PATIENT SAFETY

Achieving high reliability: Other industries can help health care's safety transformation

By Jeffrey P. Brown, M.Ed.

INTRODUCTION

Health care organizations are systems. They are characterized as such by the complex interrelationships and interdependencies among people and technology organized to care for patients. Because many routine processes and technologies of health care carry significant risk of injuring patients and providers, health care systems in the event of failure may also be characterized as "high consequence" systems.

Extensive research has been conducted in organizations that manage high-risk, high-consequence processes with low rates of failure and harm. These organizations have been called "high reliability organizations" (HROs). Health care institutions are struggling with the challenges of transitioning from high-consequence, low reliability to high-consequence, high-reliability.

This report provides a theoretical framework for exploring accidents as decision side effects, propagating from all levels of the U.S. health care system. This theoretical framework will helps us explore the safety merits of five key traits of highly reliable organizations. A brief discussion of frontline communication and interaction strategies that appear to support the emergence of these traits in health care organizations is followed by thoughts on the role cross-industry collaboration plays in supporting progress toward high reliability.

BACKGROUND

During the latter half of the 20th century, advances in medical knowledge and technology profoundly improved our chances of avoiding or surviving illness and trauma. Yet, attendant with these advances, escalating social and technical complexities have created safety problems.

Patients are too frequently injured by organization and management strategies that were appropriate to a much earlier time when health care was provided by smaller numbers of caregivers with limited coordination needs and fewer diagnostic and therapeutic technologies.(1, 2, 3) The Institute of Medicine (IOM) has recommended that health care organizations adopt principles and practices that have enabled organizations in other industries, such as air transportation and nuclear power generation, to operate high risk processes with comparatively low rates of failure and harm.(1, 4)

High-risk/high-consequence common ground

Although health care organizations may seem to have little similarity to organizations involved in air travel and nuclear power, the following attributes establish common ground.

Social and technical complexity: The number and diversity of roles, process interdependencies and interrelationships among people and technology establish health care organizations as complex "socio-technical" systems.

High-risk/high consequence: Risks associated with the management of complex care processes, potent medications and sophisticated technologies are compounded by the risks associated with the diseases and injuries for which patients receive care. Because failure in managing these high-risk processes and technologies may cause injury or death, the provision of health care is both a high-risk and high-consequence endeavor.

Knowledge-intensiveness: Problem solving is essential to the safe and reliable achievement of patient care goals. Safety is achieved by clinical personnel solving problems, noting difference and adapting in changing conditions.

Uncertainty: The functioning of people and technology in complex systems can neither be wholly anticipated nor made fully visible. In any environment where we cannot directly observe or monitor all of the processes we are managing or depend on, we exercise judgment, make decisions and take actions with substantial uncertainty about what factors may undermine our intentions. Surprises can occur at any time.

Connotations for health care risk management

Health care organizations may improve their ability to limit the risk of accidental injury and death by examining safeguards and countermeasures against accidental injury and death that have evolved in kindred industries, i.e. those that share traits of socio-technical complexity, high risk/high consequence, knowledge-intensiveness and uncertainty.

While health care organizations have looked to other industries for safety and quality improvement methodologies, many current initiatives seem focused on the adoption of process management methodologies and technological safeguards. For example,

improved process management is being pursued through ISO 9000 and through Six Sigma.(5) Similarly, the implementation of technological safeguards against errors, such as bar coding in medication administration and computerized physician order entry, are gaining a foothold.(6, 7)

"Side effects are inevitable when change is introduced in complex systems; altering interdependencies in work processes (human or technological) can create new hazards."

While integral to organizational efforts to improve patient safety, process improvement strategies, technological safeguards and other changes intended to improve safety are often implemented without adequate frontline mechanisms for monitoring, detecting and intervening in deleterious human performance side effects.(7, 8) Side effects are inevitable when change is introduced in complex systems; altering interdependencies in work processes (human or technological) can create new hazards.

