

## IT Solutions for Patient Safety – Best Practices for Successful Implementation in Healthcare

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Recent reports in the United States and Canada have suggested that healthcare systems in both countries fall short in delivering high quality and safe patient care (Baker and Norton 2001; Institute of Medicine 1999, 2001). In addition to these reports, empirical studies have stressed the enormity of the problem of adverse events in hospitals in terms of frequency and severity (e.g., Evans et al. 1994; Budnitz et al. 2005; Classen et al. 2005). Investigators in the Harvard Medical Practice Study, for example, found that adverse events occurred in approximately 3.6% of hospitalizations in New York State (Brennan et al. 1991), the majority of which were due to drug complications (Leape et al. 1991). Such adverse events and errors have also been found to be preventable and significantly associated with longer hospital stays, disability and increased healthcare utilization and costs (Bates et al. 1997; Evans et al. 1993; Phillips, Christenfeld and Glynn 1998; Thomas et al. 1999; Classen et al. 2005). The United States incurs an estimated total (direct and indirect) cost of approximately \$17 billion to \$29 billion in preventable adverse events (Institute of Medicine 2001). Although some errors are attributable to poor performance by individual providers, the majority of preventable errors are a result of systemic and organizational deficiencies of healthcare delivery systems (Ball and Douglas 2002; Leape et al. 1998; Peth 2003).

Prevention of errors requires systems that are designed with safety in mind – systems in which sources of error are systematically recognized and diminished (Bates et al. 1995b). General recommendations for reducing errors necessitate restructuring healthcare systems in a way that creates an environment conducive to the delivery of safe

healthcare. Strategies for system redesign include changes to and standardization of clinical processes and procedures, improvements in communication and information sharing, as well as greater attention to systems that prevent and mitigate errors.

To meet these objectives, healthcare providers are increasingly looking to information technology for assistance in gathering, interpreting and communicating clinical information and in applying the most current medical knowledge possible to the care of their patients (Haynes and Walker 1987). The use of information technologies and systems that standardize work processes are advocated widely to improve patient safety, reduce adverse events and prevent medication errors. Through the use of systems that standardize repetitive, time-consuming and error-prone work processes, information technology has the potential to reduce avoidable errors and streamline management of care, thereby promoting effective and efficient delivery of patient care. Although a recent survey indicates that the overwhelming majority (92%) of US hospitals are committed to using IT for clinical purposes, implementation of these systems has not been as widespread as one might think. Many organizations are still in the discussion and planning stages (American Hospital Association 2005). In general, there is still much debate about the barriers to adoption and implementation of such systems and how to realize the full benefit of these systems (e.g., *Health Affairs*, 2005, Volume 24:5).

Among the many interventions proposed to improve patient safety, three of the most frequently discussed are electronic medical records (EMR), computerized provider

order entry (CPOE) and electronic medication administration records (MAR).

### EMR

The electronic medical record, EMR, is a computer-based application basically used to record and access patient information. Additional functions of the EMR include entering orders, decision support and information sharing. The EMR is central to many health-care technology applications and may hold the greatest promise for improving the quality and safety of care. Previous research has demonstrated the quality benefits of EMRs (Balas et al. 1996; Hunt et al. 1998; Institute of Medicine 2001). Despite the potential for significant improvements in patient safety and quality of care and substantial interest in EMRs (American Academy of Family Physicians 2003), adoption of EMRs has been slow (Brailer and Terasawa 2003; Miller and Sim 2004). Frequently reported barriers to adoption include privacy concerns, the need for standards for the exchange of information, financial requirements and resistance by clinicians (Institute of Medicine 2001).

### CPOE

CPOE is a computer application that not only replaces handwritten orders (e.g., for drug prescriptions and lab tests) by accepting them electronically, but also offers providers clinical decision support at the point of ordering, especially if CPOE interfaces with a clinical decision-support software/system.

Research has shown that a majority of adverse events in hospitals are drug-related (Leape et al. 1991). Classen and colleagues (1997) found that adverse drug events occurred in roughly 2.43 of every 100 admissions, 3.5% of which resulted in death. There is reason to believe that there may be an increasing trend in errors, as the number of deaths due to medication error increased 2.57-fold between 1983 and 1993 – faster than the increase in the number of drug prescriptions during that time (Phillips et al. 1998).

