

TELEMEDICINE 101 – TELEMEDICINE TECHNOLOGY TOPICS

Hospitals Unplugged: The Wireless Revolution Reaches Healthcare

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Typing on the flat screen display of his wireless workstation, a nurse records his patient's history and vital signs directly into the patient's electronic record. As the patient continues to discuss his family's medical history of heart disease, the nurse's pager rattles and buzzes, displaying an abnormal ECG rhythm and heart rate of a critical patient five rooms away. The nurse excuses himself and attends to the ECG alarm. Elsewhere in the hospital another nurse administers medication to another patient after using a wireless scanning device to double check that it's the right medication and dosage for that patient. Minutes later, the patient's physician walks in after reviewing the patient's dynamically updated medical record via her wireless digital assistant. After speaking with her patient at some length, she enters her notes and orders additional medication and physical therapy. These orders are instantly checked with the pharmacy and logged in at the physical therapy department.

A new medical revolution

As the health care industry's transition from paper to electronic medical records continues, another technological revolution is taking place in hospitals, clinics, and practitioner's offices. Health care delivery itself is being increasingly mobilized through the use of wireless technologies. Innovation in wireless technology has exploded for all kinds of users in recent years. Consider, for instance the progression from those bulky, gray cellular phones to their Web-surfing progeny that are now just slightly larger than a matchbox and have infrared capabilities. Widespread reliance upon computer networks (present in almost every kind and size of organization), coupled with the colossal growth of the Internet demonstrates the benefits

of shared data and resources. Wireless technology simply adds another critical layer to sharing information: mobility.

Driving forces

Driving this wireless technology phenomenon are the recognizable goals of increasing the *efficiency* of health care delivery—which usually translates into saving/making money—and improving patient care through enhanced communication of medical information. Champions of the wireless revolution claim this technology—at least some applications—will reduce medical errors, increase accuracy of data, increase efficiency of health care personnel, and overall, improve patient care. They make a convincing case by claiming that caregivers need real-time access to accurate patient data — clinical histories, treatments, medications, tests, lab results, insurance information. With wireless networks and mobile computing solutions, caregivers can tap vital information anywhere in the healthcare network. Timely information is obviously valuable and leads to more efficient, cost-effective care. The cost of medical errors to our health care economy—not to mention the actual lives lost or harmed—may even be reduced using wireless technology that is integrated with a medication management system (more detailed discussion to follow).

Wireless computing basics

Utilizing wireless technologies on any significant scale requires installation of a wireless local area network (WLAN). WLANs are flexible data communication systems that link together various wireless end users within a physician's office, hospital building or even medical campus. Using electromagnetic waves (radio and infrared), WLANs transmit data through the air at a defined (and safe) frequency, and thereby minimize the need for wired connections. Thus, WLANs combine data connectivity with user mobility.

Albeit on a much simpler scale and different frequency, WLANs are akin to cordless phones, with a base station, antenna, and hand-held wireless receiver. WLANs use transceivers (a transmitter/receiver) that are linked to 'access points' and integrated with a facility's wired LAN. Access points act as antennae, or repeaters, and extend the distance between end users and the transceiver. End units—the actual pieces of equipment—could be mobile workstations, handheld data assistants or medication barcode readers, etc., and access the WLAN via adapters, which are essentially an antenna installed into the end user device. WLANs and their end units must conform to Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards for safe wireless transmission in medical facilities.

For a more technical treatment of how WLANs work, signaling characteristics, IEEE transmission standards, as well as wireless networks architecture, visit the *Wireless LAN Association*, a non-profit educational trade association.

The wireless market

IT market research analysts like Jason Smolek of Framingham, Massachusetts-based International Data Corporation carefully characterize the wireless LAN and devices market as growing, yet still nascent when compared to the worldwide wired LAN market. The WLAN

market was \$603.5 million in 1999, between \$785 million and \$900 million for 2000—compared to 55+ \$billion in wired LAN revenues—and forecasted to surge to 1.6 billion by 2004. Smolek admits the WLANs market is not yet a ‘mass market,’ but it is certainly gaining momentum. This is due in part to innovations in wireless technology as well as wider acceptance of IEEE’s 802.11 standard, which replaced a cadre of proprietary standards and has been adopted by over 90% of the wireless market. As a result, prices of WLANs and the wireless devices have dropped considerably.

