TECHNOLOGICAL IATROGENESIS:
THE MANIFESTATION OF
INADEQUATE ORGANIZATIONAL
PLANNING AND THE
INTEGRATION OF HEALTH
INFORMATION TECHNOLOGY

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ABSTRACT

The Institute of Medicine (IOM) views Health Information Technology (HIT) as an essential organizational prerequisite for the delivery of safe, reliable, and cost-effective health services. However, HIT presents the proverbial double-edged sword in generating solutions to improve system performance while facilitating the genesis of novel iatrogenic problems. Incongruent organizational processes give rise to technological iatrogenesis or the unintended consequences to system integrity and the resulting organizational outcomes potentiated by incongruent organizational–technological interfaces. HIT is a disruptive innovation for health services organizations but remains an overlooked organizational development (OD) concern.
Recognizing the technology–organizational misalignments that result from HIT adoption is important for leaders seeking to eliminate sources of system instability. The Health Information Technology Iatrogenesis Model (HITIM) provides leaders with a conceptual framework from which to consider HIT as an instrument for organizational development. Complexity and Diffusion of Innovation theories support the framework that suggests each HIT adoption functions as a technological change agent. As such, leaders need to provide operational oversight to managers undertaking system change via HIT implementation. Traditional risk management tools, such as Failure Mode Effect Analysis and Root Cause Analysis, provide proactive pre- and post-implementation appraisals to verify system stability and to enhance system reliability. Reconsidering the use of these tools within the context of a new framework offers leaders guidance when adopting HIT to achieve performance improvement and better outcomes.

Keywords: Health information technology; planning; error; iatrogenesis; risk management; failure mode effect analysis; root cause analysis; diffusion of innovation theory; complexity theory; organizational development; patient safety; change management

Each year health-care organizations harm about 10% of patients globally (World Health Organization, 2006) and approximately 200,000 patients in the United States due to unsafe and unreliable health systems (Zhan & Miller, 2003). Overall, the health industry “frequently harms [patients] and routinely fails to deliver the appropriate standard of care” (Palmieri, DeLucia, Peterson, Ott, & Green, 2008, p. 34). As safety is “a national problem increasingly difficult to ignore” (Devers, Pham, & Lui, 2004, p. 103), health leaders are forced to identify opportunities for organizational improvement in an attempt to reduce the numbers of poor outcome (Berta & Baker, 2004; Wachter, 2004). The current U.S. agenda to increase organizational effectiveness in health delivery systems is premised on adopting innovative technologies to streamline processes (Thompson, Osberoff, Classen, & Sittig, 2007), improve human performance (Page, 2004), and reduce the overall cost of care (Hillestad et al., 2005).

Expert panels sponsored by the Institute of Medicine (IOM) believe Health Information Technology (HIT) is an essential organizational prerequisite for the delivery of safe, reliable, and cost-effective health services (Aspden, Corrigan, Wolcott, & Erickson, 2004; Aspden, Wolcott, Bootman, & Cronenwett, 2007; IOM, 2001). Despite future prospects, HIT presents the proverbial double-edged sword in generating solutions to limit health errors (Battles & Keyes, 2002) while facilitating the genesis of novel iatrogenic issues (Ammenwerth et al., 2006; Koppel, Wetterneck, Telles, & Karsh, 2008). The introduction of new technology
and innovative software is believed to be among the tools necessary to tame the performance complexity experienced by clinicians at the human–system interface (Harrison, Koppel, & Bar-Lev, 2007). However, organizations develop over time with strategic planning to continually improve the effectiveness of organizational processes (Tucker & Edmondson, 2003), which in turn improves work outputs (Bohmer & Edmondson, 2001). Technology contributes a new approach to solve traditional organizational problems, but these problems are seldom eliminated with a silver bullet approach. As such, this paper addresses the exuberant celebration for HIT adoption in health organizations with a cautious, more balanced approach, by considering the potential pitfalls inherent when relying on novel technological products to resolve traditional organizational deficiencies.

