Point of View

Wireless Technology Usage from a Clinician's Perspective

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Introduction

A Day in the Life of a Primary Care Provider

It is another day at the office. The clinic where I practice just finished installation of an electronic health record (EHR) system. The practice now has computerized patient records, e-prescribing, and even decision support. At the office, work is simpler as calls from pharmacies for clarification and formulary issues almost have disappeared. In many cases, decision support systems guide me to the best treatment for my patients. Patient documentation has become much simpler. In most cases, it's completed before the patient leaves the exam room. It's also easier to return patients' calls because now there is an efficient view of the patient's history from the virtual chart. Yes, it definitely was worth the effort to install the application. Unfortunately, I do not have access to these benefits when I am not in the clinic or at my home office.

Last night, while at dinner, I received three calls from patients. Unfortunately, not being at the office or home, I did not have access to patient records. Since I couldn't remember all of the patients' conditions, I provided them with a broad spectrum—"clean" medication that should treat their symptoms with minimal drug-drug or possible drug-disease interactions. This may not be the most effective or least expensive treatment, but it's the best one can do without comprehensive information.

One hour later, I received two more calls—both from different hospitals about patients I was treating. When I called the first hospital back, they could not locate the nurse who initially contacted me. I knew she would call again. When we finally connected three hours later, I learned my patient's arterial blood gases (ABGs) were life threatening, so I went to the hospital to evaluate her. The call to the other hospital was much simpler. They just required a verbal order for a medication. Now I needed to visit the hospital the next day—not to evaluate this patient, but simply to sign the verbal order. If I had access to the hospitals' systems over a wireless network, I would have noticed the problems with one patient sooner, and entered the orders on the other electronically, thereby avoiding the trip to the hospital.

I still struggle researching patients' conditions. In general, I have about five unanswered questions a day. I thumb through internal medicine references and consult books, but they are out of date and it takes too long to find information when needed. I try to run these questions past my collaborating physician, but she is a challenge to find and is busy seeing patients and overseeing another nurse practitioner. I heard about quick references that are current and can run on my mobile phone. Maybe that is part of the solution.

I know there is a way to use technology to provide access to the practice's systems, hospital systems, and research wherever I may be. I see businesspeople at restaurants, golf courses, even airports using mobile technologies, so why don't healthcare practitioners do the same?

This document will discuss applications that can improve healthcare with mobile computing technology. In addition, it will describe how to start delivering these benefits to healthcare practitioners.

Challenges Facing Healthcare Practitioners

Many healthcare providers struggle with similar challenges. Workload and shortages have caused providers and policymakers to look for means to improve productivity. Physicians have increased their average work week from 57.6 hours in 2001 to more than 60 hours in 2002.[1] Nursing workloads and shortages have reached critical levels as well. According to the U.S. Department of Health and Human Services, there was a 6 percent nursing shortage in 2000; that shortage will double by 2010, resulting in a shortage of 275,000 full-time registered nurses. By 2015, the shortage is expected to more than triple to 20 percent, and it will escalate to 29 percent by 2020.

In addition, new advances in medicine and ancillary care have made it nearly impossible to stay up-to-date. It has been determined that medical knowledge doubles every 19 years. This means that the body of knowledge increases by at least 400 percent if a provider has a 38-year career.[2] Research and provider knowledge deficits have led to significant divergence between recommended care and what patients actually receive. A 2004 RAND Corporation study shows that patients receive recommended (or evidence-based) care about half of the time. This creates unique opportunities to improve healthcare by delivering information to the practitioner at the point of care. The statistics on clinician research are particularly troubling. In a paper published in the Annals of Internal Medicine,[3] it was shown that physicians had, on average, three questions per patient. A recent paper published in the Journal of the American Medical Informatics Association (JAMIA)[4] found that surveyed physicians asked 1,062 questions but pursued answers to only 585 (55%). The most commonly reported obstacle to the pursuit of an answer was the physician's doubt that an answer existed (52 questions, 11%).

Patient information often is scattered in many locations and unavailable when needed. Even when the data is available in health IT systems, there frequently are no wireless facilities that provide access to practitioners when not in the office or at the hospital. Wireless technologies, properly integrated into hospital and practice systems, can streamline the practitioner's work and even provide up-to-date, evidence-based treatment plans.