Case 1, for example, illustrates how a seemingly slight change in purchasing kindled a serious safety problem.(9)

CASE 1: CHEAPER MORPHINE, GREATER RISKS

VP for process and QI learns of dangerous work-around

Our risk management office advised me that a nurse educator wanted help regarding an emergent problem: Unlabeled syringes containing morphine in saline solution were being found around the hospital. There are laws, policies and procedures directing us not to do this. I was very curious because this was a previously unheard of problem in our organization.

On exploring the issue with the nurse educator, I learned that nurses had begun keeping syringes with morphine solution in their pockets because patients need frequent pain management. This didn't explain why they were now carrying morphine around instead of drawing up a single dose each time a patient needed a shot.

I went to the floor and teamed with a nurse to walk through the medication administration process. We looked at a patient's chart, which had an order to administer 4mg morphine every two hours. We then went to the AccuDose dispenser, a box with narcotics and drugs prescribed for the patient for each day. To access the drugs, the nurse entered her identification and opened the dispenser. Inside was a 10mg ampule of morphine. The nurse informed me that this was the only size carried in our pharmacy. It was also the only non-bar-coded medication in our pharmacy.

It turns out that a decision had been made to purchase the 10mg, non-bar-coded morphine because it's cheaper than the premeasured, bar-coded variety.

This change in purchasing might not seem like a big deal but it has significant impact on nursing work processes. Because nurses never use 10mg of morphine at once, they must go to a separate area, draw the needed amount into a syringe and dilute it to 1mg per cc. Then they look for a bar-coding device to "tell" it they are going to dose the patient. However, they can't just scan in the information because these morphine vials have no bar code. Nurses have to override the bar code function and enter that they are administering only 4mg, not 10mg. Once that's accomplished, they find a handheld and scan the patient's armband to tell the device they are about to administer the morphine and then that it has been delivered. After that, they must find another nurse to witness them dispose of the excess morphine. Finally, they document the patient's response to the injection.

The morphine administration process had become incredibly time consuming, intruding on other patient care needs and responsibilities. Not surprisingly, if a nurse was unable to find another nurse to witness the disposal of excess morphine and a patient needed attention, the syringe would go into his/her pocket for disposal later (if remembered). Then nurses began saving the syringe for the next shot to avoid the entire rigmarole.

In short, the added steps and delays in care processes that were introduced by a switch to non-bar-coded morphine undermined the ability of nurses to meet the needs of their patients, complete other duties and ultimately provoked a hazardous work-around. Deviation from morphine handling standards was rapidly normalized under the pressure of meeting patient needs.

Note: The vice president was unable to gain support for return to use of bar-coded morphine. Instead, nurses were advised that if they were found to have improperly handled morphine, including delay in wasting and documentation, they would be reported to the state nursing board and dismissed. The vice president attempted to explain why she believed this wouldn't correct the problem, stating that it was not an issue of rogue nurses and that the use of non-bar-coded morphine would continue to impinge on nursing work processes, regardless of whom might be fired, leading replacement nurses into the same unsafe practices.

Case 1 demonstrates how changes that are perceived to be minor at upper levels of an organization may significantly and unexpectedly compromise frontline human performance. The unintended complication of the medication administration process made it difficult for nurses to fulfill their patient care responsibilities and other duties. In fact, it was subsequently determined that it was during short-staffed shifts that the deviation from required morphine handling practices began to be "normalized," i.e., to become the rule rather than the exception.

A striking feature of this case is the unintended subversion of expensive bar coding medication administration technology, a significant financial investment in safety. This illustrates how safety "solutions" can quickly and insidiously become entwined in safety problems.(7, 10)

The organization's response

Because the nurses' hazardous work-around constitutes a violation of criminal law, administrative regulation and organizational policy, it is easy to identify the "culprits" and investigate no further ("if the nurses can't comply with the law, fire them"). Implicit in this stance is the assumption of incompetence or criminal intent. Get rid of the bad nurses and the problem will go away.