Leape and colleagues' studies of adverse drug events (1991, 1995) attribute 58–78% of errors to medical management and systemic failures. Specifically, several studies have found that the majority of medication errors occurs at the prescribing and ordering stage (Barker et al. 2002; Bates et al. 1995b; Fortescue et al. 2003; Lesar et al. 1990; Lesar et al. 1997). Conclusions from these studies confirm other research suggesting that medication errors are preventable (Bates 1996; Bates et al. 1995a; Rothschild et al. 2002).

Despite preliminary evidence indicating CPOE can reduce medication errors, successful implementation of CPOE systems has not been widespread (Ahmad et al. 2002; Kaushal et al. 2003). A 2002 survey indicated that approximately 21% of healthcare organizations were

currently implementing CPOE, 17% were in the development phase, 28% were in the discussion phase, 17% had no current plans related to CPOE and 14% answered “do not know or not applicable” (Healthcare Information and Management Systems Society 2002).

### MAR

The medication administration record (MAR) is an interactive part of a hospital's information system, which integrates drug purchasing, distribution and information services in a unified database (Cherici and Remillard 1993; Low and Belcher 2002). MAR is used in pharmacies to process, store and categorize information such as patient medication profiles, drug-interaction and dosage screening, drug compatibility and pharmacokinetic calculations. Furthermore, systems for medication administration may also automate the storage and physical distribution of pharmaceuticals (Lee et al. 1992). MAR may therefore be considered a technology that “closes the loop” of medication distribution (Cherici and Remillard 1993).

In a survey of medication safety technology in community hospitals, pharmacy directors considered medication safety to be one of the most important issues facing pharmacy departments (Schumock et al. 1999). Case studies in the literature report decreases ranging from .04 to as much as 71% in medication errors due to MAR use in hospitals (Borel and Rascati 1995; Cherici and Remillard 1993; Childs and Poikonen 1993; Cook 1985; Grabowski 1994; Low and Belcher 2002; Puckett 1995). Despite common organizational barriers such as lack of time, personnel and the financial resources to implement systems to decrease medication errors, electronic MAR is the most commonly used medication safety technology in hospitals. Roughly 80% of hospitals had implemented electronic medication administration records in 2002, and an additional 10% of hospitals were planning to implement such systems in the future.

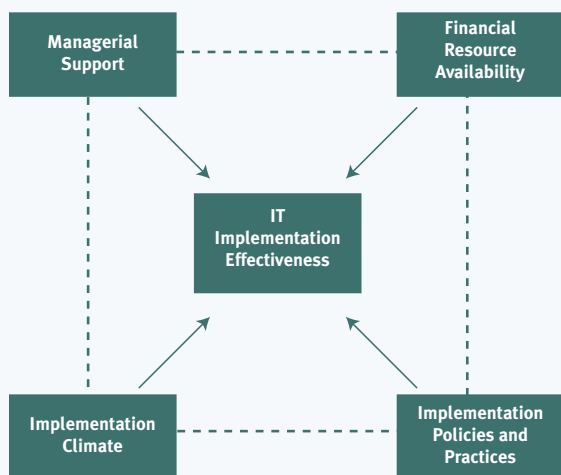
In summary, EMR, CPOE and MAR both individually and collectively appear to have great potential for improving patient safety. Although some progress has been made, widespread implementation of such information technologies has been slow. Furthermore, little is known about the best practices in implementing IT changes in healthcare. While most papers in the literature examine innovation effectiveness, few discuss the organizational dimensions of technological innovation that precede and potentially explain its effectiveness. By merely examining the relationship between implementation technical logistics and implementation effectiveness, we ignore essential organizational activities that exist long before and have tremendous influence on the implementation process and its success. The purpose of this article is to review the literature on the facilitators and barriers to successful implementation of EMR, CPOE and MAR.

More specifically, the focus is to identify organizational and environmental factors known to facilitate successful implementation.

### CONCEPTUAL FRAMEWORK

To facilitate identification of key organizational factors, the literature was analyzed according to the conceptual framework depicted in Figure 1. This framework was modified from previous innovation research by Klein and colleagues (2001), which suggested that four organizational factors – management support, financial resource availability, implementation climate and implementation policies and practices – were critical to successful implementation of innovations.