Innovative wireless healthcare applications: more than souped up Palm Pilots™

A fair number of wireless technologies resemble Palm Pilots™, and are equipped with some amazing medical software. Beyond hand-held devices, the breadth of wireless applications show just how vast and innovative this wireless revolution is becoming. Most obviously, wireless technology seems to fit best in settings that would be difficult to install network cabling, such as imaging centers, laboratories, and surgery suites. Yet, wireless solutions could be useful at virtually every point of patient care, and even some places where patients themselves rarely tread—administrative offices. Medical wireless applications range from clinical monitoring to lab result reporting to medication management to robotic delivery carts to real-time eligibility verification and claim submission. The following illustrations show just a few of the wireless applications found in health care facilities today. (Where possible, Web sites for vendors have been provided.)

Administration and resource management

Wireless networks and mobile computing devices such as hand-held computers make quick work of healthcare paperwork. Wireless LANs connect hospitals, clinics and doctor's offices directly to insurance companies so that claims can be submitted as the care is actually delivered. Mobile computers and scanners can also keep medical supplies moving efficiently from the distributor, to the warehouse and to the health care facility. The logging of equipment, and management of inventory on wireless units can make the work of resource management much more efficient. (Symbol Technologies, <http://www.symbol.com>)

Wireless pre-hospital care

Wireless technologies can be implemented even before the patient enters the hospital with devices installed in ambulances. Critical cases often call for paramedics to call ahead to the emergency department to prepare the waiting medical team. However, with a wireless based video system, video images, audio, vital signs, and ECG rhythm strips can be captured and sent from a moving ambulance. Images can be automatically captured from a moveable camera in the ceiling of the ambulance, above the patient’s head. This information is reviewed in real or near-real time by not only the ED team, but also other tertiary center specialists. (EMS Wireless, <http://www.emswireless.com>; MedNets, <http://www.mednets.com/teleproducts.htm>)

Mobile workstations

Nurses stand to gain in the wireless revolution as well, as a growing number of hospitals are being outfitted with mobile workstations. This will allow health care personnel to collect a wide array of patient information, as well as carry out real-time charting in the patient's electronic medical record, and place orders for equipment or other therapies. The advantages of a nurse walking from patient to patient collecting and transmitting data on a mobile unit are obvious compared to running back and forth to the nursing station for manual input and retrieval of data. Whether these workstations are installed in patient rooms or fixed to a rolling cart, wireless technologies permit a growing number of functions to take place remotely.

Mobile workstations can also be found in surgery suites and during emergency procedures, where wireless technologies keep operating room and emergency room staff in constant communication with each other and with lifesaving patient data. Laptops equipped with wireless PC card adapters stay at the surgeon's side, even in the operating room. (Intel, <http://www.intel.com/network/go/wireless/health.htm>)

Medication management

Handheld scanning devices, analogous to the bar code scanners found in grocery stores, are now being used by nurses to access Internet-based electronic medication records databases. A nurse scans the bar-coded medication and the patient's bar-coded ID bracelet to confirm that the right medication is given to the patient at the right time and right dosage. Mobile systems like this have the obvious benefits of improved medication management, which potentially can reduce medical errors—a costly by-product in an increasingly complicated and fast-paced health care system. Other wireless hand-held devices allow medical personnel to access patient medication profiles, request medication refills, and perform dosage calculations. Still others provide chronically diseased patients with wireless devices to ensure that they not only start their medication regimen, but also continue to alert patients (with alarms) to take their medication on time. (Numoda, <http://www.Numoda.com>; Pixys, <http://www.Pixys.com>; SmartMeds, <http://www.SmartMeds.com>; and Symbol Technology, <http://www.Symbol.com>)

Hand-held data assistants

The days when physicians kept a pocket full of paper scraps with patient data, notes, and a tattered mini drug reference guide in their lab coats may soon be over. In its place are wireless hand-held devices that offer the practitioner a multitude of instant references, patient tracking software and a real-time access to the pharmacy for starters. By the time practitioners master those functions, they'll also be able to tie in distant satellite clinics, access the hospital's patient record system, and connect to insurance companies or hospital database systems. It all boils down to more efficient access to information that will lead to quicker and possibly more accurate medical decision-making. (E-Physician, <http://www.ephysician.com>; I-Scribe, <http://www.iscribe.com>; PatientKeeper, <http://www.patientkeeper.com>; Unbound Medicine, <http://www.unboundmedicine.com>)