In contrast, while the vice president in **Case 1** also recognized both the safety and legal ramifications of having nurses walking around with unmarked syringes containing morphine in their pockets, she refused to simplify the reasons. Implicit in her approach to investigating this problem was the assumption that the nurses involved were competent professionals. If competent professionals have begun to engage in hazardous, illegal practices, it is unlikely to be the result of spontaneous malevolence. She reasoned that this change in practice must have been shaped by some difference in the environment, tasks, tools, materials or social context of nursing work. Failing to gain support for a return to using bar-coded morphine, she was left to reformulate her case for change while we were left to wonder why she was unsuccessful in garnering support at this level of the organization.

A partial answer may lay in a "craft era" organizational construct linked to the persistence of an archaic mental model of hospital organizational structure.(3) Specifically, administrative and clinical functions in hospitals are "siloed." The decisions and actions of administrative professionals often seem conceptually divorced from the decisions and actions of clinicians. While systems thinking has made significant inroads into health care administrative circles, it is often applied only to those activities that have traditionally been viewed as the domain of administrative personnel, such as finance, planning, purchasing, regulatory compliance, maintenance, staffing and ancillary services.

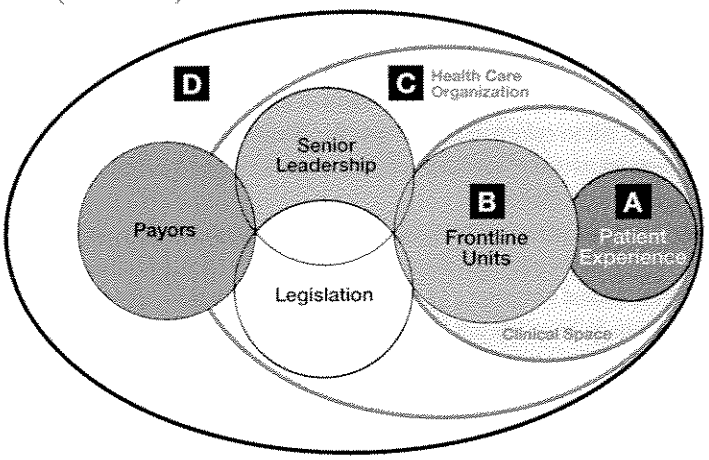
Clinicians, on the other hand, are commonly viewed as autonomous craftpersons, individually responsible for the safety and quality of patient care. A hospital is, for example, a place for physicians to have privileges, where they may practice medicine as individuals. The burden of safety and quality of care is placed squarely on individual physicians, nurses and other clinicians. This perspective disavows the clinician as part of a complex interdependent system of care managed by many people in a variety of clinical and non-clinical roles.

Managing the risk of failure in the socially and technically complex world of health care requires acknowledgement and management of the myriad interrelationships and interdependencies that are unrecognized on contemporary organizational charts and transcendence of craft era concepts of medical practice and health care organizing and administration.

Accidents as decision side effects

Frontline tragedies are typically shaped by complex influences, often over extensive time frames.(8, 11) As illustrated in **Case 1**, these influences originate not only in clinical environments but also in the larger system of care in which frontline care units are embedded as well. **Figure 1** shows a model of the U.S. health care system based on a description developed by the Institute of Medicine.(4, 12)

FIGURE 1: LEVELS OF THE U.S. HEALTH CARE SYSTEM (IOM 2001)

