhs.gov/admnsimp/Index.htm).

Risks with Implementing Mobile Computing

Because implementation risks with newer technologies and first-generation applications from new vendors can be substantial, organizations should document potential problems and create a risk management plan to minimize impact. The following are some risks specific to mobile computing and wireless technology.

Impact on user productivity and workflow. A concern often voiced by physicians is loss of productivity. Therefore, solutions designed for ease of use and adaptability to workflow are generally the most successful. To insure the impact of a particular solution on productivity is a positive one, it is important to learn as much as possible about the flexibility of the screen flow, user-definable data fields, implementation timing, and training requirements. It is likely that mobile computing helps to improve only certain tasks within the workflow; it is not the whole solution. Improvements in productivity and workflow will be incremental, as these tasks are automated using mobile computing.

Technology support required. Implementing a mobile computing application, especially one supported by a wireless LAN, will most likely require additional technical support, considerable implementation time, and close involvement with the vendor technical support staff. Implementing newer technology will often uncover problems never seen before and on which the vendor and information services (IS) staff must work together to solve. Once implemented, supporting these newer technologies requires highly skilled, and currently scarce, technical resources. These factors will impact both the selection process and implementation timelines.

Vendor stability. Because mobile technology is an emerging market, the viability of vendors must be considered. Vendors have been affected by the limited capital funding that providers have for IT investments, and few have achieved profitability or gained a critical mass of users (although some are testing different pricing and business partnership models with health plans, pharmaceutical firms, and other software vendors). As the recent dot-com fallout illustrates, the promise of new technology is no substitute for a solid market share, a large number of installed products, and, of course, profitability. The prospect of mergers and acquisitions in the mobile computing market increases the necessity of ensuring long-term product support. Organizations will also want to consider the rapid development cycle of this technology and plan the duration of the contract accordingly.

Tactics for Success

After the selection decision for a particular mobile computing application has been made, implementing the system just as carefully will help to ensure that the end-users are satisfied and full value is realized. The following implementation tactics, based on the most recent mobile computing project experiences, should help projects move smoothly.

Understand the integration of workflow, information flow, and technology. Mobile computing is not the entire solution; it addresses specific tasks within the care delivery process. Understanding the points where technology is provided and the information collected or displayed for the end user will lead to a clear map of the necessary changes in the current process and roles. In many projects, implementing the process, roles, and responsibility changes is far more challenging than installing the new technology.

Set user expectations. Take the time to understand, document, and set expectations related to each functionality and technology that will be installed. Many device manufacturers and application vendors claim incredible functionality and access to information. Remember that mobile does not necessarily mean wireless, real-time access to data. Make sure that end users are not led to believe that the application is going to give them access to the same services and functionality that they have on their PCs with wired connections. Mobile computing will give them basic functions with the added benefit of mobility.

Learn from experience. Comb the health industry trade press, network with contacts, and perform a literature search to get valuable insight into how the technology works on the ground. Useful starting points include product, vendor, and organization Web sites. These often provide detailed information on the application or technology and typically include case studies and links to related sources. (Refer to Appendix D and E for more information.)

Pilot the application. A great implementation advantage with mobile computing is that piloting is possible. The cost for the handheld devices, software, and basic data synchronization interfacing is very low, especially if the vendor is willing to partner with the organization to gain experience with implementations and have reference sites. By starting small, users get a clear understanding of how mobile computing impacts their work environment. Pilot implementations identify process and technology adjustments that will improve user acceptance and the overall success of the project when it is rolled out.

Appendices

Appendix A: Wireless Landscape Diagram

Voice Systems

Data

Application
Servers

Legacy Data Systems

Application—Systems Integration

Web Server

Mobile
Application
Servers

Mobile Integration

FIREWALL

Internet

Gateway

Gateway

Wireless
LAN Point
of Access

Sync

Wireless Network

Cellphone

PDA

Laptop

PDA

Mobile Devices

Source: ArcStream, Inc.

