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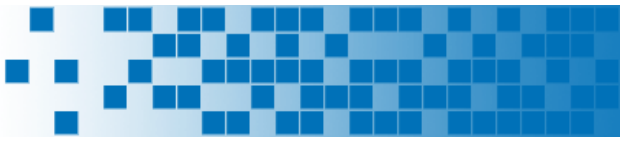

Innovative Technologies in the Emergency Room Department

June 2007

"Don't wait for the future, it comes too fast."
-Unknown

Introduction:

The intent of this paper is to describe the problems and challenges that Emergency Departments (EDs) are facing in the current healthcare environment. Due to rising costs and increased pressure on delivering high quality health care, the hospital's ED is often neglected because of internal hospital economics. The ED of today's hospital has become the "bleeding edge" of the health care delivery system. The ED is a major consumer of hospital's resources and the returns are often marginal.

If you are considering closing your ED for economics reasons, be aware that there are technologies available that will improve the functionality of the ED and also provide a sufficient return on investment.

The Vision:

In July 1998, Mark S. Smith and Craig F. Feied, wrote a paper that was published in the *Annals of Emergency Medicine*. The paper illustrates a vision of how the Emergency Department of the future might look and function; advances in clinical care, administration, research and education are described. Interestingly enough, the advances described in the paper were driven by the technology that is currently available.

The theme of the paper is to restore and enhance the traditional role of the physician as a hands-on provider of direct patient care. The efficient flow of information is the focal point for these changes. It has been nearly a decade since this paper was published and the technology available today is more advanced and less expensive. However, only one in six EDs nationwide utilizes this advanced technology.

The Reality:

We can't fix a problem if we can't measure it. So let's attempt to measure the current state of ED operations. The emergency department structure and design in today's environment is based on models developed in the 1970's. Much of the documentation and flow of information in the EDs of the 1970's was paper-based; the paper-based environment continues to dominate the majority of the EDs across the country.

Much of the provider's time is consumed by looking for charts, recording and re-recording the same data over and over again, tracking lab and radiology results, and trying to locate a patient or staff member. As a result, more time is spent looking for information than is spent analyzing that information. This disconnect in the flow of information coupled with significant increases in the number of patients seen in the ED leads to increased medical errors and, as a consequence, increased malpractice premiums.

The current ED is in crisis due in part to the following:

1. In 2003, Americans made 114 million visits to the ED - an increase of more than 26% from a decade ago.
    a. During the same period, the number of Emergency Departments decreased by 12.4%. In the past decade, more than 100,000 inpatient beds and nearly 8,000 Intensive Care Unit beds were also closed in an effort to reduce hospital costs.
2. Visits to the ED for severe and chronic illnesses by patients over 65 years of age are increasing and contribute significantly to overcrowding.
    a. In April 2002, the *Annals of Emergency Medicine* reported an increase of 59% in critically ill patients visiting the ED in California emergency departments over the past decade.
3. Cutbacks in reimbursement from Medicare, Medicaid, and other payers have reduced the hospital's resource capacity to take care of patients in the ED.
    a. Payment denials and an increasing number of uninsured patients also contribute to the problem.
    b. Approximately 50% of emergency services go unpaid according to the Centers of Medicare and Medicaid Services.
4. In 1986, The Emergency Medical Treatment and Labor Law (EMTALA), enacted a law that requires that anyone who is present at an ED is entitled to be treated and stabilized, regardless of their ability to pay.
    a. EMTALA is an unfunded mandate. According to the American Medical Association, an emergency physician provides an average of $140,000 in uncompensated EMTALA-related care each year.
    b. Over one third of the emergency physicians provide more than 30 hours of EMTALA-related care each week.
5. The US Department of Health & Human Services estimates that nearly $60-$108 billion of the total healthcare costs are due to medical liability.
    a. Insurance premiums for emergency physicians grew on an average by more than 50% from 2002 to 2003 to nearly $53,000 annually, with some paying more than $100,000 per year.
    b. Physicians on call specializing in Neurosurgery, Orthopedics, and Obstetrics & Gynecology have the highest premiums because they perform procedures with higher risks and treat patients with more serious illness than other specialties.
6. Increasing numbers of frivolous medical liability suits and skyrocketing jury awards have forced many specialists to either change their specialties or give up their practice entirely.