**Figure 1: Organizational/environmental factors for IT on effectiveness**



Adapted from: Klein, K.J., A.B. Conn and J.S. Sorra. 2001. "Implementing Computerized Technology: An Organizational Analysis." *Journal of Applied Psychology* 86(S): 811–24.

### Definitions and Measures

The following definitions and measures were adapted from Klein and colleagues' framework (2001) and used to analyze the evidence from the literature on EMR, CPOE and MAR. *Implementation effectiveness* was defined as an organization-level outcome measure describing employees' use and/or satisfaction with the IT innovation. Measures of implementation effectiveness included users' satisfaction, diffusion (i.e., spread of use), infusion (i.e., depth of use) and adoption. *Management support* referred to management's commitment to and active interest in the IT implementation. Indicators of management support included identification of a physician champion, communication of leadership's commitment to the IT implementation and management's willingness to provide the human and financial resources necessary for the IT solution. *Financial resource availability* was defined as having an ample and appropriate budget for the hard-

ware, software, training, user support services and time necessary for the implementation. Indicators of financial resource availability included a budget allocated for the implementation and acceptance of lost productivity during and shortly after implementation. *Implementation climate* referred to employees' shared perceptions of the importance of the implementation within the organization. Indicators of implementation climate included the congruence of organizational culture and values with EMR implementation. *Implementation policies and practices* were defined as all procedures associated with the implementation. Indicators of implementation policies and practices included training on the new IT system, ongoing technical support, rewards for use of the system, communication and project management during the implementation and design of the system.

### LITERATURE REVIEW

Using the framework outlined in Figure 1, research studies and related literature on experiences with the implementation of EMR, CPOE and MAR were analyzed. The findings are summarized in Figure 2.

#### Management Support

##### EMR

The presence and broad communication of strong management commitment was noted in several studies as critical to the successful implementation of an EMR system (Chiang and Starren 2002; Townes et al. 2000). More specifically, organizational support was found to be a strong, positive predictor of perceived usefulness of an EMR system (Dansky et al. 1999). In addition, firm institutional commitment and commitment from program leadership and a core group of faculty was found to help overcome barriers to EMR system adoption (Swanson et al. 1997).

The identification of a physician champion was also cited as essential for the successful implementation of an EMR system (Miller et al. 2003; Smith 2003; Wager et al. 2000). The physician champion, defined as a leader who is well-respected, knowledgeable, committed to the system's success and powerful enough to make things happen, was identified as an individual who could serve as an advocate, garner buy-in, and help people overcome their fears and apprehensions regarding EMR implementation (Wager et al. 2000).

##### CPOE

Since experience has shown that resistance to CPOE comes primarily from physicians and other staff who do not want to change their work processes (Kuperman and Gibson 2003), management support in terms of CPOE implementation should involve clinical as well as administrative leadership (Davidson and Chismar 1999). Top administrators (e.g., the CEO, CIO, CMIO) facilitate