In this paper, we begin with a discussion about health organization complexity and expanded HIT adoption to address poorly performing systems. Complexity Theory guides us to consider technology as a disruptive force in organizations, and we label the resulting negative consequences as technological iatrogenesis. Then, we present the Health Information Technology Iatrogenesis Model (HITIM) to illustrate the potential opportunities and threats organizations face with HIT adoption. Next, we discuss HIT project planning and development within the context of the Diffusion of Innovation Theory (DIT) and suggest leaders consider technological iatrogenesis a direct but manageable consequence. As such, we offer traditional risk management tools, such as Failure Mode Effect Analysis and Root Cause Analysis, as proactive pre- and post-implementation evaluations to verify efficacy and maintain system integrity. Finally, we conclude by reviewing the implications for HIT adoption and provide guidance to health leaders undertaking HIT projects. This paper contributes to the health-care literature in two ways: (1) identifies the problems reported in the literature when HIT projects are adopted by mature health organizations and (2) it advocates an organizational framework for adopting HIT projects to address system problems. As such, organizational development (OD) strategies can guide leaders in the strategic application of HIT projects within mature health organizations as solutions that stimulate safer and more reliable delivery systems.

HEALTH-CARE ORGANIZATIONS AND HEALTH INFORMATION TECHNOLOGY

Complex Adaptive Systems

Health-care organizations are complex adaptive systems (CAS; IOM, 2001; Plsek & Greenhalgh, 2001). CAS are defined by their structures, processes,
and patterns (Capra, 2005). CAS are multifaceted and demonstrate self-organization as diverse agents interact spontaneously in nonlinear relationships (Anderson, Issel, & McDaniel, 2003). In health-care (McDaniel & Driebe, 2001), agents, such as physicians, nurses, and pharmacists, act as information processors (Cilliers, 1998) and co-evolve with their environment (Casti, 1997), both locally, such as within nursing units, and organizationally. These agents act while utilizing a variety of methods to process information (Coleman, 1999) and to solve systemic problems within and across organizational layers (McDaniel & Driebe, 2001). Due to the unpredictable nature of human interactions, these interconnected actions contribute to “generative relationships” (Maxwell, 1996) that change the context for each agent. As such, even seemingly minor or micro-alterations to any process at any organizational level can stimulate unexpected system outcomes, either beneficial or detrimental.

Originating at the clinical micro-system, such as the pharmacy department, agents act to stimulate emergent properties that diffuse over time and throughout the organization. As improvement efforts, such as HIT adoption, modify agent interactions, the organizational outcome includes process realignments and system alterations. The system is adaptive since feedback mechanisms continually function at the agent level, in an attempt to maintain a dynamic homeostasis (Johnson, 2001). Homeostasis is achieved when individual agents contribute critical feedback to the system through decisions, actions, and at times inactions. Ultimately, this feedback mechanism cultivates adaptation in the CAS congruent with the emergence discussed in the DIT (Rogers, Medina, Rivera, & Wiley, 2005). The system, through its agents’ work, is continually adjusted and managed at the micro-level in order to maintain system stability despite the macro-level changes introduced by leaders. Therefore, the system is collectively engineered at the micro-level as individual agents are stimulated to respond to decisions made by the leaders.

**Emergent Organizational Properties**

HIT is a label to describe a variety of computer and electronic applications such as bar code medication systems (BCMS; Poon et al., 2006), electronic health records (EHR; Sidrov, 2006), computerized provider order entry (CPOE; Bates, 2005b), and decision support systems (DSS; Kawamoto, Caitlin, Balas, & Lobach, 2005). HIT adoption projects result in emergent care delivery properties, specifically related to process alterations and agent
responses to new working conditions. Emergence is derived from the altered interactions between clinicians, clinical departments, and system components as each new technological innovation is introduced into the system. Under the influence of new technology, the system becomes dynamic and overtly and, at times subvertly, responsive.

Technology promises to reduce costs and improve quality by streamlining processes, facilitating communication, reducing human error, organizing and storing data, and digitizing billing and reimbursement (Aspden et al., 2004, 2007). However, these promises have yet to be fully realized (Ash et al., 2007). One prominent concern is the additional complexity created by new technologies, such as CPOE, with the capability either to reduce adverse drug events and their associated negative consequences (Ford, McAlearney, Phillips, & Menachemi, 2008) or to further deteriorate system performance (Classen, Avera, & Bates, 2007).

For example, research indicates HIT adoption projects for a specific clinical function, such as CPOE, impact every clinical discipline, multiple administrative functions, and numerous clinical processes (Tucker, Nemhard, & Edmondson, 2007), yet CPOE initiatives often address larger superficial tasks assumed to be problems in the pharmacy or on nursing units while ignoring the related underlying complexities associated with system attributes such as policies and procedures. Technology can not only impact specific tasks, such as ordering medications, but also many associated processes and related people (Harrison et al., 2007; Koppel et al., 2008). Inadequate attention to detail manifests as technology vendors market products with little regulatory supervision and limited safety oversight; hence organizational complexities are ignored, negative consequences are understated, and positive attributes are overtly advertised.