1. AMA, 2003-2004
2. Smith, Richard, BMJ, 1996, www.bmj.com/cgi/content/full/313/7064/1062
3. www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=2001091&dopt=Citation
4. "Answering Physicians' Clinical Questions: Obstacles and Potential Solutions," *Journal of the American Medical Informatics Association* 2005; 12(2):217-224, John W. Ely MD, Jerome A. Osheroff MD, M. Lee Chambliss MD, MSPH, Mark H. Ebell MD, MS, and Marcy E. Rosenbaum PhD

The Base Solution

Advanced applications (electronic health records, decision support, e-prescribing, e-research) have the potential to improve healthcare for practitioners, patients, and payers. Without a secure, reliable, and flexible infrastructure, however, the applications are nothing more than a dream. Wireless infrastructure typically can be thought of as long range or localized (short range). Short-range wireless communications use wireless local area network (WLAN) technology, commonly known as Wi-Fi. Long-range wireless communication takes advantage of technologies available to mobile phone providers. While the two wireless technologies are distinct, the services they provide are complementary in providing ubiquitous communication to the practitioner.

Wireless LANs

Clinicians are familiar with Wi-Fi due to its ubiquity. Wi-Fi often is available at hospitals, airports, coffee shops, and many other public locations. For clinical purposes, however, it is necessary to harden these technologies to meet healthcare needs. Wireless technologies for healthcare necessitate 24x7 availability. Additionally, healthcare wireless networks should identify, secure, and provide access only to individuals who require, and are authorized, to use system resources. Wireless standards have been developed by the Institute of Electrical and Electronics Engineers (IEEE). Some high-level information about current wireless standards can be seen in the below table. Further information regarding these technologies can be found in Cisco's Medical-Grade Network white paper.[5]

Wireless Standard	Description
802.11a	High-speed wireless standard (speeds up to 54 Mbps). Uses different frequencies than 802.11 a/b. Enables healthcare organizations to have parallel wireless networks (e.g., network for wireless voice, network for biomedical applications).
802.11b	Available since 2000. First commonly available wireless standard. Supports speeds of up to 11 Mbps. Commonly available at public facilities.
802.11g	Available since 2003. First high-speed, commonly available wireless standard. Uses the same frequencies as 802.11b. Backwards compatible with 802.11b.
802.11n	Newest wireless standard (2007). Enables highest speed of options available (speeds up to 248 Mbps). Higher speeds are achieved by using multiple-input multiple-output (MIMO) technology. This technology uses multiple transmitter and receiver antennas to improve system performance.

5. The Cisco Medical-Grade Network, Cisco white paper, Mike Gibbs, 2007

Long-range Wireless

Long-range wireless provides mobility over mobile phone systems. Currently, there are four options available for mobile data users (see table below). Long-range wireless technology has two major advantages over Wi-Fi—it is available everywhere and system security is part of the base technology design. Initial security is accomplished as these technologies uniquely identify the PDA or phone when they register with the network.

The above discussion focuses on wireless infrastructure. For this infrastructure to be useful to the clinician, computing must be available at the point of care. The next section describes the types of mobile computing platforms available to clinicians.

Wireless Standard	Description
EVDO	Evolution Data Optimized (EVDO) is a high-speed wireless data service that runs on wide-band code division multiple access (CDMA) networks. EVDO networks can support speeds of 300–3000 Kbps. EVDO is popular in the United States and offered by Verizon Wireless.
EDGE	Enhanced Data rates for GSM Evolution (EDGE) is a technology that provides network connectivity over Global System for Mobile communications (GSM) networks. It was introduced in North America in 2003 as a means to provide higher speed than previously available with Generic Packet Radio Service (GPRS). It is considered to be a low-speed, third-generation mobile data technology.
GPRS	General Packet Radio Service (GPRS) is a generation 2.5 mobile communications technology that enables mobile wireless service providers to offer data services over GSM networks. GPRS has become primarily a legacy technology.
UMTS	UMTS is a 3G mobile communications technology that provides CDMA technology based upon GSM-standard radio technology. This technology supports speeds of up to 2 Mbps. The technology offers high-throughput and end-to-end quality of service (QoS). This enables real-time services such as video delivery. UMTS is being deployed across many GSM networks in Europe, the Middle East, Africa, and Asia.

User Access Devices

Essentially, three mobile computing platforms are available to clinicians. The platforms are Smartphone, Tablet PC, and Notebook. Each of these devices has a place in optimizing the healthcare experience for the clinician and patient. Each has distinct advantages and disadvantages. A summary of the platforms and their advantages/disadvantages can be seen in the following table.