**Figure 2: Recommendations for successful EMR, CPOE and MAR implementation**

	EMR	CPOE	MAR
<b>Management Support</b>	<ul style="list-style-type: none"> <li>• Develop and communicate strong management support throughout the organization</li> <li>• Identify physician champion(s)</li> </ul>	<ul style="list-style-type: none"> <li>• Integrate management support with efforts of physician champions</li> <li>• Communicate the vision</li> <li>• Identify multiple champions, preferably senior clinicians</li> </ul>	<ul style="list-style-type: none"> <li>• Create and support several interdisciplinary committees to design implementation processes</li> </ul>
<b>Financial Resource Availability</b>	<ul style="list-style-type: none"> <li>• Commit sufficient financial resources for hardware, software, and reduced productivity</li> <li>• Avoid underestimating necessary financial resources</li> </ul>	<ul style="list-style-type: none"> <li>• Include costs for training, technical support, and productivity losses</li> <li>• Emphasize patient safety gains to justify financing</li> </ul>	<ul style="list-style-type: none"> <li>• Secure sufficient resources for implementation processes</li> </ul>
<b>Implementation Climate</b>	<ul style="list-style-type: none"> <li>• Foster a culture of change and place that value on innovation</li> </ul>	<ul style="list-style-type: none"> <li>• Foster a climate reflecting that the new system is being promoted, supported and rewarded</li> </ul>	<ul style="list-style-type: none"> <li>• Foster positive perceptions of MAR's potential to decrease medication errors and turn-around time for medication orders</li> </ul>
<b>Implementation Policies and Procedures</b>	<ul style="list-style-type: none"> <li>• Provide adequate, timely and ongoing training</li> <li>• Protect time for training</li> <li>• Communicate about expectations and experiences</li> <li>• Involve key individuals in the EMR system design</li> <li>• Design the system for efficiency of use and avoid interfering with patient care</li> <li>• Provide ongoing, on-site technical support</li> <li>• Ensure EMR system back-up</li> </ul>	<ul style="list-style-type: none"> <li>• Solicit clinician input on system design to facilitate buy-in</li> <li>• Develop committees and teams that meet and work over an extended period of time</li> <li>• Capitalize on the ability of individuals holding dual roles (i.e., clinical and administrative) to bridge gaps between groups of stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• Develop formal goals, objectives, and key indicators of success</li> <li>• Anticipate challenges to implementation</li> <li>• Encourage participation in the design of the system by clinicians</li> <li>• Develop new practice standards and routines</li> <li>• Integrate CQL processes</li> <li>• Provide adequate human resources training for use of MAR</li> <li>• Reconfigure roles, responsibilities and work tasks across departments</li> </ul>

implementation by providing a clear vision for CPOE and unwavering support of the process; connecting and communicating with staff (Ash et al. 2003a; Dykstra 2002); identifying possible CPOE champions (Ash et al. 2003a; Poon et al. 2004); interpreting administrative concerns for physicians and medical concerns for administrators (Ash et al. 2003a); and addressing workflow concerns (Poon et al. 2004).

Whereas administrators are in the position to provide traditional “management support,” physicians can provide support as CPOE “champions,” promoting the benefits of the proposed system to colleagues. However, champions face a challenge because they are often viewed skeptically by their peers who are less willing to adopt the new system. Having multiple champions in each clinical area will help offset this skepticism and prevent champion burnout. Even with multiple champions, however, these individuals will have to remain steadfast in the face of resistance. Senior clinicians, widely respected by their peers, therefore, are typically best suited to be champions

(Ash et al. 2003a). Senior physician champions should work closely with younger physicians in promoting widespread system adoption. Young physicians are often less resistant during the implementation process because of their exposure to CPOE in medical school (Poon et al. 2004).

#### MAR

Management’s determination that the benefits of an automated system outweigh its disadvantages, combined with their focus on improvement in patient care, confirms their dedication to MAR implementation. Furthermore, management support for MAR has also been demonstrated by the establishment of interdisciplinary committees (Ouellett et al. 1991). These committees, which represented members from various department units throughout the hospital, convened to determine MAR need and feasibility, system design, user training and implementation.

## Financial Resource Availability

### EMR

Costs associated with EMR system start-up and ongoing maintenance were identified as a significant barrier to the successful implementation of an EMR system (Audet et al. 2004; Brailer and Terasawa 2003; Miller and Sim 2004; Wager et al. 2005). The size of the physician practice or organization, however, was found to affect the degree of importance of this barrier. More specifically, costs were reported to be a less important barrier to larger physician groups than to smaller physician groups or to physicians in solo practice (Audet et al. 2004).

In addition to the need for significant financial resources, several studies identified the importance of organizational preparation for reductions in productivity, both during and after implementation, as critical to the effective implementation of an EMR system (Aydin and Forsythe 1997; Miller and Sim 2004; Tonnesen et al. 1999; Townes et al. 2000; Wager et al. 2000). For example, time pressure and the perceived need to return as quickly as possible to pre-implementation levels of productivity were found to be a source of physician dissatisfaction (Gamm et al. 1998). Scheduling fewer patients during the learning period and ensuring protected and adequate time for training on EMR system adoption were identified as key factors for successful EMR system implementation (Aydin and Forsythe 1997).

### CPOE

Little research has been done to assess how strongly the presence of available financial resources influences the success of CPOE implementation. Clearly, an organization needs dedicated resources for purchasing or developing a CPOE system. However, the system itself is not the only cost to consider (Ash et al. 2003a), as training, technical support and productivity losses during the learning phase can also be costly.