**Organizational Development**

HIT adoption within mature health delivery systems is an overlooked OD concern (Ovretveit, Scott, Rundall, Shortell, & Brommels, 2007; Ramanujam & Goodman, 2003; Shortell, 2004). Beckhard (1969, p. 9) defined organizational development as an effort that is “(1) planned, (2) organization-wide, (3) managed from the top, to (4) increase organization effectiveness and health through (5) planned interventions in the organization’s processes” utilizing scientific knowledge. In health organizations, HIT can operate as an agent of change by stimulating predictable system improvements and facilitating unpredictable process technicalities
(Drummond, Ferranti, Lehmann, & Lighter, 2009). For example, the idiosyncratic and potentially severe issues associated with CPOE implementation recently gave rise to novel unexpected outcome reports and adverse event discussions (Campbell, Sittig, Ash, Guappone, & Dykstra, 2007; Weiner, Kfuri, Chan, & Fowles, 2007).

Many organizations continue to approach HIT as a tool to address the obvious symptoms of dysfunction (Loewe & Domininquini, 2006) while leaving problematic remnants in place such as outdated systems or processes that do not fully integrate with the new technology (Harrison et al., 2007). Despite the realization that health-care organizations are unsafe and often unreliable in the care delivered (Kohn, Corrigan, & Donaldson, 2000), organizational learning from failures is limited (Edmondson, 2004) and remains a significant challenge (Tucker & Edmondson, 2003). The problems associated with HIT implementation projects have become frequent and serious enough to stimulate publications such as H.I.T. or Miss: Lessons Learned from Health Information Technology Implementations to detail factual accounts of seldom discussed mishaps, errors, and adverse events (Leviss, 2010).

**TECHNOLOGICAL IATROGENESIS**

The ancient directive *Primum non nocere*, or “first do no harm,” is the gold standard for every health-care professional. For centuries this directive has supported the belief that patient harm caused by a health-care professional, whether intentional action, preventable error, or accidental, is a punishable offense; this remains true in modern health-care (Palmieri & Peterson, 2008). Iatrogenesis literally means “brought forth by the healer” (*iatros* means healer and *genesis* means brought forth by) and describes unintended consequences of care at the clinical level (Palmieri, Peterson, & Ford, 2007). But leaders and nonclinical professionals are also responsible for iatrogenic occurrences, directly and indirectly, that result from inadequate organizational system (Kohn et al., 2000) and process management (Palmieri et al., 2008).

Health-care management and clinical publications often speak of the term iatrogenesis without specific reference to a model, conceptual framework, or philosophical underpinning. In the 1970s, Ivan Illich published *Medical Nemesis*, to describe the etiology of patient harm generated by poorly designed health delivery processes. Illich (1976) explicated the dangers related to the complex and dynamic interactions typically found in health
systems. Cultural, social, and clinical iatrogenesis form the fundamental basis for his work. Given the considerable technological advancements in health-care, Palmieri, Peterson, and Ford (2007) proposed a fourth iatrogenic type called technological iatrogenesis to address the emergent errors associated with HIT adoption (Aspden et al., 2007). The emergent errors named technological iatrogenesis are defined as the unintended consequences to system integrity and the resulting system outcomes potentiated by incongruent organizational–technological interfaces.

**Etiology of Technological Iatrogenesis**

Technological advancements represent a contemporary form of organizational development in health-care (Palmieri, Peterson, Pesta, Flit, & Saettone, 2010). Although technology is an essential component for improvement (Aspden et al., 2007), “for successful implementation, it is secondary to organizational development” (Shortell, 2004, p. 12). Technologies evolve with organizations and transform even the most basic work processes (Harrison et al., 2007). Hence, HIT is a modern instrument for leaders to further potentiate change in health-care organizations.

Technological iatrogenesis is a contemporary term to describe the technology-induced failures caused, at least in part, by superimposing new systems within and even upon discrete areas of mature systems (Palmieri et al., 2007). Layering technological “solutions” in organizations is common with technological integration (Harrison et al., 2007) in an attempt to solve particular system problems, yet this layering contributes to unanticipated changes in organizational processes that lead to novel and at times consequential issues (Koppel et al., 2005). In a qualitative study, health-care professionals actively engaged in system redesign indicated successful projects involve coordinating changes across multiple organizational levels rather than within specific projects (Wang, Hyun, Harrison, Shortell, & Fraser, 2006).

