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Information management in the emergency department

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"If you cannot measure it, you cannot manage it"—trite, but true. Such is the state of many emergency departments (ED)—unmanageable because of a lack of valid measurable metrics of patient care. Even worse, often the information that *is* available is inaccurate, too little, and too late to affect patient care on a real time basis. Such are the challenges for ED managers in the current health care environment. It seems that technology would be a natural tool to fill this information gap. On the other hand, for technology to help, it must be usable, reliable, appropriate to the task, cost effective, effectively implemented, and it must improve efficiency of the ED—a daunting task. There are perhaps few other initiatives in the ED that have such potential for good *and* harm as ED information systems (EDIS). This article focuses on the critical aspects of EDIS and offers suggestions for successful product selection and implementation.

Emergency department information system (EDIS): "garbage in—genius out"?

One of the common mistakes when deciding to install an EDIS is assuming it will make a bad situation better. The best way to assess and implement an EDIS is to design a good process and then automate it. Otherwise, computers offer the opportunity to make bad things happen faster and bigger, if poorly designed and implemented.

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Many EDs, even on a good day, are dysfunctional, and the reasons for this have been well documented [1]. Just as adding a new baby to a dysfunctional marriage always makes things worse, one should not assume that adding an EDIS will solve fundamental inadequacies of an already dysfunctional ED. In fact, doing so will undoubtedly exacerbate the situation.

Example #1. If identifying, repairing, and maintaining broken equipment in the ED is already a problem, adding hundreds of additional pieces of computer equipment will exacerbate the problem. When the EDIS depends upon having a functional "special" printer in each ED area and that printer fails, so does the EDIS. Planning for equipment redundancy for the EDIS is as important as other ED equipment.

Example #2. If patient throughput is a problem in the ED because of poor staffing or other reasons, adding the additional work required by an EDIS to already overworked staff will make the situation worse, perhaps much worse. In a large urban trauma center with 70,000 annual visits, Left Without Treatment (LWOT) increased by 100% in the first month after installation of a new triage/tracking EDIS [2].

In preparation for introducing an EDIS, one therefore should first assess and repair the current ED processes and environment. Once implemented, the EDIS can assist in refining these fundamental improvements, rather than merely illuminating, documenting, and exacerbating an already broken system.

The interface—making EDIS work

EDIS only reaches its potential and offers a real opportunity for efficiency if it is integrated and properly interfaced with all necessary new and legacy hospital information systems. These interfaces include often ignored equipment such as cardiac monitors, EKG machines, and automated vital sign and pulse oximetry equipment. In the future, interfaces with community-wide and even nationwide health care information networks will truly provide all of the information necessary to care for any patient at any time.

Most EDs rely on computer interfaces to hospital systems that are not totally reliable. Anyone who works the night shift knows how frustrating it is when the hospital system "goes down" for routine maintenance. During this downtime, ED personnel are forced to fall back on archaic manual methods of information management. As a result, many EDs have acquired standalone, proprietary EDIS products that are difficult, if not impossible, to integrate into hospital-wide systems. At best, these standalone systems are transition technologies that serve limited functionality and will perhaps never meet all of the EDs information needs.

Efforts to redesign the information environment must go beyond simply automating paper flow in the ED. Instead, the goal should be to support the

department's business plan with a design that combines productivity and profitability with the delivery of high quality patient care. This can be best accomplished in a stepwise approach (Box 1). This article helps begin that process and provides the tools necessary to implement a usable, functional, and efficient EDIS. For an expanded view of where EDIS should be, read *A view of the emergency department of the future* [3].

EDIS functional considerations

Remote access

ED managers never really leave work and increasingly that is true of other staff as well. The need to remotely access data is a new health care reality and comes in a variety of forms. Medical records retrieval, online authorization (signature), staff scheduling management, e-mail advisories—the list may be endless. Although perhaps intrusive into one's personal life, the efficiency gained by this functionality is enormous. The goal is to have the ability to securely access the EDIS from any web-enabled computer worldwide.

Authorization and identification systems

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) has forced many hospitals to reassess how Protected Health Information (PHI) is accessed. At the same time, it is an opportunity to apply new technology to what may seem an onerous mandate. Automated login/logout by way of infrared badges is one such solution. Regardless of the technology, the need to access multiple computers and information systems must be coordinated to avoid "password-bloat." Using the same technology, access to various hospital locations can be authorized and restricted for hospital personnel.