Allocating the necessary funds for CPOE implementation may be more difficult for small, rural and critical access hospitals than for larger urban and rural referral hospitals. Although the cost for all types of hospitals is substantial, larger hospitals may require only modest cost savings and increased revenue to offset these costs. Such savings for the smaller hospitals are not likely to be sufficient; therefore, subsidization from third parties may be necessary (Ohsfeldt et al. 2005).

Some senior administrators recommend shifting organizational priorities toward patient safety to facilitate the allocation of resources for CPOE. Although this shift in priorities may require putting other capital investment projects on hold, management often can justify such moves by referring to increased public attention on medical errors, measuring cost savings due to CPOE and communicating the extent of the savings throughout the organization (Poon et al. 2004).

### MAR

Surprisingly, none of the empirical or case studies in literature examined or discussed the availability or allocation of slack financial resources for their implementation of medication administration systems. It is possible that healthcare provider organizations' investment in the adoption of these information technologies assumes the availability and subsequent use of these financial resources.

## Implementation Climate

### EMR

The effect of implementation climate on EMR implementation effectiveness was rarely addressed in the literature. However, in their review of issues influencing the implementation of EMR systems at academic health centres, Retchin and Wenzel (1999) identified academic health centres' culture of change and innovation as an attribute that could foster EMR system adoption, diffusion and infusion.

### CPOE

No studies were found that tested the importance of implementation climate on CPOE implementation effectiveness. Nevertheless, the concept appears valuable for future research. "Climate" may be a better predictor of implementation success than any isolated implementation practice, for example, because it captures the interaction of financial resource availability, management support and implementation policies and practices.

### MAR

None of the studies examined organizational implementation climate, as defined by Klein and Sorra (1996). Rather, the following results were extracted from literature that generally described shared perceptions of the importance of MAR implementation within the organization. Specifically, acceptance and continued use of MAR in clinical practice are influenced by shared beliefs in MAR's potential to decrease medication errors, improve patient care and decrease turnaround time for medication orders (Schwarz and Brodowy 1995). Although users of medication administration systems have mixed opinions about the time savings generated by MARs, an overwhelming majority recommend continued use of this technology (Lee et al. 1992; Puckett 1995; Schwarz and Brodowy 1995).

## Implementation Policies and Practices

### EMR

Training was the most common implementation policy or practice discussed in the literature. In general, EMR system implementation was found to be most effective when training for EMR system users was adequate, timely, tailored to meet the specific needs and experience of the users and available on an ongoing, as-needed

basis (Aaronson et al. 2001; Aydin and Forsythe 1997; Dansky et al. 1999; Gamm et al. 1998; Wager et al. 2005; Wager et al. 2000). The critical importance of sufficient protected time for initial and ongoing training for all EMR users was frequently cited (Aydin and Forsythe 1997; Miller and Sim 2004; Tonnesen et al. 1999; Townes et al. 2000; Wager et al. 2000). For example, providers who perceived training to be adequate were found to be more likely to perceive the EMR to be beneficial and were more likely to choose the EMR over traditional paper records for future use (Aaronson et al. 2001). Also highlighted was the importance of including time for users to get comfortable with the computer, offering self-learning programs and intensive training just before the live date, and ensuring the trainer is experienced and can talk to the level of the novice user (Wager et al. 2005; Wager et al. 2000). Simulated patient encounters were also found to help physicians adapt their practice patterns to the new EMR system.

The findings regarding the effect of previous computer experience on EMR implementation effectiveness and the need to specifically address user computer experience and anxiety in training were mixed. Aaronson and colleagues (2001) found that computer background was not related to perceived satisfaction with the EMR, nor was it related to perceived difficulty of implementation, adequacy of training or anticipated future use of an EMR system. However, Dansky and colleagues (1999) found that computer experience was a positive predictor and computer anxiety a negative predictor of perceived usefulness of an EMR system. Gamm and colleagues (1998) reported the need for implementation plans to be responsive to computer experience among personnel.