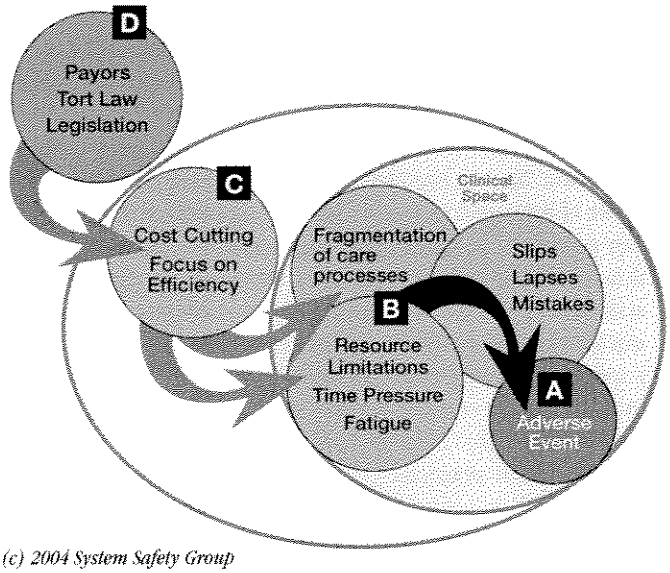


(c) 2004 System Safety Group

FIGURE 1: The experience of patients (A) and frontline units (B) compose a subsystem embedded within a health care organization (C). The interactions among patients and frontline caregivers (A & B) constitute "clinical space," the frontline environment where direct patient care is provided. The health care organization (C), in turn, is a subsystem embedded in a larger system (D) populated by payors, legislative bodies, regulators and the like.

As depicted in **Figure 2,** legislation, tort law and payment systems (D) exert significant influence on the attention, decisions and actions of a health care organization's senior decision-makers (C). Typically, cost cutting goals are communicated by senior leaders to middle managers who then develop and implement approaches to achieving them. Common approaches to reducing costs and improving efficiency include staffing reductions, postponing maintenance, outsourcing, delaying acquisition of technology, creating efficiency improvement strategies and reinforcing hierarchical purchasing approval processes.

FIGURE 2: SYSTEMIC VIEW OF DECISION SIDE EFFECTS



(c) 2004 System Safety Group

FIGURE 2: Each of the four levels of the U.S. health care system is depicted by letters A-D. The consequences of decisions can be seen as cascading through the health care system, with the unintended potential to undermine the performance of frontline units, compromising patient safety.

While cost cutting and efficiency initiatives often yield short-term improvement in the organization's bottom line, they also have unintended side effects that can increase the risk of failure in frontline operations. **Figure 2** depicts side effects of cost cutting initiatives on the performance of frontline units (B). Resource limitations, undue time pressure and fatigue are common contributing factors in adverse events.(13) Under time pressure and stress, communication and coordination of activities tend to break down or fragment, and critical processes are interrupted by the challenges of meeting multiple demands.(14) These conditions lead to slips of action, lapses of memory and procedural or knowledge-based mistakes.(13) Patients (A) can be harmed if the consequences of these slips, lapses or mistakes are not identified and effectively mitigated.

"Under time pressure and stress, communication and coordination of activities tend to break down or fragment, and critical processes are interrupted by the challenges of meeting multiple demands."

James Reason has described hazards and error-provoking conditions that arise in workplaces as "latent failure conditions."(13) The hazardous work-around that arose from a change in morphine purchasing in **Case 1** is a classic example of how latent workplace conditions can initiate deviation from safe practice. Organizations that scan frontline environments primarily for evidence of progress toward financial goals are largely blind to conditions in the workplace that provoke human performance failure – for example, malfunctioning equipment, poorly designed technology and unworkable policies and procedures.

As shown in **Case 2,** such unsafe conditions of work can arise rapidly, even suddenly, from the perspective of frontline personnel.(9)

CASE 2: JUST-NOT-IN-TIME INVENTORY

Surgeon is forced to adjust to substitute supplies

Our CFO made a decision to go to a just-in-time inventory system. Clinical personnel were not included in the decision nor given a heads-up.

We began receiving substitute drugs, tools and other equipment without advance notice. With the old inventory system, we usually had some forewarning of a substitute; the new drug or tool would appear on the shelves while we were still working through the supplies being replaced. Now these things just appear and we have to figure out on the fly what therapeutic differences there may be or how we will have to adjust to a new tool design.

Packaging of a new product may look like something we are familiar with, which can create problems of misidentification. For example, new syringes had packaging with the same colors and appearance of syringe for insulin. Even out of the package, the syringe looked very similar to the insulin syringe except that it was calibrated differently. There were some mistaken efforts to use this syringe for insulin, which fortunately didn't result in harm to patients.

We have begun to call our new inventory system "just-not-in-time" because we have found ourselves without necessary equipment or other stock when encountering unexpected problems in surgery.