Positive identification of patients also must be addressed. The extension of "unsecured health care loans" under the guise of "you don't have to pay today, we will bill you," has become a severe financial strain on EDs. This is often due to inaccurate or even fraudulent information. Integrating

Box 1. Strategic information systems planning overview

Step 1. Establish planning parameters
Step 2. Assess the current information environment
Step 3. Propose a new conceptual information environment
Step 4. Investigate potential solutions
Step 5. Plan implementation strategies
Step 6. Develop action plan

demographic verification software and procedures is an often missed opportunity for revenue capture in the ED [4].

Patient-centered automation

The electronic medical record (EMR) should be updated automatically as soon as the information becomes available.

New patients to a doctor's office spend the first several minutes completing medical history forms. This is not only a vital part of the medical database acquisition, but also important for coding and billing. Most EDs fail to take similar advantage of those patients who are capable of completing this part of their medical history on their own. Automating the process of registration, chief complaint, history of present illness, review of systems, family/social histories, medications, and allergies is a ripe opportunity to gain vital information and efficiency in the ED data collection process. Using a touch-screen computer (no keyboards) and scanner, most patients are able, and perhaps be more than willing, to self-register and feel as if they are actively involved in the process.

Passive patient tracking (by way of infrared or radio frequency tracking devices) not only automatically tracks location, but also how long it takes to move through the ED. Such systems can also automatically log patients into the computer terminal closest to them and avoid misidentification. Tracking of staff using similar technology is somewhat controversial, but can provide invaluable data for staff management and productivity.

Computer-assisted triage protocols based on data input can help ancillary personnel to initiate diagnostic tests and necessary treatment from the moment of arrival. Artificial intelligence protocols have the potential to further automate the clinical decision-making process and provide enhanced ability for the ED staff to recognize common and not so common clinical syndromes. Prompting for diagnostic considerations and providing recommended treatment standards can greatly enhance staff efficiency and clinical accuracy.

Computerized provider order entry

Computerized provider order entry (CPOE) is the latest buzzword in EDIS. A landmark CPOE study [5] from 1993 showed that physicians using a computerized order-writing system discharged patients on average 1 day earlier and with medical bills $900 less than physicians using traditional order entry methods. The system also warned of potential drug interactions, patient allergies, and expensive treatments.

CPOE promises to be a key component to increasing patient safety, efficiency, and functionality in patient care, but research and development in this area is ongoing. Although this aspect of EDIS serves as an enhancement, it should not necessarily be considered a prerequisite to implementation of an EDIS. For more information go to www.cpoe.org.

Consolidated digitized environment

For an EDIS to be truly efficient, information must be in digital format. Any EDIS should keep digital information digital (CT scans/ultrasound/EKGs/cardiac monitoring/automated vital signs), transition analog information to digital (digital plain radiography), and digitize everything else (scan all paper). Before implementing the EDIS, every effort should be made to transition the entire ED to a digital environment. This allows the Bill Gates concept of "Information at Your Fingertips" to become a reality in health care. The goal should be for all information necessary to manage patient care to be available at a single computer workstation or mobile terminal.

Digital radiography in the ED has been demonstrated to be as reliable as hard copy [6]. The advantage is wide simultaneous accessibility and opportunities for contemporaneous reading by radiologists even at a remote site. Picture Archiving and Communication System (PACS) is becoming the standard in radiology for digital information management. Extending this to the ED is only logical and perhaps vital to an EDIS. Further, as the PACS can operate over the hospital TCP/IP network, the PACS workstation can also be used as the emergency physician primary workstation for all other computer functions. This concept reduces the number of necessary workstations, saving space and capital investment.

Scanning technology is inexpensive and reliable. Barcoding every piece of paper used in the ED allows for automatic archiving of digitized material and reduces the need to manage paper. The cost savings by eliminating NCR (no carbon required) paper alone often pays for such systems in short order.

Other digital opportunities, such as digital photographs and video, are made possible by the digital environment, but are not required for implementation of the EDIS.

Patient safety

The opportunities for patient safety systems in the digital ED abound. Computerized alerts for abnormal values (symptom recognition, laboratory values, vital signs, wait times, syndromic surveillance), drug-drug or drug-syndrome interactions, and patient monitoring (pulse oximetry, CO_2 monitoring) are but a few of the many opportunities.