Users' expectations and concerns regarding the EMR system were also found to influence the success or failure of implementation. For example, in their study of end-users' attitudes and expectations before and after implementation, Gamm and colleagues (1998) found that experience with the new EMR system generally fell short of expectations. Based on a study conducted three months after implementation, Likourezos and colleagues (2004) reported both physicians and nurses believed the EMR system would not yet improve quality of care, reduce risk of making errors or reduce costs. These findings highlight the need to identify and address unrealistic expectations and concerns and to convey a clear statement of the goals for and anticipated benefits of EMR implementation (McLane 2005; Townes et al. 2000).

The inclusion of appropriate individuals throughout the organization in the design of the EMR system and implementation planning process was also found to improve the effectiveness of EMR system implementation. For example, insufficient user involvement in project design and planning was found to be a significant risk factor for implementation failure in large organizations

(Chiang and Starren 2002), while participative decision-making, defined as using appropriate people throughout the organization as decision-makers, was found to have a significant positive effect on EMR diffusion (Ash 1997). In addition, physician buy-in was reported to be vital to the effectiveness of EMR system implementation (Brailer and Terasawa 2003; Miller et al. 2003; Wager et al. 2000).

The specific design of the EMR system was also identified as critical to the success or failure of EMR system implementation. For example, EMR system accessibility, efficiency of use and ease of navigation were found to strongly influence the acceptance and use of the EMR system (Aaronson et al. 2001; Aydin and Forsythe 1997; Gamm et al. 1998; Miller and Sim 2004; Sittig et al. 1999). Numerous studies also reported physicians' concerns that the EMR system would interfere with or negatively impact the physician-patient encounter (Aaronson et al. 2001; Aydin and Forsythe 1997; Blair and Schutte 2003; Brailer and Terasawa 2003; Chiang and Starren 2002; Gadd and Penrod 2000; Gamm et al. 1998; Swanson et al. 1997). Despite preliminary studies indicating that patients do not sense any lost rapport with their physicians when EMRs are used (Blair and Schutte 2003; Gadd and Penrod 2000), the presence of significant physician concerns highlights the critical importance of considering the physician-patient encounter during the design and implementation of an EMR system.

Finally, ongoing, on-site technical support and EMR system redundancy and back-up were identified as critical success factors for EMR system implementation (Aydin and Forsythe 1997; Miller and Sim 2004; Miller et al. 2003; Swanson et al. 1997; Tonnesen et al. 1999; Townes et al. 2000; Wager et al. 2005; Wager et al. 2000). Physicians specifically identified EMR system downtime and system failure or corruption as significant sources of dissatisfaction and concern regarding potential risk of patient injury as well as liability if patient information could not be obtained in a timely manner or was lost (Aaronson et al. 2001; Blair and Schutte 2003; Tonnesen et al. 1999; Wager et al. 2005).

#### *CPOE*

Developing committees or teams within each clinical area is one method for facilitating needed input and promoting system use. Ideally, these working groups become permanent, or at least long-term (Davidson and Chismar 1999), as the implementation process likely will not have definite starting and ending points.

Although training is another key to implementation success (Ash et al. 2003a; Davidson and Chismar 1999; Lee et al. 1996), research thus far has not yielded clear recommendations about the best methods for conducting training. One study failed to find a statistically significant difference between one-on-one sessions versus large

group sessions with respect to implementation success. This study indicated, however, that hospitals that successfully implemented the system were marginally more likely to use one-on-one sessions than those that did not, and that physicians from these hospitals rated their CPOE skill level higher after training than their counterparts at hospitals that were not successful in implementation (Weir et al. 1995).

In addition to training, the amount of technical support system users have is believed to influence implementation success. This support helps offset increases in workload that accompany learning a new system (Poon et al. 2004) and preferably should be available 24 hours a day (Ash et al. 2003a).

Communicating the reasons for adopting and implementing CPOE is perceived to be important to implementation effectiveness (Poon et al. 2004; Wang et al. 2002). In addition to conveying the expected cost savings and reductions in errors prior to implementation, however, it is also important to maintain bidirectional communication (Ash et al. 2003a) throughout the process, to enable staff to see current measures indicating cost savings and error reductions, as well as to ensure that staff are providing input about the system's usefulness and potential modifications.