Appendix B: Mobile Device Operating System Summary

One of the most publicized debates in the world of handheld computing is the ongoing discussion about the "best" operating system for PDA devices. Is it the first and widely accepted Palm operating system developed by Palm or the newer entrant Windows CE, now called Pocket PC OS, created by Microsoft? Although there are others, these two garner the majority of market for current health care applications.

The Palm system operates a small touch screen that is manipulated with a stylus; data can be entered using menus or a simple character-recognition language. Pocket PC OS GUI more closely resembles the standard Microsoft PC desktop and is manipulated by a small keyboard and/or touch screen. The Palm system drives smaller devices and is somewhat simpler to use; but not as function rich as Pocket PC OS.

Why is it important to know about mobile device operating systems? For many organizations, it is not. However, it is important for organizations to look at operating system capabilities for two reasons. First, there are a growing number of caregivers who are making individual PDA

purchases for a variety of personal and professional uses. To help set standards for ongoing support, volume contracting, and future application and data integration, it is wise to investigate the capabilities of both operating systems and decide on a "preferred" standard up front.

The second reason is for internal application development. For those sites that anticipate that commercial applications will not be able to fulfill their requirements, they will need to determine the best platform for development. For applications that are focused on lists, text storage and retrieval, and basic computations, Palm is well suited to complete these functions. If integration with desktop applications, SQL support, Windows look and feel, and enhanced screen resolution for more complicated displays is needed, then Pocket PC OS may be the best choice.

However, upgraded capabilities, new functions, and add-on enhancements are announced on a regular basis, so refer to the Palm and Microsoft Web sites as well as consumer Web sites such as www.handheldmed.com for the latest product information.

Table B1. Key Differentiatiors between Palm and Microsoft Operating Systems

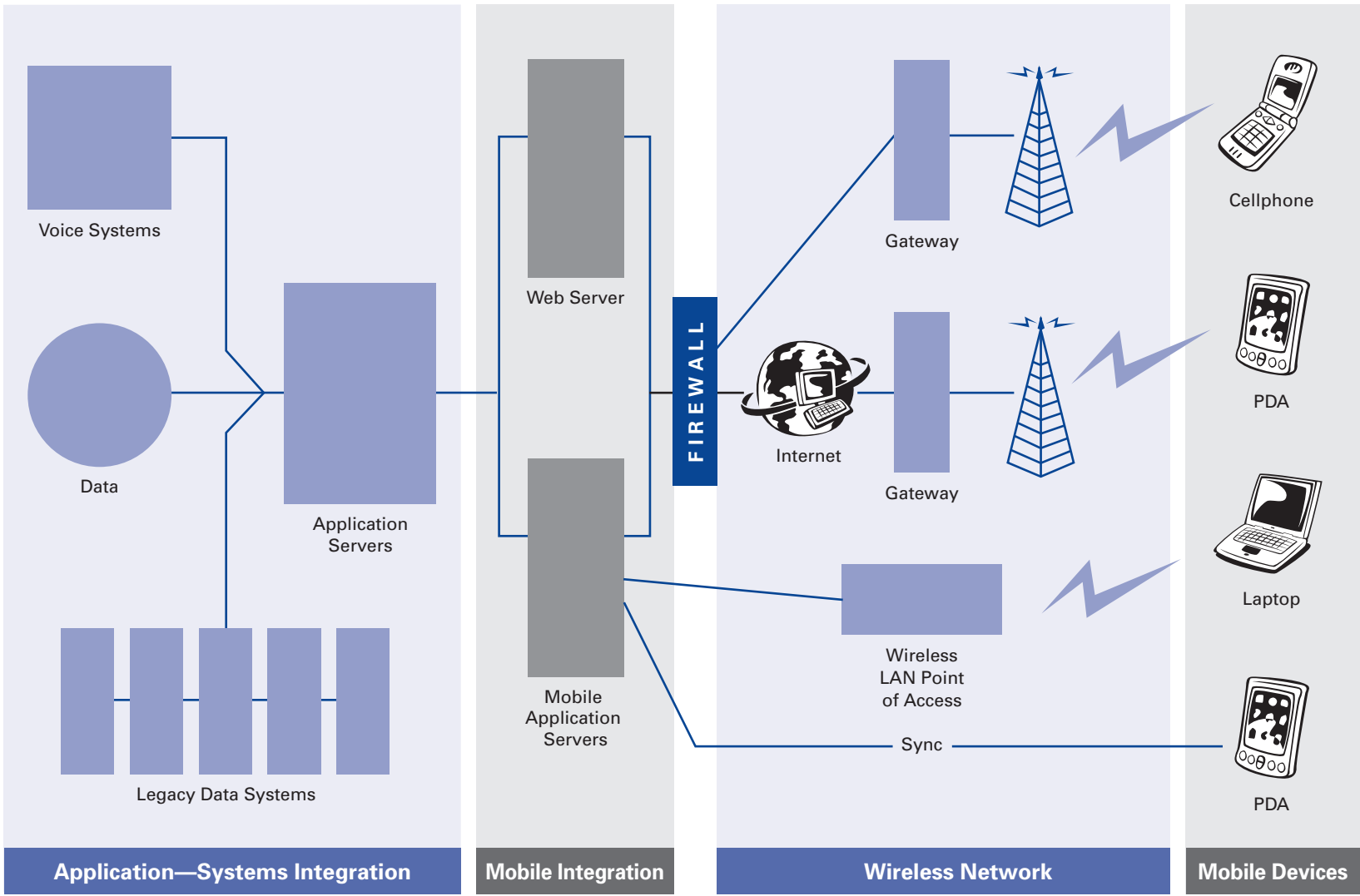| Palm OS	Windows CE (now Pocket PC OS)
• Designed for text storage retrieval: calendar, address book, scheduler • Simpler to use • Used in smaller, lighter PDA devices that easily fit into lab coat pockets • Lower memory requirements	• Scaled-down version of Microsoft Office applications including Word and Excel • GUI has the familiar Windows user interface "look and feel" • Screen resolution is much better for Pocket PC devices
• Uses a touch screen with a stylus	• Uses touch screen or keyboard for data entry with superior handwriting capability
• More vendors use it for application development • On the market for a longer time and viewed as more stable • Currently less expensive	• Better integration with Microsoft Office desktop application suite • Greater functionality; e.g., supports MP3, multimedia, advanced graphics, and SQL