Device	Description	Advantages	Disadvantages
Smartphone	Mobile phone that blends the capabilities of a phone and personal computer. In recent years, the computing power has increased significantly.	Small, light, and offers ubiquitous network access via Wi-Fi and mobile phone networks. Fluid-resistant covers usually available to permit cleaning. Long battery life. Relatively inexpensive.	Small screen. Fewer applications than Tablet PC or Notebook.
Tablet PC	Small, lightweight computer that blends the power of a notebook with compact system design.	Small, lightweight, long battery life, high level of computing power. Several options that have been customized for healthcare (fluid-resistant, drop-resistant, cameras, bar-code readers, extended batteries). Can run all applications available to the healthcare community.	Requires Wi-Fi or cellular modem card for ubiquitous network access. Most expensive.
Notebook Computer	Small mobile computer that can perform the functions of a desktop computer.	Highest computing power. Can run all applications available to the healthcare community. Has become a commodity in recent years.	Largest in size and weight. Generally not fluid-/drop-resistant. Many have short battery life. Requires Wi-Fi or cellular modem card for network access.

Medical Applications Available to Mobile Users

In general, all applications available for clinical computing can be made available to clinicians operating over a wireless network. This section provides a high-level description of the applications available to clinician practitioners.

Computerized Physician Order Entry

Computerized physician order entry (CPOE) systems allow practitioners to enter orders electronically rather than through handwritten or verbal instructions, decreasing manual-entry and transcription errors.

Electronic Prescribing

Electronic prescribing (eRx) provides the ability to write and transmit new or renewal prescriptions electronically. Practitioners can access patient-specific drug histories, check prescribed medications for potential adverse interactions, and then write prescriptions electronically. Additionally, these systems often integrate with the formulary of the payer, decreasing the costs associated with patient care.

Picture Archiving and Communication Systems

Picture archiving and communication systems (PACS) enable the capture, storage, retrieval, distribution, and presentation of diagnostic images. Picture archiving and communication systems range in ability to support images from various modalities, such as ultrasonography, magnetic resonance imaging, positron emission tomography, computerized tomography, and radiography (X-rays).

Electronic Health Records

Electronic health records (EHRs) provide electronic documentation of patient encounters. To provide the most functionality, these systems can be integrated with hospitals' departmental clinical systems to provide a comprehensive view of patient histories, diagnoses, and treatments. Furthermore, they can be integrated with clinical decision support and CPOE.

Alerting

Alerting systems through unified communications can integrate with mobile computing platforms, thereby informing the clinician of key alerts pertaining to stat labs, trauma, cardiac disrhythmias, or code situations.

Radio Frequency Identification (RFID)/Location Tracking

Healthcare organizations have large numbers of medical devices, instruments, and equipment. Finding devices in the healthcare environment, when needed, is often a challenge. Radio frequency identification enables efficient tagging and locating of assets. These systems can reduce the time and expense necessary to find medical devices.

Unified Communications

Unified communications enable the marriage between voice and data systems. This can increase clinical agility by helping to integrate communications more closely with business and clinical processes, ensuring that information reaches those who need it quickly, effectively, and securely.

Unified communications can provide single-device and phone-number accessibility to the provider. It enables clinicians to use mobile computers to receive a unified view of calls, calendars, data, and e-mail anywhere, anytime, on any wired or wireless device. It also allows collaboration with voice, Web, or videoconferencing participants. This technology has specific clinical applications with video translation services or specialty collaboration.

Research

The above applications require infrastructure investment by the healthcare organization. These applications should make significant differences in the lives of clinicians, and in the cost and safety of healthcare.

As previously discussed, clinicians often struggle with research. There are a host of applications that can assist the provider with research on medication dosing, patient diagnosis, and standards of care. Many of these applications are free and available for Smartphone users. An excellent, extended list for Medscape subscribers can be found at: www.medscape.com/viewarticle/502873. Several examples can be seen below.

Software Package	Description
Epocrates Rx	This software package provides a free medication database that includes adult and pediatric dosing, contraindications, adverse effects, pricing, and formularies. It has a function to allow checking of drug-to-drug interactions on a patient's current medications. It is available for download at: www2.epocrates.com/products/rx.
Johns Hopkins University Antibiotic Guide	This guide provides information on infectious disease and antimicrobial therapy. It provides management guidelines, diagnostic criteria, and broad information on medications and pathogenic bacteria. It is available for free download at: www.hopkins-hivguide.org/download_center/main/palm/handheld_application_download_instructions.html?siteId=7151.
Diagnosaurus Medicine	This software package assists the clinician by generating possible differential diagnoses based upon patient signs and symptoms.