Technological iatrogenesis is an element that aligns with the other three iatrogenesis types offered by Illich (social, cultural, and clinical). Iatrogenesis associated with system change is not apparent without the visible manifestation of counterproductivity (Illich, 1976), those issues that detract from system reliability. Technological iatrogenesis represents what Marcus, Schuler, Quell, and Humpfner (2002) describe as the visible and paradoxical, or unwanted, side-effects associated with altered organizational inputs that lead to unexpectedly varied outputs. Latent errors are one
example of the unwanted side-effects that can lead to an unexpected or varied output such as patient harm. The IOM notes health errors result from system complexity (Aspden et al., 2004) while emphasizing the interdependent variables implicated in the manifestation of adverse events can be formed by technology (Aspden et al., 2007). Therefore, technology is a contemporary health tool that leaders should judiciously regard as a probable solution and a potential threat to system stability.

System stability is at risk as health facilities rapidly attempt to meet the recommendations that the IOM (2001) called for, including the use of electronic prescribing systems, such as CPOE, in all health-care organizations by 2010; codified by an executive order and then delayed. This order heightened the urgency for adoption by hospitals, yet there is a noticeable lack of regulatory oversight and substantial variation in system architectures because basic industry standards remain unsettled (Taylor et al., 2005). In addition, many system implementations have experienced costly failures (Ammenwerth et al., 2006). Furthermore, there is ample evidence that electronic prescribing systems contribute to some types of adverse events and other medical errors (Koppel et al., 2005). For example, the period immediately following CPOE implementation resulted in significant increases in reported adverse drug events (Bradley, Steltenkamp, & Hite, 2006), and evidence of other substantial errors has been reported (Bates, 2005a; Bates, Leape, Cullen, & Laird, 1998). Collectively, these accounts depict the phenomena; technological iatrogenesis, stimulated by misaligned processes; disrupted agent interactions; and detached communication networks.

*Health Information Technology Iatrogenesis Model*

Illich’s conceptual framework (1976), with the addition of technological iatrogenesis, explains the role of contemporary organizational attributes in the proliferation of adverse events. The four iatrogenic concerns are illustrated in the HITIM; see Fig. 1. Although we provide the entire model, this paper is principally concerned with the circle identified in Fig. 1 as technology. The point where the system is resilient to error, or the least harm is observed, is identified by Fig. 1a. Alternatively, the system with a propensity for iatrogenesis, or where frequent harm is observed, is illustrated by Fig. 1b. While Fig. 1a illustrates the safer environment, in reality the majority of organizations are represented by Fig. 1b because leaders overlook organizational complexity when addressing seemingly basic problems with HIT solutions. To the extent the various spheres of iatrogenesis do not overlap or
interact, there is increased opportunity for system failure. For improved patient outcomes, health systems must become more resilient to errors (IOM, 2001; Reason, 2000). In order to progress health delivery systems using innovative technologies, further emphasis on HIT as an organizational development strategy is an essential antecedent and risk assessment a prerequisite for planning and implementation activities.

Previous scholarly work supports the basic model tenets. For example, when evaluating health organization complexity, McDaniel and Driebe (2001) argue neglecting underlying system relationships and the associated interdependent variables are the main causes of technology failures. Furthermore, Palmieri and colleagues (2008, 2010) include health organization complexity such as cultural attributes, social systems, technology innovation, and human resource management as fundamental components to consider when seeking to organize highly reliable processes. Finally, Harrison et al. (2007) offer the Socio-Technical Model to describe the human–user interfaces and the associated organizational attributes that lead to both expected and unexpected outcomes when mature health-care systems adopt new technologies.

As we will explain in the coming sections, leaders often contemplate system changes or novel innovations as strategies to improve safety and quality; however, they rarely consider the four iatrogenic typologies that impact the greater organizational culture. Achieving the theoretical point of iatrogenic avoidance, as identified by Fig. 1b, is possible when leaders concentrate on technologies, such as CPOE, as an organizational change
agent and a method for system reengineering rather than merely the installation of a technological product to solve specific problems, such as CPOE to help prevent medication errors.