Appendix C: Performance Shortcomings of Wireless LAN, Wireless Internet, and Data Synchronization Technologies

Issue	Wireless LAN	Wireless Internet	Data Synchronization
Slow Data Transfer Speed	**Current:** Data transfer speed is 7 Mbps (mega bits per second) versus 10 to 100 Mbps for wired LANs.	**Current:** 14,400 bps (bits per second), much slower than modem Internet connections (56,000 bps).	**Current:** Not an issue.
	Impact: Cannot send images (e.g., radiology images) or large amounts of data (e.g., entire electronic patient clinical record).	**Impact:** Can send or receive only a few lines of text or few data points.	**Impact:** N/A
	Resolutions: Many technology vendors are promising improvements in speed that are expected to be available in the 2002 time frame. Application vendors are building browser based applications to minimize data transfer between the handheld device and the application server.	**Resolutions:** 3G technology will significantly improve transfer speeds with increased speeds ranging from 144 kilobits per second (Kbps) in 2001, 384 Kbps in 2002 and 2Mbps in 2003+. Not expected in the U.S. until early 2002.	**Resolutions:** N/A
Lack of Data Interfacing Standards	**Current:** Point-to-point customized data interfaces between handheld devices and server applications.	**Current:** Not an issue as few data are exchanged between device and server, mostly messages.	**Current:** Point-to-point customized batch interfaces between handheld devices and server applications.
	Impact: Costly, custom interfaces inhibit the rapid deployment of applications	**Impact:** Not a factor with current use, but may increase if more data are sent via this technology.	**Impact:** Costly custom interfaces inhibit rapid deployment of applications.
	Resolutions: Development of "wireless LAN" interfacing middleware. Mobile computing vendors and traditional vendors are developing standard interfaces.	**Resolution:** Not an issue at this time.	**Resolution:** Not seen as a big issue at this time given the limited functionality of the handheld applications.
Lack of Connectivity Standard	**Current::** IEEE 802.11 standard is the emerging leader.	**Current:** Multiple prevalent connectivity standards in place.	**Current:** Not an issue
	Impact: Not a major issue because many vendors adhere to IEEE 802.11.	**Impact:** A device designed to work with one technology cannot be used on a network that employs another unless special programming is included to translate the different formats.	**Impact:** N/A
	Resolutions: N/A	**Resolutions:** Inter-system connectivity products now available but overhead decreases transfer speeds. Given the wide use of the different connectivity standards by AT&T, Sprint, Pacific Bell, and Verizon, convergence on a single standard in the near future is not likely.	**Resolutions:** N/A