Coordination of care

Automated notification of specialists, primary care physician, ancillary services (respiratory care), radiology technician, housekeeping, admitting department, and insurance plans are but a few of the opportunities available with EDIS. Further, exchange of patient data easily becomes HIPAA-compliant, immediate, and inexpensive using encrypted or secure internet

transmission. Nursing report for admitted patients can become an automated process. Documentation is completed simultaneously with patient care, so delays caused by documentation completion are eliminated.

Automated alerts can be transmitted easily to staff by way of pager or cell phone, such that work flow is not interrupted simply looking for data. For example, ordering a small volume nebulizer (SVN) treatment automatically notifies the physician for re-evaluation 10 minutes after completion. Automatic notification of laboratory and radiology results is automatically transmitted to the ordering physician.

Content

Computer systems are of limited value without reliable, up-to-date, evidence-based clinical content. This may well be the greatest future challenge for EDIS. Although most currently available EDIS provide adequate technical infrastructure necessary to manage data, the technical aspect of a comprehensive EDIS may be the easy part. The real challenge is to provide high quality clinical content that enhances the clinical staff's ability to make better clinical decisions and focus on patient care.

For example, discharge planning. A recent survey [7] revealed that there is no currently available peer-reviewed, evidence-based discharge instruction content. Further, the content that *is* available is often presented to patients in a non-user friendly way (ie, unformatted plain text).

Clinical decision-making content is also often lacking. Web links to emergency medicine web sites such as the National Center for Emergency Medical Informatics (NCEMI) are helpful, but often require searching for useful information. Integration of clinical decision-making content into the EDIS is essential to achieve the full potential of such systems.

Regulatory and liability considerations: when does an EDIS become a ''medical device''?

As ED information systems become more sophisticated and take on larger roles in patient monitoring and care management, they have the potential to create new opportunities for introducing error or fostering complacency among the ED staff. Reliability testing and perhaps even Food and Drug Administration (FDA) approval may become necessary. In the short term, these considerations may limit technology advancement or require frequent human acknowledgment of data input.

There are many obvious advantages to EDIS. The staff can spend time caring for and talking with patients instead of shuffling paperwork. Physician support is enhanced by the availability of remote specialists in real time who directly assist in making diagnoses. The EDIS also aids in diagnosis, so less time is spent wondering what you may have missed. Patients receive optimal care regardless of time of day. Updated medical records are distributed to appropriate parties instantly.

There are also some not so obvious advantages. Clinical information captured in local and national databases would allow real-time CQI/QA and opportunities for national data mining for research. Patient tracking identifies inefficiencies in department processes and enhances ED management. Staff productivity can be monitored in real time. Family members can be kept informed even from remote places.

There are many hurdles yet to overcome and perhaps hurdles not as yet realized. Nevertheless, the technology necessary to implement basic systems is now available and future enhancements can be added as they are developed. The possibilities are limited only by our imaginations.

Strategies for emergency department information systems planning [8]

Establish planning parameters

A management steering committee should be established and charged with overall project oversight. This oversight should include seeking input from stakeholders, integrating input into strategic objectives, and implementing the project in accordance with the agreed plan and timeline. The committee should include clinicians, information systems consultants, local experts in the field of emergency medical informatics, and hospital information systems personnel. It is important at this stage to develop the EDs strategic objectives supported by well defined goals and potential benefits of the project (Table 1). The list of goals should be developed from stakeholder input and may be extensive, depending on the scope of the project. It is the steering committee's duty to develop objectives based on these stated goals and justify them by identifying benefits. The objectives should be reviewed by a broad range of stakeholders (eg, management, physicians, nurses, security, and pharmacy personnel) for additional input and revisions. Capital allocation funding is key to the success of the project and should be addressed and committed at an early stage.

Assess the current information environment

It is important to define the current information environment; otherwise, there is little chance of knowing where you want to go. Current software, hardware, network, and operating systems need to be inventoried. Understanding how these systems are currently integrated with the hospital's main computer is critical. Because many EDs have only limited automation in place, this step may be easier than anticipated.