**Organizational Incongruence and Misalignment**

**Active Errors**

Health-care, with all the scientific advancements, is surprisingly far behind in technical development and system integration compared to other industries (Aspden et al., 2007). As an all-too-frequent artifact of poorly constructed health delivery systems (Helmreich, 2000; Kohn et al., 2000; Reason, 2000), iatrogenesis is a considerable, but controllable, health-care reality (Page, 2004; Reason, Carthey, & de Leval, 2001). With continued technological advancement and system improvement, the outcomes that result from common errors (Chiles, 2002) represent “the failure of planned actions to achieve their desired goal, where this occurs without some unforeseeable or chance interventions” (Reason & Hobbs, 2003, p. 39). Reason, Carthey, and de Leval (2001) describe this failure as the “vulnerable system syndrome” and emphasize early identification, evidence-based treatment, and prevention strategies to address process and system failure. Furthermore, vulnerable systems remain suspect and prone to frequent errors (Battles, Kaplan, van der Schaaf, & Shea, 1998; van der Schaaf, 1992) when the iatrogenic typology is not appropriately regarded (Illich, 1976), or is insufficiently addressed by leaders (Reason, 1990).

To facilitate system redesign, errors first need to be accurately described (Benner et al., 2006; Wiegmann & Shappell, 2003) with emphasis on the etiology and the associated system attributes (Palmieri et al., 2008). Broadly stated, there are two products of iatrogenesis – latent and active errors (Reason, 1990, 2000). Active errors are actual breaches, or failures, in system defenses arising from dormant conditions that are energized by some type of stimuli (Reason, 1990; van der Schaaf, Lucas, & Hale, 1991), such as disturbances from system changes.

Manifesting from hidden conditions, active errors in patient care can result from strategic and operational decisions made at the highest organizational levels (Reason, 1998; Reason et al., 2001). Active error materialization provides immediate feedback about the presence of iatrogenic system properties (van der Schaaf, 2002). As such, leaders immediately respond to active errors with simplistic corrective strategies that often implicate a person instead of the system or management (Reason, 1998). In this case, Ramanujam and Rousseau
Technological Iatrogenesis

(2006) argue this challenge is organizational in nature and results from consequential leadership decisions focused on specific clinical problems while often missing the broader system implications. Understanding and recognizing hidden system properties is needed to reduce the likelihood of iatrogenic events (Hoff, Jameson, Hannan, & Flink, 2004), especially those active errors stimulated during HIT adoption.

Latent Errors

Technology implementation, such as CPOE, gives rise to expected benefits that can quickly become overshadowed by new and unanticipated problems (Zahn, Hicks, Blanchette, Keyes, & Cousins, 2006). Primarily, the problems are the production of latent, or unnoticed, errors. Latent conditions, or hidden malfunctions, have been characterized as situations placed into the system, as part of its design, or caused by actions taken by decision makers removed from the direct work (Sasou & Reason, 1999). Reason (1998, p. 10) provides a living comparison: “Latent conditions are to technological organizations what resident pathogens are to the human body.” Similar to the pathogen–host analogy, many technology projects expose the existing system to larger-than-anticipated changes and incompatibility manifests progressively with worsening signs and symptoms. The resulting system instability is often exposed as an adverse event (Page, 2004).

As “accidents waiting to happen” (Whittingham, 2004), new technologies are rapidly added to existing system complexity to solve problems (Weiner et al., 2007). With inadequate organizational planning, however, the solution can lead to new problems generated by latent conditions (Reason, 1990). For example, CPOE implementation without workflow analysis can lead to seemingly inert changes to the medication delivery process, at the clinician level, but these can negatively impact system stability. As such, nurses (DeLucia, Ott, & Palmieri, 2010) and pharmacists often develop system workarounds, or improvisations (Palmieri et al., 2008) without management knowledge, in an attempt to reconcile the incongruent work conditions.

System alterations contribute to the occurrence of adverse clinical events that often harm patients (Rasmussen, 1990; Reason, 2000). More importantly, latent errors provide early and perhaps repetitive warnings of imminent accidents of consequence, such as adverse events (Reason, 1998; van der Schaaf, 2002) much like the tremors preceding an earthquake. Thus, in relation to health systems, latent error identification and intercession provide an important adverse event prevention strategy (Cook & O’Connor, 2005; Cook & Woods, 1994; Reason et al., 2001). As indicated by Fig. 1, errors are best identified prospectively as social, cultural, clinical, and
technical system characteristics that should be considered in the planning process, prior to system changes.

Change Processes and Organizational Performance

Change processes expected to improve organizational performance often lead to unintended increases in the incidence of latent errors (Rasmussen, 1999; Reason, 1998). Researchers have completed empirical studies that conclude there is a propensity for unplanned changes in nursing performance and workflow following technology implementation (Cheng, Goldstein, Geller, & Levitt, 2003). In particular, CPOE (e.g., Koppel et al., 2005) and BCMA (e.g., Koppel et al., 2008) implementations have caused significant, but unanticipated, workflow changes. For example, nurses are required to engage in additional coordination activities with members of the care team who were not realized during the planning process. These workflow changes reduce the amount of time nurses can spend at the bedside (Rutherford, Lee, & Greiner, 2004), which contributes to time pressure and additional workload and increases cognitive load (DeLucia et al., 2010). These workflow changes often lead to adverse consequences (Kurtzman & Kizer, 2005), which manifest as e-iatrogenic errors (Weiner et al., 2007), the error product of technological iatrogenesis.