Appendix D:
Representative Mobile Computing Vendors and Products*

Vendor/Product	Contact Information	Functionality
Allscripts Healthcare Solutions First Fill TouchWorks Professional Enterprise Master Chart	2401 Commerce Avenue Libertyville, IL 60048-4464 www.allscripts.com (800) 654-0889	• E-prescribing • Charge capture/coding • Lab orders and results • Clinical documentation • Clinical decision support
AUTROS Healthcare Solutions, Inc.	One Yorkdale Road, Suite 310 Toronto, Canada M6A 3A1 www.autros.com (800) 537-2255	• Medication administration
Becton, Dickinson and Company BD Rx System	1 Becton Drive Franklin Lakes, NJ 07417 www.bd.com (201) 847-6800	• Medication administration
Bridge Medical, Inc. MedPoint	120 South Sierra Solana Beach, CA 92075 www.bridgemedical.com (858) 350-0100	• Medication administration
Cerner Corporation Millennium	2800 Rockcreek Parkway Kansas City, MO 64117 www.cerner.com (816) 221-1024	• Adapted Cerner HNA Millennium applications
Data Critical AlarmView StatView FlexView PocketChart (by Physix) WebChart (by Elixis) UniwiredDr	19820 North Creek Parkway, Suite 100 Bothell, WA 98011 www.datacritical.com www.unwireddr.com (425) 482-7000	• Alert messaging • Charge capture/coding • Clinical documentation • Lab orders and results • E-prescribing
DynaMedix Corporation PocketCode	222 West Las Colinas Blvd., North Tower Irving, TX 75039 www.dynamedix.com (800) 522-3692	• Charge capture/coding
ePhysician ePhysician Practice	1390 Shorebird Way Mountain View, CA 94043 www.ephysician.com (650) 314-2000	• E-prescribing • Charge capture/coding • Drug reference • Clinical decision support
ePocrates ePocrates Rx ePocrates ID DocAlert	120 Industrial Road San Carlos, CA 94070 www.epocrates.com (650) 592-7900	• Drug reference • Alert messaging and clinical decision support
iScribe i3000 i5000	1400 Industrial Way Redwood City, CA 94063 www.iscribe.com (877) 771-4900	• E-prescribing • Clinical decision support

Vendor/Product(s)	Contact Information	Functionality
Mdeverywhere, Inc. EveryCharge EveryNote ClearCoder EveryReference EveryOrder	PO Box 14669 Research Triangle Park, NC 27709 www.mdeverywhere.com (919) 484-9002	• Charge capture/coding • Clinical documentation • Reference • Order entry
Meditech	MEDITECH Circle Westwood, MA 02090 www.meditech.com (781) 821-3000	• Clinical documentation
Medscape, Inc. Medscape Mobile	20500 NW Evergreen Parkway Hillsboro, OR 97124 www.medicalogic.com (503) 531-7000	• Drug reference
MicroMed Healthcare Systems NextGen EMR	200 Welsh Road Horsham, PA 19044 www.micromed.com (215) 657-7010	• Electronic medical record • Clinical decision support
PatientKeeper Corporation (formerly Virtmed) PatientKeeper Personal PatientKeeper Enterprise	Brighton Landing East 20 Guest Street, Suite 500 Brighton, MA 02135 www.patientkeeper.com (617) 987-0300	• Charge capture/coding • Lab orders and results • Clinical documentation • Patient tracking
PenChart PenChart System	2389 Main Street, Suite 101 Glastonbury, CT 06033 www.penchart.com (800) 568-1528	• Electronic medical record