A crucial decision at this juncture is whether current systems can be upgraded or whether a completely new system will be installed. Because of the rapid pace of technologic advances, this is often a difficult decision. The multimillion-dollar system of 5 years ago may be worth only a few thousand

Table 1
Example of goals, strategic objectives, and potential benefits of an integrated EDIS

Goal	Objective	Benefit
Minimize redundant input	Automate ATD input into ED system Automate laboratory, ECG, radiology, and ancillary reports into the ED record Integrate discharge instructions and prescriptions into chart and automate output for patient	Saves staff time
Improve tracking of patients, equipment, and staff	Obtain a passive tracking system that automatically tracks department assets and provides regular status reports	Saves time and provides information on productivity and efficiency
Provide cost-effective physician charting	Investigate various methods of physician charting to determine if a better alternative is available	Depending on the system, productivity may not provide any additional benefit over current charting methods
Provide digital (filmless) radiology	Investigate digital radiography systems	Allows immediate access to and archiving of radiographs; may be cost prohibitive

dollars today. A final decision is often based on whether it is more cost effective to upgrade, adapt the current system, or simply start over. A new system usually provides more flexibility and can integrate the latest technologies but is more expensive and often more difficult to implement.

It is also important to decide at this point whether the ED system will be a standalone system or be integrated into (or part of) a hospital-wide system. A hospital-wide information system redesign is a huge project but solves the most frequent cause of failure of standalone ED systems—the interface (sharing data between incompatible systems).

A standalone system is designed to perform specific functions (eg, patient triage or tracking) only within the ED. When planning or deciding on a standalone ED system, one should consider how it interfaces with the current (and future) hospital system [9,10]. The EDIS must interface with pharmacy, laboratory, radiology, ICU/medical/surgical units, registration/admitting, general accounting/billing offices, medical records, dictation/transcription, staff management systems, facility maintenance, and information sources outside the hospital. The cost of creating these sometimes complex interfaces can be prohibitive. Without such interfaces, however, the

EDIS ultimately fails to reach its potential and becomes an island of information cut off from the outside world.

The analysis at this stage should delineate information flow (what, when, where, and by whom) in the ED and hospital-wide. This allows identification of current information issues and areas of potential improvement in quality of care, staff productivity, and cost effectiveness. It is important that key personnel in each functional area be involved in this analysis to identify the pertinent activities for their areas and document the flow of information. A case scenario approach that follows the paper trail may be useful.

Propose a concept for a new information environment

Using the information obtained in the previous steps, a core group needs to develop a plan for a new information environment. This may take the form of a flow chart that acts as a blueprint for future planning. Emphasis should be placed on improving quality of care and productivity, reducing operating costs, decreasing inefficiency and redundancy, decreasing errors of omission and commission, and increasing the availability of information necessary for effective decision making. Again, input should be solicited from all parties involved.

Investigate potential solutions

At this stage a decision must be made whether to develop a proprietary system from the bottom up or investigate commercially available systems that may meet the identified needs. Proprietary bottom-up system development requires many more resources and likely a longer development time. Its advantage is flexibility and an almost guaranteed ability to interface with existing systems. Depending on the resources available, however, such an approach may not necessarily result in the most robust of systems.

Several commercially available products have been developed in recent years and vary considerably in features, compatibility (ability to interface with existing systems), flexibility (modular versus packaged), and price. Depending on the hospital's main computer system, an ED module may be available from the current enterprise-wide vendor. If so, this vendor should be a major consideration and the possibility of building upon the current system should be investigated.

Resource information on vendors include ACEP's Directory of Software in Emergency Medicine [11], Pennsylvania ACEP's National Symposium on EDIS [12], and commercial consulting resources such as the KLAS Enterprise ED Systems Study (Table 2) [13].

Although software decisions are typically made first, hardware and connectivity infrastructure (eg, wiring) are likely to significantly affect the total system cost and should be considered together. How the final product is selected depends on the corporate structure. A request for proposal (RFP) is often formulated and sent to several contractors, but forming a group to

Table 2: EDIS Vendor Contact Information *(Updated July 2004)*

Product Name	Vendor	Web Site
Niche Vendors	***Listed Alphabetical by Company Name***	
HealthMatics ED	A4 Health Systems	www.a4healthsystems.com
Codonix ED System	Codonix	www.codonix.com
Emergisoft ED	Emergisoft	www.emergisoft.com
PulseCheck	IBEX	www.ibexhealthdata.com
OnTrack, CHECKOUT, PET	LogiCare	www.logicare.com
ED Management System (EDMS)	MedHost	www.medhost.com
MediLinks®ED	MediServe	www.mediserve.com
AmeliorED	Patient Care Technology Systems	www.pcts.com
NavigatorWeb	The Poseidon Group	www.poseidongroup.com
T-SystemEV	T-System	www.tsystem.com
EMstation™ & EMTrack™	VitalWorks	www.vitalworks.com
Well*soft* EDIS	Well*soft*	www.wellsoft.com
Enterprise Vendors	***Listed Alphabetical by Company Name***	
FirstNet EMIS	Cerner	www.cerner.com
Sunrise™ ED Manager	Eclipsys	www.eclipsys.com
EpicCare ED	EPIC	www.epicsys.com
Horizon Emergency Care™	McKesson\HBOC	www.mckesson.com
ED Management Application	Meditech	www.meditech.com