Now we're lobbying the CFO to establish contingency supplies. This is a huge safety issue. We have had to do some jerry rigging during surgery that should just never happen, except maybe under battlefield conditions in a mobile army surgical facility.

The change to just-in-time inventory was intended to reduce the amount of stock wasted due to expiration and to avoid tying up money in stock that sits on shelves awaiting use. There was no consideration given to possible patient safety side effects of this change. Even though the hospital is using failure mode and effects analysis, no one thought to use this process to anticipate problems with just-in-time inventory.

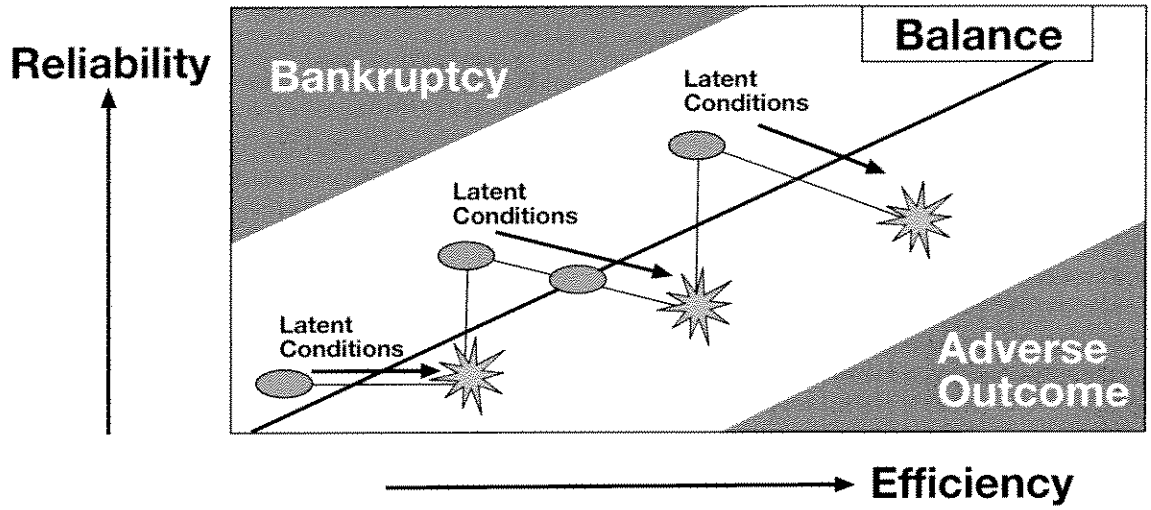
At one level, the artificial separation of administrative and clinical arenas shown in **Case 2** is due to the old model of medical safety and reliability being the sole responsibility and purview of individual physicians. It leads needlessly to dangerous events in clinical work and renders the organization blind to unintended hazardous effects of administrative decision-making.

Organizations make decisions that influence the balance between safety and efficiency. The only way for a health care organization to fully guarantee the safety of patients and staff is to stop providing health care. Conversely, if it focuses on cost cutting and efficiency, its is likely to create unsafe frontline conditions that render personnel vulnerable to error and adverse events. Somewhere in between is a hypothetical region of balance where decisions and actions are continuously monitored and adjusted based not only on their short-term financial consequences, but also on their safety consequences.

continued on next page

FIGURE 3: EFFICIENCY VS. RELIABILITY

Organizational Learning, Forgetting and the Functioning of Frontline Units Over Time



(c) 2004 System Safety Group *Adapted from Managing the Risk of Organizational Accidents, J. Reason, 1997.*

In **Figure 3,** the blue dot represents a frontline unit at the start of its existence. It begins life balanced in favor of safety, but over time organizational emphasis on cost cutting and efficiency leads to the emergence of unsafe conditions – Reason's "latent failure conditions" in the workplace that provoke error and lead to accident. In response to an accidental injury or death, the organization reacts by focusing on safety for a time, but slowly slides back to focus on cost reduction and efficiency, becoming blind anew to emergent safety problems.