The items above lead to overcrowded, understaffed, error-prone EDs that drain the limited hospital resources and force many EDs to close. The closing of EDs compounded the problems for the remaining emergency departments by increasing their patient volume, patient wait times and compromising the quality of care.

The Answer Lies Within:

While patient traffic in the ED has increased and the treatment for certain emergencies has changed, there has been relatively little done to streamline the workflow and processes to make the ED function efficiently. Unfortunately, the healthcare industry has always been behind other industries in adopting new technology and redesigning work processes. The level of efficiency

achieved by other industries is visible in our day-to-day life. If you have ever made any online purchase, you can track the progress of the shipment minute by minute until it is delivered. However, we seem unable to track our patients, wheelchairs, and other equipments in our EDs even though the technology is widely available.

The key to the problem is to re-design and re-engineer the work process of the ED and using technology as a tool to get the best "bang out of the buck." Re-design is the key; automating the current environment will just speed up our inefficiency and we will just make the same mistakes at a faster rate.

Special needs and requirements:

1. Real-time, fast access to critical data allows informed decisions at the point-of-care;
2. Positive patient identification and tracking;
3. Improved patient flow - faster input, throughput, and output;
4. Improved communication systems provide easier access to physicians and staff.

Technology that will improve the flow of information:

1. Radio Frequency Identification Device (RFID)
2. Voice & Data Transfer (VoIP)
3. Mobile Computing
4. Wireless Infrastructure

Radio Frequency Identification Device (RFID)

The components of a RFID system consists of a RFID tag which is an electronic chip with a unique Identification number and an RFID reader with an antenna connected to the internet or the hospital's intranet. The information captured by the reader is transmitted to the hospital's servers and enterprise applications.

Mid- to High-Frequency RFID tags are the most commonly used RFIDs. They are used mainly for access control and managing smart cabinets, exit door security, and prescription tracking.

High- to Ultrahigh-frequency tags are used in Real Time Location Systems such as patient tracking, patient monitoring, sensors and telemetry equipment monitoring.

Microwave tags are now being used because of their applications in VoIP, Wi-Fi, and utility monitoring. These Ultra-wide Band tags are still in the experimental stages; it is believed that they will be capable of managing high volume data and video streams.

Types of RFID:

There are two types of RFID tags available**,** Active and Passive. Active Tags have their own power source in the form of a battery and a transmitter which broadcasts the signal to the nearby antenna. The range of an active tag is about 30-100 meters. The active tags costs about $10-$50. Passive tags don't have their own source of power, they just receive radio waves, alter them and reflect the waves back to the reader. The reader can identify the unique tag by the way the radio wave has been altered.

The range of passive tags is from few inches to 30 meters. The passive tags can cost anywhere between 20 cents to 40 cents. The cost variation is due to the frequency range of the radio waves in which the tags work and also the amount of memory in the chip.

Some applications of RFID specific to the ED are:

1. Positive Identification of patients and patient tracking;
2. Medication and transfusion error reduction;
3. Assets, supply and inventory management;
4. Patient flow, event specific tracking,
5. Laboratory, and radiology ID and tracking.

Approximately 20% of the staff nurse's work is spent on trying to locate a patient or trying to reach a staff member. Assigning a unique RFID tag to a patient (Real Time Location Tracking) will significantly reduce staff and physician time locating patients. The same tagging process works well with physicians and staff. The system can track the location of the physician or nurse and also record time spent with patients. The unique ID number also allows for quick retrieval of patient information.

Time saved in the ED is very apparent; the implementation of RFID has reduced overcrowding in some EDs by almost 50%. The time saved in the ED can used for providing better care to the patient and will ultimately improve the quality of care. An Active RFID system working on Wi-Fi network not only saves time in the ED, it also helps in monitoring patient biometrics when combined with Nanosensor technology used in implants.

Case Studies

Newark, Delaware-based Christiana Care Health System (CCHS) solved its patient tracking by using a Wireless infrared passive tracking system and RFID technology. The hospital reported a of 20-45 minute reduction in the length of stay of patients treated and released from the ED. Patients that were admitted were reported to have a reduced wait time of about 35 minutes. The study also reported a reduction in the manual entry of patient data at various patient encounter points. The effectiveness of the RFID implementation was also aided by installing an EDIS called ED Tracker which linked the ED data to the laboratory, radiology and other ancillary departments.