Table 2
EDIS vendor contact information

A4 Health Systems	http://www.a4healthsystems.com
Cerner	http://www.cerner.com
Codonix	http://www.codonix.com
Eclipsys	http://www.eclipsys.com
EmergiSoft	http://www.emergisoft.com
Ibex	http://www.ibexhealthdata.com
LogiCare	http://www.logicare.com
Mckesson	http://www.mckesson.com
MedHost	http://www.medhost.com
Meditech	http://www.meditech.com
Patient Care Technology Systems (PCTS)	http://www.pcts.com
T-System	http://www.tsystem.com
VitalWorks	http://www.vitalworks.com
WellSoft	http://www.wellsoft.com

simply shop around may be equally effective. A model RFP is available from the author (for a copy, send an e-mail request to tbtmdaz@cox.net.

Regardless of how the vendor is selected, it is important to set performance and milestone parameters in the final contract to ensure that promises made in the selection process are honored during installation and implementation. Payment for the system should be graduated and predicated on the vendor meeting these criteria. If possible, define critical criteria that if not met would result in a full refund. These might include a guarantee of a workable hospital–ED system interface, system fault tolerance (ie, limited downtime), and system support.

The fiscal health of the vendor should be ascertained. Most ED system vendors are venture capital businesses that do not have the fiscal robustness of a publicly traded company. Seeking information on current installations is critical; do not rely on the vendor-provided referral list alone. The ACEP Section for Emergency Medical Informatics list server (American College of Emergency Physicians, Section for Computers in Emergency Medicine, Dallas, Texas) can be a valuable tool for finding current and former installation sites for real user experiences. Telephone contact or onsite visits of current and former clients are valuable in determining vendor reliability.

Software versus hardware selection

Depending on the vendor, the hardware and software may come as a package or may require independent selection and purchase. Failing to appropriately investigate and plan for hardware is a prescription for failure. Large CRT monitors that do not fit on a counter, small LCD monitors that are difficult to read and require constant scrolling to view information, slow printers that frequently run out of paper, slow computers/networks that delay information access, insufficient number of workstations, nonstandard

equipment (ie, rollerball mice without a scroll wheel or keyboards in atypical layouts), poorly placed workstations, and equipment (such as computers, battery backups, power strips, power cords) lying on the floor, are all examples of hardware foibles. Table 3 lists several hardware considerations.

Also, depending on the current ED space environment, a redesign of work areas may be necessary to allow for efficient use of the new system. Few EDs have ever been constructed with enough counter space to accommodate all the typical equipment necessary. Adding an EDIS complicates the space crunch. Consolidating work functions into single workstations may help, but significant forethought as to the location and type of equipment is essential to a successful implementation of an EDIS.

Implementation

Buying something that no one uses accomplishes nothing.

Implementation is the most crucial stage of the process with the most opportunity for failure. Approximately 25%–50% of the cost of the system may need to be reserved for implementation. Besides initial training costs, additional onsite clinical and clerical staff may be necessary during the rollout to assure as little impact on patient care as possible. Additional unplanned expenditure for equipment and infrastructure is necessary. Retraining and ongoing training also should be anticipated.

A phase-in or modular approach to implementing the new system allows incremental learning and adaptation with less impact on patient care during the transition. Where to begin depends on the priorities set by the steering committee, but starting with the simplest and most efficient part of the system is recommended. A sample implementation schedule is outlined in Box 2.

Physician charting traditionally has been touted as an area with great potential for cost savings (return on investment) and is often implemented first. Unfortunately, physician charting is the most difficult module to implement because it requires a fundamental change in the way physicians accomplish their work. In addition, this part of the patient information system has almost infinite variability and makes charting system design difficult.