Alternatively, **Figure 4** shows an ideal world where frontline personnel are dynamically limiting errors and intervening in unsafe conditions before they provoke an accidental injury or death. They are also reporting potential error-provoking conditions and hazards for correction. This frontline capability of actively limiting errors and reporting unsafe conditions is key to the organizational ability to navigate the line of balance between reliability and efficiency.

Mindfulness and dynamic balancing of safety and efficiency objectives

In practical terms, the ability to detect and mitigate errors and unsafe conditions depends upon "mindful" communication and interaction among personnel. Mindfulness is important when operations are conducted under conditions of uncertainty, ambiguity, risk and constant change – traits that define the practice of medicine and the provision of health care. Mindfulness has also been discussed as an organizational characteristic, key to consistently managing hazardous processes with low rates of failure and harm.(15)

Mindful organizations have been labeled "high reliability organizations" (HROs).(16)

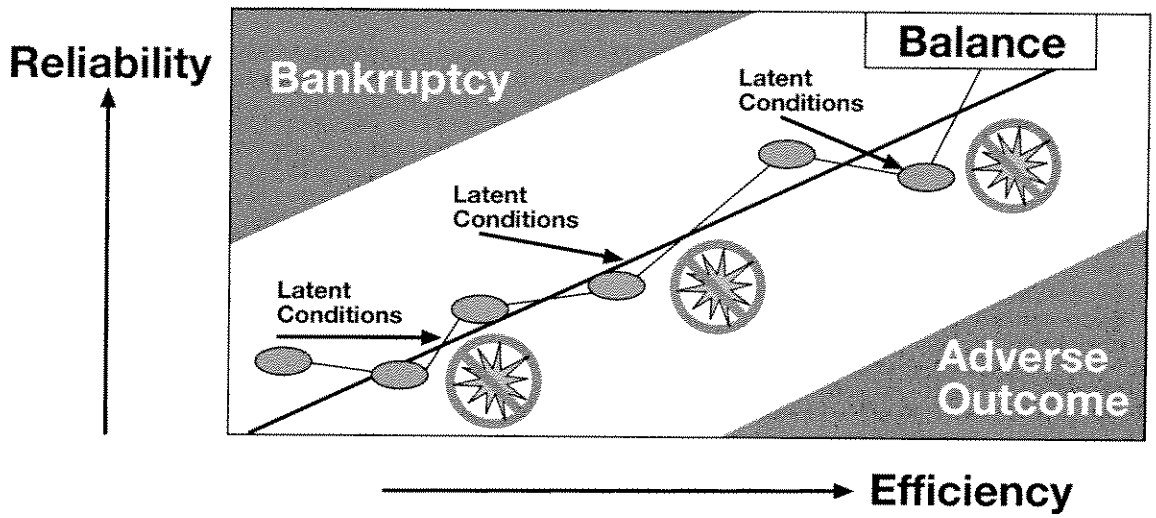
Weick and Sutcliffe, in their book *Managing the Unexpected,* provide five traits of HROs that establish "mindfulness."(15) These are summarized here as 1.) preoccupation with failure, 2.) reluctance to accept simplification, 3.) sensitivity to operations, 4.) commitment to resilience and 5.) deference to expertise.

Preoccupation with failure

Personnel in HROs are preoccupied with the risk of failure, rather than confident of success (think "vigilant"). They set goals and develop and implement strategies. Then they closely monitor effects relative to expectancies.

FIGURE 4: EFFICIENCY AND RELIABILITY

Limiting Errors and Adverse Events Through Adaptive Frontline Action and Organizational Attention to Evolving Needs



Adapted from Managing the Risk of Organizational Accidents, J. Reason, 1997.

Personnel in HROs:

- Seek to recognize change in situation, reassess and adapt activities and actions to dynamically sustain or recover safety boundaries.
- View small or inconsequential lapses as a symptom that something is wrong in the system that could recur with more serious consequences if left unattended. HRO personnel encourage reporting and analysis of such precursors of failure and are always developing and monitoring interventions to correct error-provoking conditions and hazards.