CCHS also found that the tracking data collected by the RFID was used to analyze wait times and improve upon operations of the ED. CCHS attributes its success in implementing and using the RFID technology mainly to the recognition of the importance of this technology by the management and staff of the ED.

Goodall Hospital in Maine initiated a $50,000 pilot project to use Active RFID tags with wireless technology to track patients and staff in their ED in October 2006. The project was intended to replace the traditional whiteboard to track patients and improve the workflow of the physicians and nurses. The tags were put on the patient in the form of a 2X2 wristband powered by a battery and in the badges of the emergency staff.

The system alerted the emergency staff of exceeding wait-times, allowing caregivers to respond appropriately. The ED reported a decrease in the patient wait-time in the ED to about 2 hours, which is well below the national average of three and a half hours. The hospital also uses this system to analyze and predict the patient flow and to align staff according to needs.

RFID vs. Bar-Coding

RFID offers some distinct benefits when compared to Bar-Coding:

- No “line of sight” requirements
- More automated reading
- Less labor required
- Improved read rates
- Larger data capacity
- Ability to “write” information on a tag
- Effectiveness in harsh environments (e.g., temperature extremes, dusty and dirty conditions)

VeriMed Inc

VeriMed’s VeriChip Patient Identification System which consists of handheld radio frequency identification (RFID) scanner, an implantable RFID microchip and a secure patient database, is being used to help rapidly identify and provide access to important health information on participating patients who arrive at an emergency department unconscious, delirious or unable to communicate. This implantable RFID system is the only system of its type cleared by the United States Food and Drug Administration (FDA) for use in people.

Concerns Specific to RFID

The main concern expressed by patients in RFID tagging or permanently implanted into the patient is that of privacy and unauthorized tracking. A concern of ED management is the high cost of implementing the RFID Tags and readers.

The cost of the RFID tags is declining steadily from $1 in year 2000 to about 5 cents by 2006 for the passive tags. In 2004, the RFID readers cost an average of $1000, but in 2006 the cost was about $200.

Return on Investment (ROI) & Financial Impact of RFID Implementation

The ROI of RFID implementation cannot always be quantified in dollars; many of the benefits are in the form of improved quality, efficiency, and safety. Direct cost savings can be achieved through improved inventory, asset tracking, and reduction in equipment theft. Reducing staff overtime is an ROI by itself. RFID also systems must also be integrated with EDIS for efficiency.

Voice over Internet Protocol (VoIP)

The use of a standardized, platform neutral, device neutral IP-based communication system integrating VoIP and Wi-Fi allows for cost-effective communication and improved quality of clinical care.

Voice over Internet Protocol or VoIP is a method of transmitting voice data over the Internet or the Intranet that provides efficient and inexpensive communication along with extended capabilities and features over the traditional telephone. It could be through an Analog Telephone Adaptor (ATA) or IP phones or Computer to Computer. VoIP can use several protocols depending on the network. The VoIP system can also be seamlessly integrated with the existing PBX systems without disrupting existing communications channels.

For example, using a traditional PSTN or a PBX, a 10-minute phone call will consume a 10 full minutes of transmission time at a cost of 128 Kbps. With VoIP, that same call may have

occupied only 3.5 minutes of transmission time at a cost of 64 Kbps, leaving another 64 Kbps free for that 3.5 minutes, plus an additional 128 Kbps for the remaining 6.5 minutes. Based on this simple estimate, another three or four calls could easily fit into the space used by a single call under the conventional system. The use of data compression can further reduce the size of each call. VoIP is an inexpensive and efficient alternative to communication with better ROI than other systems.

A VoIP infrastructure requires a VoIP capable handset or a VoIP soft phone installed on the desktop and connected to the intranet or the internet. A traditional phone connected to the network through a VoIP Adaptor can also be used. A Wi-Fi enabled VoIP "hands fee" communication device allows extended mobility.

VoIP can be enabled in numerous devices such as notebooks, smart phones, Handheld PDA or desktop computer by installing the soft phone and logging on to the network. This mobility allows the user the freedom to choose the device of availability or preference. Staff in the ED can use the "hands free" devices to communicate with other departments. Physicians can use the VoIP to conduct emergency calls while they are scrubbed and performing a procedure.