The advancement of technological solutions purposed to address health system problems frequently leads to increasingly complex processes. Absent adequate planning and system knowledge, problems can generate cascade iatrogenesis. The term “cascade iatrogenesis” describes a series of multiple issues with increasingly more severe effects (Rothschild, Bates, & Leape, 2000) ultimately leading to system maladjustments. This cascade is caused as a new technology is applied to the system in order to solve a previously recognized problem. The cascading of multiple complications, at different layers, set in action by errors (Reason, 2000; Rothschild et al., 2000) is what leads to HIT-related near and adverse events.

DIFFUSION OF INNOVATION AND TECHNOLOGICAL INTEGRATION

DIT offered by Rogers (2003) provides assistance to leaders intending to adopt HIT as a solution to improve mature systems. While the DIT framework describes various rates of innovation adoption, there are
important parallel considerations to determine the “innovation fit” in a CAS. Decisions for HIT implementation ought to be evaluated by leaders while concurrently considering environmental factors, such as those related to the cultural, social, clinical, and technological domains identified in Fig. 1. The relevant characteristics of HIT innovation, relative advantage, complexity, observability, innovation, and adoption are described below.

Relative Advantage

First, leaders should decide if the relative advantage and the impact afforded by the technology are better than the relative norm from the user’s perspective, not the top management team (TMT) perspective. This evaluation is the compatibility, or the degree to which the technological innovation is compatible with the experiential knowledge of the organization’s collective members (Rogers, 2003). With technology in health-care, the specific benefits to reduce system errors and to improve cost containment are not often understood. For example, Rosenstein and O’Daniel (2008) report the disruptions created by technological innovations in hospitals, such as to communication and clinical practices, may overshadow the potential system benefits. As such, prudent leaders should consider the possibilities of disruption early in the planning process.

Complexity

Complexity is the degree to which technological innovation is perceived as difficult or easy to implement and use. Rogers (2003) explains that the more complex an innovation is, the less likely the innovation will be successfully adopted. The degree to which the technological innovation can be tested or used prior to implementation is considered to be “trialability” (Rogers, 2003). By using “trials,” an organization can help to decrease innovation adoption uncertainty and increase implementation effectiveness. These trials provide an opportunity for leaders to garner user feedback about implementation and usability issues. With CPOE implementation, the technology has been adopted within entire systems and then studied, with leaders expecting many benefits and little harm. Unfortunately, this strategy has yielded increased mortality (Han et al., 2005) and high rates of adverse medication events (Nebeker, Hoffman, Weir, Bennett, & Hurdle, 2005).
Observability

Rogers (2003) believes observability, the degree to which a technological innovation is viewable to organization members, is perceived as either positive or negative. In reality, observability reflects the extent to which the technological innovation is supported, or perhaps not discouraged, by organizational users. The innovation diffusion rate depends on the extent to which the innovation is tailored to the organization. This tailoring, or best-fit provision, determines the adoption impact and the user commitment to the technology. Rogers (2003) considers innovation complexity to be a key attribute that lessens the need for tailoring to positively influence diffusion. Reports have surfaced about the evolution of stealth errors, such as computerized physician orders not being completed or electronic medical record data disappearing within mature systems, especially those previously considered to be high-reliability systems (Kuehn, 2009).

Innovation

Innovation within organizations, such as hospitals, results in consequences that manifest as system enhancements or detractions and/or result in user adoption or rejection. As such, Rogers (2003) describes three classifications of consequences: desirable or undesirable (related to function or dysfunctional), direct or indirect (immediate or second-order responses), and anticipated or unanticipated consequences (recognized and intended consequences). Since change agents during innovation adoption frequently focus on potential system improvements while discounting possible iatrogenic consequences, it is important to bring these consequences from the background to the foreground. By incorporating heightened awareness and vigilant monitoring in HIT implementation projects, leaders can minimize the manifestation of iatrogenic situations, or at least attempt to mitigate the resulting consequences with early detection.