The antithesis of preoccupation with the risk of failure is forgetting to be afraid. As shown in **Figure 3,** when organizations that manage high-risk, high-consequence processes forget to be afraid, they become increasingly vulnerable to failure. Over time, as an organization develops a successful track record, personnel may become confident of success while losing touch with the role of expertise, or of procedural or technological safeguards and defenses, in bringing about success. If the safety purposes of technologies, policies, procedures and practices are not self-evident or reinforced through daily routines, personnel are likely to perceive them as unnecessary and drop them. Deviation from safer practices becomes normalized. This is not only true at the operational level of organizations, but also at upper management levels. Diane Vaughn, in an analysis of the Space Shuttle Challenger launch decision, termed this tendency to deviate from safe practices "normalization of deviance."(17)

Forgetting to be afraid and the normalizing deviance were also implicated in the report on the Space Shuttle Columbia disaster.(18) Early in 2003, the Space Shuttle Columbia broke apart upon re-entering Earth's atmosphere, killing all of her crew. During launch, foam from an external tank had broken loose, striking and damaging Columbia's left wing. Subsequently, this damage was implicated in Columbia's structural failure. NASA was aware, prior to the launch, that there was a possibility of debris strike but over the course of many years had become confident that this was not a serious threat to flight safety.

Following is an excerpt from the report of the Space Shuttle Columbia Accident Investigation Board (NASA, 2003):

"The Columbia accident is an unfortunate illustration of how NASA's strong cultural bias and its optimistic organizational thinking undermined effective decision-making. Over the course of 22 years, foam strikes were normalized to the point where they simply a maintenance issue – a concern that did not threaten a mission's success. . . ."

Reluctance to accept simplification

Case 1 depicted the emergence of illegal and hazardous morphine handling among nurses. Despite evidence of this problem arising as an unintended side effect of a change in purchasing, the organization's key leaders chose to view the problem as one of incompetence or criminal intention on the part of nurses. Firing nurses, however, would not correct the violation-inducing conditions and would likely lead replacement nurses into the same hazardous work-around. The organization's executives, focused primarily on cost reduction, simplified the problem and its "solution," leaving unsafe conditions in place to harm others in the future.

HROs recognize that performance is shaped not only by the intentions and actions of frontline personnel, but by "upstream"

decisions. They acknowledge that unintended effects are inevitable as a function of making changes in systems. To improve the ability of personnel to intervene in unsafe conditions and to better manage complex situations, they encourage resistance to simplification, organizing for and supporting diverse perspectives. Decision-making strategies are promoted that include, rather than inhibit, nuances and insights that emerge in diverse groupings. Interdisciplinary decision-making and management methodologies offer an important means of resisting simplification in frontline and senior management domains.

Sensitivity to operations

Mindful organizations probe continuously for holes in their safeguards and defenses against failure. Over time, problems such as deviation from safety-critical procedures, improper maintenance of equipment, clumsy technology, inadequate training or unworkable policies can undermine human performance and render organizations vulnerable to failure. The change in morphine purchasing described in **Case 1,** and the implementation of "just in time inventory" in **Case 2,** are classic examples of how unsafe conditions arise. In organizations that are not finely attuned to frontline experience, such "latent failure conditions" are commonly detected only after an accident has occurred, and are rarely understood as a byproduct of upstream decisions. To limit the progression of latent failure conditions to accidents, HROs continually seek information on anomalous events, emergent hazards and error-provoking conditions from frontline personnel.

Trust is critical to successfully eliciting frontline feedback and sustaining sensitive surveillance. If an organization reacts to frontline feedback on problems by blaming individuals, or simply by not responding at all, communication will cease. When personnel do not have a voice in identifying and correcting unsafe conditions, they tend to adjust by learning to work around the problems (as in the morphine case). A current limitation of safety reporting programs in health care is that frontline personnel have long tolerated unsafe conditions and may not recognize them as such. See **Case 3.**

CASE 3: Intolerable tolerance of unsafe conditions

Human factors specialist finds danger in the OR

A study of neo-natal arterial switch operations in the United Kingdom illustrates how tolerance of unsafe conditions contributes to error.(19)

One aspect of the study required operating room personnel to debrief each of their surgical shifts in order to identify any close calls or unsafe conditions that may have arisen during surgery. A human factors specialist observed each procedure.