Appendix E. Reference Web Sites

Web Site	Name	Description
MOBILE COMPUTING AND WIRELESS NEWS SITES		
www.cewindows.net	Chris De Herrera's Windows CE Web site	Information and comparisons on Windows CE and Palm OS
www.cewire.com	CE Wire news Web site	Windows CE News and Information source
www.ft.com/wap/	Financial Times WAP Web site	Understanding WAP and other numerous articles, key players, Web links, glossary of terms
www.mbizcentral.com	M-Business Magazine	News and articles as well as links to resources and data
www.mobilevillage.com	Market development company for mobile computing	News and limited case studies on mobile computing, conference information, hardware and software stores, and consulting services
www.pencomputing.com	Pen Computing Magazine	Full spectrum of wireless articles and product information
www.thinkmobile.com	Internet.com's mobile computing portal	News, articles, links, product information, and vendor and service provider information
www.wirelessweek.com	Web site for wireless news items	Content Web site for wireless technologies
www.wlana.org	Wireless LAN Association (a nonprofit vendor consortium)	Introduction/overview of wireless LANs, events, suggested reading, related Web sites, user stories (including health care)
www.wow-com.com	World of Wireless Communication	Sites sponsored by the Cellular Tele-communication Industry Association with news, regulatory, and consumer information on wireless

Web Site	Name	Description
HEALTH CARE SITES		
aspe.os.dhhs.gov/admnsimp	HIPAA Web site	Information on HIPAA regulations sponsored by the Department of Health and Human Services
www.fcc.gov/healthnet	Health care and the FCC	News and links related to tele-communications in health care
www.fda.gov/cdrh/index.html	Center for Devices and Radiological Health	Information on federal programs and alerts relating to the safety and effectiveness of medical devices and limiting the exposure to radiation
www.handheldmed.com	Clinical handheld computing	News, product reviews, vendor press releases, articles ("Palm vs. WinCE"), user forum, glossary, applications for downloading
www.mohca.org	Mobile Healthcare Alliance	Open forum for exchanging ideas, promoting learning, and sharing solutions for managing and securing health information
www.pdamd.com	Medical PDA Web site	News, product reviews, tutorials ("Choosing the Right PDA"), extensive discussion board/chat room
COMPANY SITES		
www.arcstreamsolutions.com	ArcStream Inc.	Wireless systems integration firm
www.724.com	Interconnectivity software vendor	Gateway technologies for Wireless LAN interconnectivity with disparate transmission standards
www.microsoft.com/mobile	MS Mobile Device Web site	Product, news, and support information related to Windows CE
www.palm.com	Palm Handheld Computing Solutions	Company Web site. Product information, solutions, support, and resources
www.wirelessknowledge.com	Web site for Wireless Knowledge Inc	Company formed by Microsoft and QUALCOMM. Develops core technology in enabling wireless access to the enterprise environment

* Compiled March 2001

Appendix F: Glossary

Access point—Radio-based two-port network bridge that interconnects a wired local area network to a wireless LAN.

Ambulatory medical record (AMR)—Generic name for a computer system that automates the care delivery processes and stores patient clinical data in support of outpatient care services (sometimes called electronic medical record or EMR).

Application service provider (ASP)—A vendor that deploys, hosts, and manages access to a packaged application for multiple parties from a central facility, charging a subscription use fee.

Browser—A software program that interprets documents written in HTML, the primary programming language of the World Wide Web. A browser such as Netscape or Microsoft Explorer is required to experience the photos, video, and sound elements on a Web page and assists in quick, easy travel around the Web.

Data synchronization/data syncing—The process of sending updates between the mobile computing device and the application server in a batch mode to keep both sets of files in sync. Sometimes called "hot syncing."