Some of the salient features that the VoIP communications are:

1. Seamless Voice Contact: The user can call to a land-line, PDA smart phone, notebook, or the Wi-Fi phone.
2. Broadcasting, Conferencing, Call-Transfer, Voicemail are much easier to use in a soft phone when compared to the traditional land-line. All these additional features can be configured according to the user's preferences.
3. Automatic Call transfer allows for routing the call to a back up nurse or physician if the primary contact is unavailable.
4. Alerts and Alarms from a patient room are managed better because the departments involved in emergencies are notified automatically.

VoIP Communications systems provide enhanced staff productivity due to presence detection and instant messaging capability. Instant teamwork allows for better outcomes in the ED by reducing time in tracking physicians and staff members. A single interface allows for better management of the user's communication. Since VoIP systems allow for the integration of voice, data and support services results in a better work environment in the ED. A better work environment allows more time for hands-on clinical care.

The seamless communication ability of VoIP anywhere in the wireless enabled hospital is far superior to cellular phones and makes a strong case for the usage of VoIP devices in the ED.

Case Studies

St. Agnes Hospital & Vocera VoIP Communication Device

St. Agnes HealthCare is a 299-bed non-profit healthcare organization serving in the Baltimore/Washington Area. St. Agnes Hospital recognized the benefits of a mobile workforce and deployed a solid, secure, highly-available wireless infrastructure in the late 1990s. Vocera Communication Systems is a communications application that utilized speech recognition software on the hospitals wireless network. The system enables the staff to communicate instantly hands-free manner one another either hands-free to hands-free, or to wired phones.

After installing the Vocera hands-free, voice recognition system in 2003, the hospital has reported a substantial time savings in overall communication. The unit secretaries saved 1650 hours, nurses saved 1,146 hours, and nurse technicians 626 hours. The cumulative savings amounts to an equivalent of 1.7 FTEs or 3,400 hours saved annually. The study also reported an improvement in the workflow and the care-givers ability to deliver quality care. The communication system utilizing Vocera was found to be approximately five times faster than the conventional system. Significant features of the Vocera system include the ability for voice controls and to call the contact by name, title, designation, function or group eliminating the need to remember numbers. The system is also integrated the hospitals existing PBX for outside calls (both incoming and outgoing).

MetroHealth

MetroHealth's Emergency Department nurses are provided with wireless VoIP devices which uses the Emergin Middleware to assign each nurse with a unique ID. This helps mapping each nurse's assigned patient to their cardiac monitors and call buttons. The nurses receive calls from the wireless network and alerts from the cardiac monitoring devices. Any emergency alert or a Code Blue notifies all staffers through their wireless devices. The nurses reported efficient communication with monitored patients and with the physicians with no missed calls. MetroHealth was able to reduce the number of staff dedicated to monitoring the cardiac patients from five down to one. The outcome is an annual savings of $200,000 with significant improvements to quality and patient care.

ROI and Financial impact of VoIP systems

The ROI of the VoIP system in quantifiable terms include larger call volumes with better usage of bandwidth, substantial savings in man-hours, cheaper extended features on voice systems. The soft-benefits include improved communication, mobility and a better work environment for physicians and staff in the ED. St. John's Hospital, Springfield, Illinois implemented a Wireless VoIP over their Wi-Fi network. They reported an average of 30 minutes saved per person per day using VoIP compared to traditional systems translates to nearly $2 Million per year.

Concerns of VoIP Systems

1. Concerns regarding VoIP include security issues while using public Wi-Fi Networks. Security issues including spamming, and spoofing which can be controlled by implementing appropriate security software
2. Confidentiality is a concern, the Voice Data is sometimes transmitted unencrypted, and requires adequate security and encryption.

Mobile Computing

The work environment in the ED is highly time-sensitive, requiring clinical data to be made available to the clinician in short periods of time creating an increased reliance on multiple computer resources. Physicians have to use more than one terminal or workstation to retrieve critical lab and radiology results. At the same time, the workstations are limited in availability leading to queuing and delay in information access and data entry which slows down the clinical workflow and decreases the quality of care provided.

The need for mobile computing in the ED is due to the demand by the ED physician to get access to critical necessary information on a personal device, wherever he is, as soon as possible in a usable format.