Patient monitoring

A wireless network enables hospitals to make any bed a 'monitored bed.' Wireless monitoring of patient beds has many benefits, not the least of which allows continuous

and non-invasive tracking of patient vital signs without disturbing the patient. Another patient monitoring application includes wireless mini-laptops that give health care practitioners real-time access to patient data. Such devices not only view live patient data, but also look retrospectively to examine trends. Some devices—which resemble pagers—ring if a predetermined vital sign or waveform (ECG) reaches an unacceptable level or form. A tone or vibration will alert the caregiver, displaying the most recent ECG waveform, heart rate, patient's name, room number and alarm message. (VitalCom, <http://www.VitalCom.com>; Data Critical, <http://www.datacritical.com>)

Ambulatory/Home patient monitoring

Wireless technologies can also be applied once the patient has left the reaches of the hospital's WLAN. Several wireless units now offer telemetry monitors which track a number of vital signs, such as ECG, heart rate, pulse oximetry, noninvasive blood pressure and send it back to a central nursing workstation. These units are slightly larger than a cordless phone, and can be used telemetrically as well as a stand-alone monitor. At home, patients can be trained to use these devices to remotely monitor and transmit their medical data to a host computer. Diabetes care is a popular application where patients can regularly monitor their blood glucose levels and send this data to a central station. (Protocol Systems, <http://www.protocol.com>)

Conclusion

Health care facilities of all sizes are taking advantage of the mobility that comes with wireless LAN technologies. With wireless technologies, a variety of health care professionals, even those in administrative offices, stand to gain from improved access to information at the bedside or other points of patient care. The proliferation of wireless enabled devices may not leave any area of health care, clinical or administrative, untouched.

User acceptance seems to be one of the keys to success for this new industry. Using a real-time, interactive portable wireless device is a clear “paradigm shift from traditional provider models, and requires high levels of solution tailoring and customer care,” according to Technology Assessment Associates. In an industry where only ten percent of doctors presently communicate with their patients by e-mail, it may be difficult to encourage more complicated technologies, like hand-held devices, to order prescriptions. Doctors, among other health care personnel, will need convincing that the wireless technology wave will save them time and/or make them money, instead of just another layer that complicates the practice of medicine.

At a recent conference, *E-Healthcare Summit* in Boston, Massachusetts, Ken Dulaney, an analyst for the Gartner Group, predicted that by 2003 forty percent of ambulances will have handheld computers to identify patient condition and status. He also expects that sixty percent of hospitals will install wireless bedside monitors to enable nurses to order supplies, update records and track medication.

While not the focus of this article, there are some limitations to wireless LANs, not the least of which is the markedly slower speed at which WLANs operate, and therefore, the speeds at which wireless devices communicate. WLANs can transmit at 11 Mbps (your results may vary) versus

the near 100 Mbps that we have become accustomed to over wire LANs. Hopes of sending digital X-rays and other diagnostics through the air may not be a reality until wireless technology catches up with wired LAN speeds. Adding wireless network management expertise to medical facility IT staff will also add to the total cost of adopting wireless solutions.

And while we may dream of delivering health care without being tethered to network cables and tripping over computer wires, we ought to approach the adoption of wireless technology with care—just as with any other technological transition. There are many innovative wireless devices currently available, and many will probably take root, but we ought to first determine what problems we need to solve in health care delivery instead of looking at the technology first and then discovering a use. Potential wireless customers should conduct a cautious analysis of critical physical and clinical problems to determine if wireless computing offers the right answers.

In general, wireless technologies remind us just how vital communication is—even in the modern practice of health care. Wireless transmission of health information may well empower nurses, physicians and the billing office alike to communicate more efficiently, and become more mobile and better informed in delivering the best patient care possible.

Learn more

- AIIM International
<http://www.aiim.org>
- E-health Group
http://www.ehealthgroup.com/mobile_health.asp
- Health Data Management
<http://www.healthdatamanagement.org>
- Hospital Network.com
<http://www.hospitalnetwork.com>
- Internet Health Care Mag
<http://www.internethealthcaremag.com>
- Mobile Healthcare Alliance
<http://www.mohca.org>