Electronic medical record (EMR)—Generic term describing a computer system that automates the care delivery processes and stores patient clinical data in support of inpatient care services.

Firewall—A security device situated between a private network and outside networks. The firewall screens user names and all information that attempts to enter or leave the private network, allowing or denying access or exchange based on pre-set access rules. Also see encryption.

Global Positioning System (GPS)—A series of satellites that continuously transmit their position. Used in personal tracking, navigation, and vehicle location technologies.

Handheld device—See mobile computing device.

Handheld PC—Small hand-size personal computer that uses a keyboard.

Health Insurance Portability and Accountability Act (HIPAA) of 1996—Federal regulatory requirements to protect the security, confidentiality, and privacy of patient data.

Hospital information system (HIS): Generic term used to describe computer systems that support the administrative and care delivery processes for a hospital.

Hypertext markup language (HTML)—The primary programming language for sites on the World Wide Web. This "skeleton" of codes surrounds blocks of text and/or images and contains all the display commands. A browser program is needed to interpret HTML and turn it into a graphical display on a computer screen.

Institute of Electrical and Electronics Engineering (IEEE)—A professional association with multiple organization groups that develops and promotes standards. The IEEE 802 standards are focused on the communication protocols for wireless LANs.

Internet—A global network of computers that operates on a backbone system without a true central host computer. It links thousands of universities, government institutions, and companies. The World Wide Web is an integral part of the Internet; its ease of use has made it much more popular than its less graphical parent.

Local area network (LAN)—A group of client computers connected to a server.

MP3 (MPEG-1, Layer 3)—Moving Picture Expert Group audio/video compression standard.

Mobile computing—Any solution where the application is accessed from a portable device. Transport of data to and from the device can either be accomplished using wireless technologies or batch-processed from docking cradles attached to the local area network (LAN).

Mobile computing device—End-user handheld wireless computer device that displays, collects, and stores data.

Network interface card (NIC)—Technology component, similar in size to a credit card, that connects a PC and the LAN.

Palm operating system (Palm OS)—Widely used handheld device operating system developed by 3Com. Strengths include operating simplicity, ease of storing information.

Personal digital assistant (PDA)—Mobile, handheld devices, such as Palm series and Handspring Visors, that give users access to text-based information. Users can synchronize their PDAs with a PC or network using a cradle device. Some models support wireless communication.

Personal information management (PIM)—Set of organizer functions that includes an address book, calendar, scheduler, notes, and access to email.

Pocket PC—PDA type device running Microsoft Pocket PC operating system.

Server—A computer on a network that manages a specific set of network resources. A server may manage network traffic, printer use, store files, or run remote applications.

Smart phone—Cellular phone that supports a number of data transmission capabilities including Web browser; sends and receives faxes and emails; provides organizer functions such as a calendar and address book.

Structured query language (SQL)—A standard programming language used to manipulate data in a relational database.

Tablet—A flat-panel laptop that uses a stylus pen or touch-screen technology.

Third generation cellular network (3G)—Advanced cellular network supporting transfer speeds from 144 kbps to 2 Mbps.

Uniform resource locator (URL)—A Web site address identifier.

Web server—A networked computer that stores and transmits data and documents written in HTML or other languages to browsers via the Hypertext Transfer Protocol, an Internet-based data transport protocol.

Web site—Group of related files, including text, graphics, and hypertext links, on the World Wide Web. Accessed by typing its unique address, a site usually includes layers of supporting pages as well as a home page. Also see URL and browser.

Windows CE (WinCE)—Handheld device operating system developed by Microsoft that includes scaled down versions of Word, Excel, Access, and Internet Explorer.

Wireless—Using radio frequency spectrum for transmitting and receiving voice, data, and video signals for communication.

Wireless application protocol (WAP)—A set of rules for transforming Internet information and other data so it can be displayed on the small screen of a mobile telephone or other portable digital device.

Wireless Internet—Wireless mobile computing that uses the Internet as part of the underlying network communications infrastructure. Sometimes called "wireless Web."