An excellent example of the possibilities of integrating wireless, unified communications, and clinical systems can be seen in the United Kingdom. Cisco and Informa Healthcare are integrating unified and wireless communications with the National Health Services' National Library for a health knowledge database. This knowledge database, referred to as the Map of Medicine, provides evidence-based recommendations for patient treatment and care pathways. Through this integration, a practitioner can have current evidence-based

recommendations for nearly any condition. Additionally, the practitioner will be able to locate an available specialist for consultation, as needed. Since the integration includes wireless, these capabilities are available to enhance collaboration in any setting. All of this functionality, plus the ability to use clinical systems such as e-prescribing, can significantly streamline the practitioner's workflow. The net result is higher quality and more efficient patient care.

What We Need to Know Now

As clinicians, it is not necessary to understand all of the inner workings of wireless technologies. It is essential, however, to understand key tenets of mobility. For the applications to meet healthcare needs, it is essential that the infrastructure be medical-grade. A medical-grade infrastructure is built upon the tenets of interoperability, availability, security, flexibility, and productivity.

The platform must meet clinical needs. It needs to be interoperable so that future devices can be added as needed, without changing the entire infrastructure. Interoperability is key, as changes to the infrastructure can cause downtime and affect patient care.

Finally, the infrastructure must be flexible so as to support new applications and fluctuations in user volume. If the infrastructure is not flexible, then it may not support new applications or workflows.

Medical practitioners need to understand the types of applications that can meet common clinical challenges. For applications to be beneficial, they should support ideal workflows, not merely digitize current business or clinical methods. Redesigning clinical processes requires participation in redesign and in the technology solution. Clinicians should align themselves with IT and biomedical departments so they have input into system design, which, ultimately, will impact clinical workflows.

To be maximally influential, clinicians should stay informed about current technology solutions. Several organizations are designed to educate clinicians about technologies that can improve their practices. One on the leading organizations is the American Medical Informatics Association (AMIA), which offers training programs and continuing education about medical computing.

The Vision of How it Could Be

Mobile and pervasive medical computing truly could change the landscape of clinical practice. Pervasive computing could put all patient knowledge in clinicians' hands, at all times. There could be on-demand diagnostic and treatment support based upon the most up-to-date guidelines. Documentation could be streamlined and standardized in a manner that avoids confusion or errors. Callbacks to hospitals and pharmacies for clarification or formulary matters would be a thing of the past, thanks to mobile CPOE. Radio frequency identification technology would assist in finding medical equipment when needed. Unified communications could enable on-demand consultation, eliminating time delays and other inefficiencies. Unified communications, with videoconferencing, would enable the use of video-enhanced medical translation services. Finally, clinicians could leave multiple devices behind and have a single device for most communications.

How Do We Get There from Here?

In order to receive the benefits of how it could be, it is essential that clinicians get involved. The simplest place to begin is by working with technologists. Clinicians must be part of the system design so that they have the opportunity to influence technologies, device selection, and future workflows. Only clinicians have the ability to truly understand how technologies can help a practice.

It is the clinician's responsibility to provide leadership by adopting technologies that can improve the practice and patient care. Better self-education on the applications available in the clinical and business environment, and how they can improve healthcare practices, is a key ingredient for higher-quality, lower-cost services.

Healthcare organizations look for clinicians to be part of pilot programs. This is a chance to evaluate and try new equipment. This also provides an excellent opportunity to get involved, provide feedback, and be part of the solution.

Insider Perspective

As a family nurse practitioner, with a background in business and technology, I have witnessed the many benefits technology has brought to business—benefits that can now be delivered to healthcare. Throughout the years, I have seen technology improve patient outcomes, decrease the cost of care, and improve work efficiency.

As we adopt new technologies that improve all aspects of healthcare services, the primary beneficiaries will be the patients—receiving better care, more timely services, at lower costs, with increased security.

More Information

The Cisco Internet Business Solutions Group (IBSG), the global strategic consulting arm of Cisco, helps Global Fortune 500 companies and public organizations transform the way they do business—first by designing innovative business processes, and then by integrating advanced technologies into visionary roadmaps that improve customer experience and revenue growth.

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