Adoption

Adoption is important in HIT as both CPOE and EHR have been federally mandated in the United States (Aspden et al., 2007; Bush, 2004). The role of these technologies will expand in the future of hospitals and physician practices. Early indications suggest that the transition will not be easy and
will cause tremendous issues in the health system. Presently, the innovators and early adopters are beginning to emerge (Jha et al., 2009). With these implementations, the previously discussed financial costs, poor operational performance, and unanticipated system issues contribute to questions about further adoption. The slow response to innovations adoption and resistance to the diffusion is strong (Ford, Menachemi, & Phillips, 2006). As such, it is unlikely that the adoption will occur by the mandated timeframe, especially where EHR are concerned (Ford, Menachemi, Peterson, & Huerta, 2009; Menachemi, Ford, Beitsch, & Brooks, 2007).

**MANAGEMENT STRATEGIES**

There are a number of tools leaders can utilize in order to reduce the impact of technological issues in HIT implementation projects. In this section, we briefly address the contributions Root Cause Analysis (RCA) and Failure Mode and Effect Analysis (FMEA) can provide to leaders contemplating HIT projects. These tools assist leaders in understanding organizational weaknesses by dissecting system properties to comprehensively examine the hierarchical processes and to identify the iatrogenic properties that could originate from HIT adoption. The Joint Commission mandates the strategic use of improvement tools such as RCA and FMEA for quality improvement. While FMEA is used as a prospective accident prevention technique, RCA is used as a retrospective accident analysis.

*Root Cause Analysis*

The RCA is a comprehensive adverse event review. This retrospective approach to evaluate failure causation is described by the Joint Commission as a systematic investigation that elucidates the “process that allowed an error to occur and identifies factors that underlie variability in performance” (Torpy, 2002, p. 178). The RCA can identify the causative etiology for error cascades with a process that identifies basic or casual factors underlying performance variation (Joint Commission Resources, 2007). As the system approach to accident analysis is preferred to human blame, accredited hospitals are required to conduct thorough investigations of each sentinel event, or the most serious iatrogenic occurrence where a patient is harmed or killed. Using a prescribed process for identifying the causal factors that trigger deviation in performance, the RCA permits a cautious
survey of the health system to determine the cultural, social, clinical, and technological implications. Often, system abnormalities in areas unrelated to the causative agents are exposed, which can lead to further system intelligence.

**Failure Mode and Effect Analysis**

While the RCA provides an important mechanism to minimize the probability of repeated events (Battles et al., 1998), the FMEA offers proactive knowledge about potential iatrogenic system properties that may result from new processes or technologies. FMEA is a risk assessment technique, which allows planners to systematically identify system innovation problems throughout the planning process (Stamatis, 2003). Undertaken early in the conceptual design stage and prior to project implementation, FMEA works to highlight potential breaches in processes that can result in system failure (Smetzer & Cohen, 1999). As such, this method is a proactive approach to minimize the probability of adverse effects arising from the iatrogenic system properties (Cohen, Davis, & Senders, 1994; Senders & Senders, 1999).

“Failure mode” describes the place(s) where the system may not perform as anticipated. The area for system concern, or the potential failure(s), leads to an extensive examination and assessment. This “effect analysis” reviews the consequences that might result from each identified but unanticipated failure (DeRosier, Stalhandske, Bagian, & Nudell, 2002). When analyzing a failure, the seriousness of consequence, the probability for failure, and the likelihood system defenses can detect iatrogenic issues are carefully considered. Leaders need to ask the following questions: (1) what can fail; (2) how can it fail; and (3) what is the cost of failure (Smetzer & Cohen, 1999). For each identified failure mode, system alternatives are considered and change modifications are implemented to minimize the probability for iatrogenic consequences.

With system maturation, signs and symptoms that depict the actual state of system stability begin to surface. Unexpected signs and symptoms often indicate the presence of iatrogenic properties. These iatrogenic attributes signal the probability of future failure and require immediate analysis. Over time, as more system intelligence is gathered, the FMEA can be used to review an aging innovation to determine the degree of system–technology compatibility (DeRosier et al., 2002). The more complex the health-care process, the more essential the expert understanding of a system’s potential
failure modes to minimize iatrogenesis and to ensure the system’s expected performance (Palmieri et al., 2008). Diligent FMEA utilization is especially important when layers of process innovations are constructed into a specific system where complexity is increased (Stamatis, 2003).

Both RCA and FMEA activities involve human recovery efforts described by van der Schaff and colleagues (2002, 1991) as an important verification feature where system usability, especially technical factors, is evaluated from the agent’s perspective in order to identify latent iatrogenic properties. As is the case with technology implementation projects, mature systems are significantly altered by computerized instruments that impact previously manual processes. FMEA, when utilized early in the planning process, can elucidate latent problems while there is ample time to find solutions and make the appropriate adjustments to the project.