Wireless LAN—A local area network that uses radio frequency technology to transmit data though the air for relatively short distances. It can serve as a replacement for or extension to a wired LAN.

Wireless LAN adapter—Component attached or integrated into the handheld device that transmits data between the device and the access point.

Wireless markup language (WML)—Web development language that allows Web sites to tailor the information format to fit the small screen and limited capability of mobile devices.

Endnotes

1. "Internet users will surpass 1 billion in 2005." eTForecasts, February 6, 2001 (http://www.etforecasts.com/pr/pr201.htm).

2. "WAP, not Web: 95 million browser handsets in 2004, marketers must resist imposing web models on mobile access." Jupiter Media Metrix, August 15, 2000 (www.jup.com).

3. "Wireless LANs almost ready for widescale adoption." InformationWeek.com, November 14, 2000 (www.iweek.com).

4. Szybal, D. "Continuity of kids' care." *Health Data Management,* pp. 22-26 (April 2001).

5. *HIS Insider Weekly,* March 12, 2001.

6. Personal communication with Kathy Lindale, director of respiratory therapy at Banner Health.

7. Scott, Lisa. "Point of contact." Modern Physician, pp. 38-54, October 2000.

8. "Physicians and the Internet: Taking the pulse." *Hospitals and Health Networks,* February 2001.

9. Shabot, M.M., M. LoBue, and J. Chen. "Wireless clinical alerts for physiologic, laboratory and medication data." Proceedings of the 2000 AMIA Annual Symposium. *Journal of the American Medical Informatics Society. Symposium Supplement,* pp. 789-793, 2000.

10. *HIS Insider Weekly,* February 26, 2001.

11. "Wires give way to wireless at a North Carolina hospital." Symbol Solutions, 2000 (www.symbol.com).

12. Leff, Marni. "A world of help in their Palm." MSNBC, January 29, 2001 (www.msnbc.com).

13. Freudenheim, Milt. "Digital Doctoring." *New York Times*, January 8, 2001 (www.nytimes.com).

14. "Wireless LANs almost ready for widescale adoption." InformationWeek.com, November 13, 2000 (www.iweek.com).

15. "Physicians and the Internet: taking the pulse." *Hospitals and Health Networks,* February 2001.

16. Scott, Lisa. "Point of contact." *Modern Physician,* pp. 38-54, October 2000.

17. Quoted in Chesanow, Neil. "Your ticket to fast, flawless prescribing." *Medical Economics,* pp. 93-104, October 23, 2000.

18. "TouchScript solution drives managed care savings." Allscripts, October 2000 (www.allscripts.com).

19. "Mobile charge capture service helps one orthopaedic practice reclaim $82,364." Mdeverywhere, October 12, 2000 (www.mdeverywhere.com).

20. Scott, Lisa. "Point of contact." *Modern Physician,* pp. 38-54, October 2000.

21. Chandler, Michelle. "Hand-held healthcare." *Miami Herald*, February 19, 2001.

22. Scott, Lisa. "Point of contact." *Modern Physician,* pp. 38-54, October 2000.

23. Sittig, D.F., H.B. Jimison, B.L. Hazlehurst, et al. "Techniques for identifying the applicability of new information management technologies in the clinical setting: An example focusing on handheld computers." Proceedings of the 2000 AMIA Annual Symposium. *Journal of the American Medical Informatics Society. Symposium Supplement,* pp. 804-808, 2000.

24. "Wireless medical telemetry." U.S. Food and Drug Administration—Center for Devices and Radiological Health, 2000 (www.fda.gov).

25. Tri, J.L., D.L. Hayes, T.T. Smith, and R.P. Severson. "Cellular phone interference with external cardiopulmonary monitoring devices." Mayo Clinic Proceedings, 76: 11-15, January 2001 (http://www.mayo.edu/proceedings/2001/jan/jan2001.html).

CALIFORNIA
HEALTHCARE
FOUNDATION

476 Ninth Street
Oakland, California 94607
Tel: 510.238.1040
Fax: 510.238.1388
www.chcf.org