Finally, given that some individuals have both clinical and administrative responsibilities, capitalizing on these dual roles is important, for example, to facilitate productive interactions between physicians and information technology staff involved in implementation (Ash et al. 2003a).

### *MAR*

Successful implementation of MAR systems is a result of several organizational policies and practices found in the literature. First, hospitals developed formal goals, objectives and key indicators for technology implementation (Cherici and Remillard 1993; Williams et al. 1994) to clearly communicate expectations of technological change among various personnel. Second, new practice standards and routines for medication administration were developed, many of which were designed to function across departmental units (Ouellett et al. 1991). To this end, implementation of new electronic medication administration systems was augmented with new systems that facilitated improved communication and coordination between staff and departmental units. Potential challenges to implementation were also identified to manage concerns and develop strategies to avoid pitfalls of the new technology (Cherici and Remillard 1993). Lastly, hospitals employed continuous quality improvement processes to routinely monitor and assess implementation processes and the new technology (Cherici and Remillard 1993).

The policies and practices listed above rely on

organizational members' collaboration and participation in technology development and implementation. Coordinated partnerships between technology vendors and hospital purchasers/users is associated with acceptance, support, satisfaction and compliance with newly implemented systems among users (Cherici and Remillard 1993; Ouellett et al. 1991; Williams et al. 1994). Seeking input from medical staff is another method of managing concerns and future challenges, as well as assuring user compliance among physicians (Cherici and Remillard 1993). Acquiring acceptance and support from other constituency committees throughout the hospital – such as Medical Executive, Nursing Patient Care, Pharmacy and Therapeutics Committees – also helps to demonstrate the importance of MAR implementation within an organization and to overcome any initial uncertainty about the implementation of their medication administration record system (Ouellett et al. 1991).

Implementation of medication administration technologies commonly included hospital adjustments in human resources. Hospitals carved out substantial personnel time for the development, testing, and eventual staff training of customized medication systems (Cherici and Remillard 1993; Puckett 1995; Schumock et al. 1999). Additional staff were also hired to provide user support and training, to facilitate implementation in departmental units (Puckett 1995; Schumock et al. 1999). Finally, rollout of new medication administration systems required substantial reconfiguration of roles, responsibilities and work tasks among staff in various departmental units (Cherici and Remillard 1993; Ouellett et al. 1991; Puckett 1995; Schumock et al. 1999).

### **DISCUSSION**

Implementation of IT solutions has been identified as one of the most important priorities in healthcare in order to create safer environments for patient care. This review aimed to determine the organizational factors that facilitate or inhibit the successful implementation of information systems and technology in healthcare organizations. From this review, the following conclusions were drawn, which were common to the implementation processes for EMR, CPOE and MAR.

#### **Management Support**

Because the IT solutions require the commitment and collaboration of the entire organization, senior management support for the importance and need for the information technology is essential. The senior leadership should define and communicate the vision for the change, specifying goals and expectations, timelines and indicators of success. The communication should be framed in terms of improving patient safety and quality of care, reducing unnecessary variation in care and improving efficiency in the organization.

It is important that administrators and clinicians be united in their leadership and support for the implementation of the innovation. It is essential for one or more champions to be identified to foster buy-in among other clinicians. Management needs to continuously communicate the importance of the change to the whole organization and to assure individuals and groups that the organization has committed the necessary resources to make the changes successfully.

### Financial Resource Availability

IT changes require sufficient resource investment both for upstart and ongoing implementation and operations. While the long-term expectation might be that the organization will save money, the probability is that the cost savings will not occur during the first five years, particularly due to reductions in productivity during implementation and for the short term after implementation. Nevertheless, there is evidence to suggest that many organizations underestimate the resource requirements needed (Ash et al. 2003c). While finding sufficient resources tends to be difficult for organizations of all sizes, small rural hospitals/healthcare organizations face the greatest challenge (Ohsfeldt et al. 2005).

Individuals and groups working close to patient care where workflow is most likely to be impacted by IT changes tend to assume that if management has decided to implement a new system, then sufficient resources have been allocated by the organization, especially if this message has been conveyed by management. Therefore, if sufficient resources are not dedicated to the change, patient care providers are more likely to feel misled or dissatisfied.