CONCLUSION

Since the inception of the safety movement, leaders seldom seek knowledge from the disciplines of human factors (DeLucia, Ott, & Palmieri, 2009; Leape et al., 1998), safety science (Battles et al., 1998; van der Schaaf, 2002), and organizational development (Alexander, Weiner, Shortell, Baker, & Becker, 2006; Shortell, 2004; Wang et al., 2006) as they work to become a high-risk but low-failure industry (Pidgeon, 1998; Reason, 1998; Roberts, 1990; Roberts, Madsen, Desai, & Van Stralen, 2005). Balancing technological innovation with the role of leadership to develop safety-oriented cultures generates continued tension (Reason, 2000). Designing a functional safety culture and concurrently managing the financial status of a healthcare organization presents additional challenges for leaders (Joyce, Boaden, & Esmail, 2005). Furthermore, health leaders face increasing pressures for action as they contemplate the penalties soon to be imposed by insurers and the government for not maintaining a safety culture, the culture that exhibits limited iatrogenic properties and is resilient enough to prevent system failures.

Leaders overwhelmed with system problems, innovative technologies, and mounting external pressures engage in “problemistic search” (Cyert & March, 1963, p. 120) as they scan the environment for quick solutions to pressing problems. Frequently, leaders discover the quick solution is to “attribute human unreliability to unwanted variability and strive to eliminate it” (Reason, 2000, p. 770). Consequently, most incident reporting systems used by organizations to identify and remove iatrogenic system
properties describe what happened while paying modest attention to the underlying iatrogenic contributors (Battles et al., 1998). Leaders can further appreciate the sources of system error with focus attention on iatrogenesis. The concurrent pressures created by unrecognized cultural, social, clinical, and technological iatrogenic traits contribute to the unreliable processes and the adverse outcomes leaders seek to eliminate (Palmieri & Peterson, 2008). In addressing these organizational issues, leaders can organize reliable systems that achieve high-quality outcomes, an important measure of organizational effectiveness (Ramanujam & Goodman, 2003; Vogus & Welbourne, 2003).

Developing better health-care systems through HIT implementation necessitates an organizational approach (Pettigrew, Ferlie, & McKee, 1992) in order to avoid costly disturbances to care delivery. Organizational cultures are created, supported, and sustained when leaders model the expected organizational values (Bennis, 1989). By understanding how culture influences behavior and process, leaders can proactively identify iatrogenic system properties and support organizational change as their response. This system approach to preventing critical failures through organizational development will contribute to improved organizational safety. As HIT innovations diffuse throughout organizations, leaders must be aware of the obstacles to innovation and strive to overcome them (see Box 1). The DIT framework can guide leaders in this regard.

Despite endorsements for developing increased HIT capacity in health organizations (IOM, 2007) and the approach for adoption advocated in this paper, the organizational characteristics and operational strategies necessary for successful adoption remain largely unknown (Jha et al., 2009).

Box 1. Common Obstacles to Successful HIT Adoption Projects.

1) short-term management focus
2) insufficient resources and inadequate time
3) unrealistic payoff and development timeframes
4) misaligned rewards not structured to support innovation adoption and implementation
5) incomplete and disorganized innovation plan
6) mistaken perception that innovation is an inherently risky undertaking (Loewe & Domininquini, 2006)
Although HIT is reported to impact social processes, human factors, workflows, information exchanges, and interpersonal relationships (Chaudhry et al., 2006; Harrison et al., 2007; DeLucia et al., 2009), researchers have only recently designed the first HIT adoption study to understand these phenomena in order to offer leaders evidence-based strategies and practices to facilitate successful HIT adoptions in their facilitates (Kitzmiller, Anderson, & McDaniel, 2010). Health leaders must remain focused on supporting evidence-based practices for both clinical and operational changes in care delivery.

Adopting HIT with attention to planning and development can achieve more cost-effective and reliable systems. However, in the quest for success, vigilant organizational awareness is necessary to identify and prevent costly technological failures. The HITIM provides leaders with assistance in considering all HIT improvements as major organizational changes instead of isolated technological solutions to solve a focused problem. Recognizing the opportunity for incongruent technology–organizational conditions, leaders will teach their organizations to anticipate new system threats. Organizations focused on adopting HIT while understanding the etiology of technological iatrogenesis will develop resilient systems with improved quality and safety, and develop the efficiencies required to achieve improved financial outcomes.

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