Efficiencies in the physician charting component are only realized once all of the other components of the system have been fully implemented. Ideally, to gain sufficient efficiency to make physician computer charting viable, elements of the Chief Complaint, History of Present Illness, Past Medical History, Social History, Family History, Current Medications, Allergies, Review of System, laboratory/diagnostic imaging/EKG, and demographic information would be collected for the physician and automatically integrated into the chart. Only the physical examination, medical decision making, disposition, and final diagnosis would then be required to be completed by the physician. Even so, one should expect resistance from the physicians, as virtually any system takes more time to accomplish charting. Gaining early efficiencies (pay back) is crucial to EDIS acceptance.

Table 3
Suggested hardware minimum standards for EDIS

Item	Considerations
File server	Standard configuration sufficient to handle the anticipated network traffic with high fault-tolerant redundancy. Dual redundant servers ideal.
Workstations (CPU)	Faster is better, but also space is a major consideration. Small compact "brick" computers amenable to attaching to the wall under a desk are ideal. In most EDIS installations, the only functions necessary are TCP/IP, video, mouse, and keyboard outputs. If a local floppy or even hard drive is not required, it is better to not have it as a potential hardware failure point.
Mobile/wireless workstations	Certain applications may be amenable to portable wireless workstations. Until recently the hardware for these devices has been heavy, expensive, not rugged enough, and ill-suited to the task. New technology has emerged that moves the video and input functions to the mobile device, making them much more usable. *(EX: Panasonic Toughbook MDWD [mobile digital wireless device] – various models, including a "brick" computer)*
Monitors	LCD monitors 19″–21″ diagonal size range is ideal. Anything less than 17″ is unusable. Lightweight and thin is best. Certain applications may benefit from monitors capable of being rotated to portrait orientation. (*EX: Samsung SyncMaster 191T*). Unless sound is required, integrated speakers only add to the bulk. CRT monitors are generally not a viable option.
Printers	Minimum 35 ppm with 1000–1500-page capacity. Duplex and dual paper trays may add additional functionality. (*EX: HP 4200 or 4300 series*)
Keyboard	No frills, rugged, standard 101 layout keyboards are ideal. Specialty keyboards (eg, Microsoft "Natural Keyboard") and nonstandard layouts are problematic.
Mice	Simple, reliable, optical, no frills, standard mice. (*EX: MS Standard USB WheelMouse Optical [Part #X08-40764]*)
Battery backup/surge protection	Ideal solution to avoid mishaps. Must be mounted off the floor to avoid damage.
Power strips and cords	If necessary, in lieu of battery backup; must also be mounted off the floor to avoid damage and mishaps.
TCP/IP network	100 Mbit or better speed
Workstation environment	Each workstation must be erogonomic and suited to the task. Nothing should be left lying on the floor, including power cords and network cables.
Large tracking monitors	Large plasma screens may be useful in certain environments, but with adequate and well placed workstations, this money may be better spent elsewhere.

Table 3 (*continued*)

Item	Considerations
Redundancy	Things break—in EDs they break often. Standardizing the workstations allows for "plug and play" replacement when failures occur. One redundant printer for every four and one redundant complete workstation for every 10 is ideal.
Supplies	Do not forget to establish a system for replenishment of consumables such as toner cartridges, special safety paper for prescriptions, and so on.

As an interim short-term charting solution, some facilities have implemented a blend of computer-based and traditional dictation. Most EDs are better served by continuing their current charting method (eg, paper-based template or transcription) until more usable computerized solutions are proven to work efficiently.

Finally, the first and last stages of implementation process are critical. A reliable interface with the hospital's main computer through an admit/transfer/discharge (ATD) interface is essential. This interface captures patient demographic information and supplies data to multiple sites throughout the EDIS. On the back end, "charge capture, coding, and billing," if properly implemented, can reap many benefits and help offset the initial and ongoing cost of a totally integrated system. As noted in Box 2, billing and other processes may need to continue independently until all the pieces are in place. Billing particularly depends on the availability of information collected by other subsystems.

Box 2. Recommended steps for implementing a modular emergency department automation system*

Phase 1. ED patient log/ATD interface
Phase 2. Patient tracking
Phase 3. Triage
Phase 4. Order entry, inventory control system, and laboratory/radiology/pharmacy interfaces
Phase 5. Nursing care documentation and interface with automated vital sign recording system
Phase 6. Physician charting
Phase 7. Patient discharge planning integration
Phase 8. Charge capture, coding, and billing system

* These items refer to a totally integrated system. Some of these items may continue to be used as standalone modules during the integration process but brought online in the proper order.