### Implementation Climate

Implementing IT solutions constitutes a major organizational change and as such can take as long as five years or more to accomplish (First Consulting Group 2000; Silver and Lusk 2002). Research to date demonstrates that IT implementation involves changes in complex organizational processes that are influenced by a variety of factors in the workplace environment (Ash 1997; Gustafson et al. 2003; Weir et al. 1995; Weir et al. 1994). The strategies used to implement the system, such as type of training, speed of diffusion, and consistency in rollout, can also affect the outcomes of IT implementation in terms of quantity and type of medication errors, staff perceptions of their roles, how staff spend their time, satisfaction with their work environment and overall hospital costs and cost revenues (First Consulting Group 2003). Use of IT may be a major culture change and evidence suggests this type of change may be easier in organizations that value innovation.

Ample opportunity must be provided for staff to discuss what is happening both before and during imple-

mentation. Open communication about the challenges being faced and opportunities to create solutions that will help the system work better are essential. Furthermore, explanation that the new system may not save time initially, but that it will provide a safer environment in the long term, will help create a shared understanding of how the new system supports goals of improved patient care and safety.

### Implementation Policies and Practices

Implementation policies and practices can greatly influence the success of an innovation implementation (Ash 1997) and the ability of an organization to reduce errors. Research indicates that training of individuals about all aspects of the new technology needs to be timely and ongoing as the innovation is diffused to new areas.

Furthermore, construction of the system's decision-support rules should be consistent, salient, user-friendly and customizable for a wide range of users. The technology must be tested, redesigned and tested again before it can be rolled out. To prevent system failure and user non-compliance, "iterative refinements" or revisions to the IT system are important throughout a hospital's use of IT (Abookire et al. 2000; Kaushal et al. 2001). In the times of system failure, back-up systems and procedures must be available, and ongoing technical support to help handle unforeseen consequences of IT solutions is important (Dykstra 2002).

Lessons learned from hospitals that implemented CPOE stress the importance of preparation for changes in responsibilities as well as patterns and priorities of work, as CPOE profoundly alters roles and relationships of staff both during and after implementation (Ash et al. 2003b; Massaro 1993; Mekhjian et al. 2002; Sittig and Stead 1994). Provider and other health professionals' involvement in developing and customizing the system is therefore essential. Furthermore, new practice standards, guidelines and routines must be established for how work gets done. Committee structures at local levels can assist in these practical aspects of implementation.

## CONCLUSIONS

### Directions for Future Research

As policy-makers and providers continue to look to information technology as a critical component of a safe and high-quality 21st century healthcare system, there is pressing need for additional research on this topic. The evidence from the literature describes the experiences of a few early adopters and their guidelines for implementing IT solutions. Therefore, it is important to note that early adopters are different from later adopters, who might be more conservative and reluctant to take risks (Rogers 1995). There has been little to no research that compares the success in implementing IT between early and late adopters, and few studies have systematically evaluated

IT in various stages of implementation. As with many innovations, the focus so far on IT has been in the early decision-making processes and implementation. Future longitudinal research should focus on the redefining/restructuring, clarifying and routinizing stages of implementing IT solutions.

In addition, unlike other types of innovations, information technology typically undergoes repeated, rapid cycles of refinement, upgrades and replacement. Indeed, some might suggest that IT implementation never ends. Additional research is necessary to study the effects of such a lengthy implementation process on patient safety.

Finally, the conceptual framework presented in this study could be further developed to explore IT implementation effectiveness in healthcare settings. For example, many implementation policies and practices have been proposed as “success factors”; however, available research does not adequately clarify the relative importance of proposed policies and practices under given circumstances. Furthermore, the model could be useful for exploring the extent to which implementation effectiveness leads to an organization’s realization of the intended benefits of the IT solution, such as cost reductions, increased patient safety and clinical quality improvements.

### Limitations

The conclusions drawn from this review and synthesis of the literature have some limitations. First, there have been few evaluations of IT implementation, partially because the methodologies for evaluation are complex and require monitoring the innovation over a long period of time. Second, there are relatively few publications that systematically document experiences or case studies in IT implementation, even for one single organization or for one information technology innovation. Finally, the published literature focuses primarily on advocating for the potential benefits of the IT application, such as reduced medication errors or reduced variation in care practices; however, it does not actually demonstrate that these outcomes have been achieved.

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