Mobile computing can be classified as personal computing devices and mobile workstations. Personal Computing devices consist of Smart phones, Palm Top Computers, Tablet PCs & Ultra-Personal Computers connected to the hospitals Wireless network. Mobile Workstations are mobile carts equipped with a laptop, scanners and readers connected to the ER's or hospital's Wireless network. Mobile computing enables physicians and nurses to access critical clinical information at point-of-care allowing for improved ability to take informed treatment decision.

Some of the functions mobile computing is used for are:

1. Charting and documentation - registering and documenting patient information and history at the bedside;
2. Monitor vital signs - vitals signs and EKG rhythms can be accessed real-time on the physician's Palm tops to allow continuous monitoring;
3. Prescription and ordering - the mobile computers are a helpful resource for up-to-date information on references and pharmacology library;
4. Drug administration - mobile workstations and PDAs with integrated readers and scanners allow for Positive Patient Identification and error-free drug administration;
5. Tracking laboratory and radiology results on the mobile computers is easier and it also allows for instant messaging through smart phones to other staff;
6. Medical calculator and access of educational information;
7. Databases - case tracking, performance evaluation;
8. Medical records - patient tracking, coding and billing;
9. Communication (combined handheld – cellular phone, PowerPoint presentations;
10. Personal Organizer - day planner and contact lists.

Benefits of Mobile Computing:

1. Reduced medical errors
2. Real-time information access of clinical information
3. Increased quality of patient care
4. Improvements in the work environment for physicians and staff
5. Faster and convenient patient registration
6. Decreased operating cost

Case Studies

Handheld computers have been used to transmit Echocardiogram and EKG rhythms real-time to the clinical personnel for review in the ED. The study in Santa Creu Hospital in Barcelona showed that the echocardiogram led to a change in the diagnosis and treatment in 27% to 46% of patients, allowing an early discharge in 49% of cases. The agreement between the observers was acceptable. The study concluded that Portable echocardiography is a useful tool in emergency rooms and may be reliably performed by medical personnel with basic training in echocardiography & EKG (Leta, R et al, July 2003).

According to Oliver Wenker, a study at the Case Western Reserve University (University Hospitals of Cleveland) indicated that handheld computers allow physicians to have information readily available at the point-of-care; one device replaces a small library of books and journals.

Additional memory can be accessed in the form of flash memory cards. Real-time access to searchable relevant medical content and results of laboratory values or other patient examinations will clearly be of benefit to the physician. The handhelds were instrumental in reducing medication errors by allowing for handheld prescriptions. Better reference of educational material and improved mobility were additional reason for acceptance of the handhelds by the clinical staff.

ROI & Financial impact of Mobile Computing

The main ROI of Mobile computing is in making better use of the clinical staff working hours in the ER. Redundant entry of data is minimized. Bedside registration and bedside clinical information access allows for time saved in charting and documentation. There is Improved Charge capture due to real-time Patient-Physician encounters being recorded efficiently. The overtime and change of charge between shifts are reduced leading to savings in FTE hours. The quality of Clinical care is improved due to point-of-care access to patient information and references.

Concerns:

Handheld computing needs uninterrupted access to the wireless networks. The access points in the ED and the hospitals should be adequate enough to provide extended coverage for the devices with no break in services. Battery power and memory are a major factor for physicians' concerns about usage of the handhelds. Security and access of the handhelds must be addressed prevent unauthorized usage of data by a third party.

Wireless Infrastructure

The technologies discussed work effectively when they are integrated to the backbone infrastructure of the wireless network. To achieve the benefit in the ED, a multi-purpose backbone infrastructure that will integrate all devices and applications across all departments and disciplines is necessary. This in turn requires that the infrastructure be designed as simple as possible for adaptability and easy integration. Increased productivity is achieved when there is seamless integration of voice and data applications on the same infrastructure.

Wi-Fi or Wireless Fidelity or 802.11 networking makes connecting to the internet easy for everyone. It is less obtrusive and good coverage is possible by having adequate number of access points all over the hospital. Wi-Fi is the solution for this infrastructure problem as it is platform independent, device-independent, physically less bulky and cheap. Also, the installation of Wi-Fi is relatively inexpensive and quick compared to other infrastructures. There is no interference of Wi-Fi with the hospital systems and equipments. If your ED is currently using a WLAN for data transfer the logical step of VoWLAN or VoWi-Fi is very cost effective.