EDIS return on investment (ROI)

An entire article or even a book could be written on this topic. Suffice it to say, ROI is always done in the EDIS selection process and is nearly always wrong. In EDIS and information technology in general, computers rarely save time or money. What they *do* is allow one to do things that were previously not possible, often taking more time and costing more money. Nevertheless, the advances in medical care demand better and more robust computer systems. Imagine trying to fly a Boeing 737 without a computer. It was computer technology that allowed such a plane to be designed *and* to fly. EDs are no different, but have been slow to adapt computer technology to the work environment. Therefore, when considering the EDIS ROI, therefore, staff efficiency, ability to gather data for ED management, patient safety, improved data distribution/access/archiving, workflow automation, and the many other benefits discussed are the true return on the EDIS investment. Cost savings on transcription, presumed ability to reduce staffing, and other hard cost savings are probably not realistic.

How to develop an action plan

The final blueprint should include a step-by-step project management scheme and cost-benefit analysis. Once this plan has been reviewed and approved by the entire team, it is validated against the business objectives. A vendor is selected to develop or supply the system, and final decisions are made regarding hardware and software. The plan is not static and should be reviewed periodically (perhaps quarterly initially, then annually) even after the immediate project has been completed.

ED automation is challenging and often fraught with pitfalls. EDIS consultants may bring valuable expertise to the process, but the success of the project depends greatly on the commitment of the development team and a willingness to dedicate adequate resources to the goal.

Summary

Information system planning for the ED is complex and new to emergency medicine, despite being used in other industries for many years. It has been estimated that less than 15% of EDs have comprehensive EDIS currently in place [14]. The manner in which administration is approached in large part determines the success in obtaining appropriate institutional support for an EDIS [6]. Active physician and nurse involvement is essential in the process if the new system is to be accepted at the user level.

In the ED, large volumes of information are collected, collated, interpreted, and acted on immediately. Effective information management therefore is key to the successful operation of any ED. Although

Box 3. Pearls and pitfalls

EDIS to address the enterprise-wide information management problem are only now beginning to become available.
Consider transition (temporary) systems as a 3-5-year solution that will likely need to be totally replaced when enterprise-wide hospital systems become readily available in the next few years.
Fix other aspects of the ED environment before implementing an EDIS.
Be careful not to develop or purchase systems that merely automate poor manual processes. The less a system requires human input, the better; consider systems that automatically capture data already available on the hospital main system and systems that automatically track patients through the ED.
Phase in the installation in a modular approach and be sure to obtain a guarantee of milestone implementation, (ie, a money back guarantee if the EDIS cannot ultimately integrate with the hospital's main system).
Spend as much time selecting hardware as software and in planning its deployment in an already crowded work environment.
Decide what it is you need, then decide what it is you want. What you end up with should be somewhere in the middle.
Be willing to fail and change course if necessary. Forcing a square, inadequate system into a round hole will end in disaster.
Waiting for the ultimate solution is no solution.

computerized information systems have tremendous potential for improving information management, such systems are often underused or implemented in such a way that they increase the workload on caregivers and staff. This is counterproductive and should be avoided.

In developing and implementing EDIS one should be careful not to automate poorly designed manual processes. Examples are ED tracking systems that require staff to manually relocate patients in the system. This task probably is completed only when the ED volume is low and "worked around" when the department is busy. Information from such a system is, therefore, flawed; at best useless and at worst counterproductive. Alternatively, systems are available that can track patients automatically through the ED by way of infrared sensors similar to those used in baggage-tracking systems that have been in place in airports for years.

In the automated (computerized) ED, we must have zero-fault-tolerant, enterprise-wide, hospital information networked systems that prevent unnecessary duplication of tasks, assist in tracking and entering data, and ultimately help analyze the information on a minute-to-minute basis. Such systems only reach their potential when they are fully integrated, including legacy systems, rather than standalone proprietary EDIS. Further, a modular approach in which individual components are connected to a flexible computer backbone is ideal.

Finally, good clinical content is key to virtually every aspect of the EDIS. Much of this content is yet to be developed and what *is* available still needs to be adapted to the EDIS environment.

Daunting as it may be, an EDIS implementation properly accomplished results in better patient care, improved staff productivity, and a satisfying work environment (Box 3).

Further readings

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