During one operation, an administrative assistant entered the operating room and interrupted the surgeon just as he was about to call for heparin to be introduced to the bypass pump, a safety critical action. The assistant made an inquiry regarding the surgeon's schedule, then left. When the surgeon returned to the delicate work at hand, he asked the perfusionist to activate the bypass pump, forgetting the heparin step. Fortunately, the anesthesiologist called out that the heparin hadn't been added, trapping the error before it led to harm. Later, when debriefing the shift, none of the operating personnel mentioned this event as close call or near miss.

To the human factors observer, the interruption of a safety critical process by the administrative assistant was an error-provoking condition. The error provoked by the interruption was an omission stemming from a lapse of memory. Such lapses are easily provoked by interruptions.

Human beings have weak "prospective memory": the ability to remember to return to the proper place in an interrupted process.(20) In this case, operating room personnel had become accustomed to interruption of safety critical processes and associated close calls. Such distractions were normalized and tolerated – no longer fully noticed nor perceived as unacceptable.

Commitment to resilience

The capability of detecting, limiting and recovering from errors or operational surprises is a fourth essential trait for organizations that successfully manage hazardous processes.

No complex system is error free, and under uncertain and constantly changing circumstances unexpected events will occur. HROs organize and manage not only to avoid error but to detect, limit and recover from errors, thus adapting activity and action to sustain safety. Expertise and the ability to develop knowledge-based responses to unusual problems – to sustain or recover safety boundaries – are highly valued in HROs. Experience, education and training are prized. Yet resilience requires not only one's own knowledge of technology, the system and self, but familiarity with co-workers and their knowledge, skills and roles.

HROs are organized to support highly functional frontline teams. The case of United Airlines flight 232 provides a classic illustration of resilience in a seemingly unrecoverable situation.(21)

On July 19, 1989, just after departure from Denver, United Airlines (UAL) Flight 232 contacted air traffic control with a chilling emergency. At a cruising altitude of 37,000 feet, its tail-mounted engine failed. It disintegrated, sending shrapnel through the primary flight control system and both back-up systems. The crew could no longer control the aircraft.

The possibility of all three control systems failing simultaneously had been considered nearly impossible when assessing failure mode and effects during the design of the aircraft – the chance placed at a billion to 1.(22) There were no policies or procedures to handle this unprecedented emergency. The expertise, skill and knowledge-based problem solving of the crew were the only possible hopes to mitigate the consequences of this pending disaster. No one on the ground,

from airline chief executive to frontline operations experts, could help. The event was unprecedented in airline aviation.

Using their piloting skills and knowledge of aerodynamics, the pilot and crew managed to shepherd the faltering aircraft to a crash landing at Sioux City, IA. While 111 people aboard the aircraft lost their lives, 185 survived.(21) Captain Al Haynes, in command of UAL 232, exhibited extraordinary leadership in harnessing the intellectual resources and skill of the crew.

"When a problem arises, authority shifts to the person with appropriate expertise to attend to it, regardless of position or rank."

Deference to expertise

Rigid hierarchies tend to spawn trouble at upper decision-making levels, shaping tools, tasks, processes and resources in ways that provoke or combine with errors and hazardous conditions at front-line organizational levels. To limit this, mindful organizations move decision-making toward the front, or delivery, end of the system. When a problem arises, authority shifts to the person with appropriate expertise to attend to it, regardless of position or rank.

This is different than deferring to the person with the most experience, as people may have long years of experience with repetitive, unchanging tasks. It is also different than seeking help or permission to seek help from people in positions of authority. In an emergent situation, personnel in HROs do not conform to rigid chains of command. They seek those who have the expertise and/or immediate authority to act.

Intervening for mindfulness

In practical terms, as outlined in the five traits above, the ability to detect and mitigate surprises depends upon mindful communication and interactions. Safety is never assured in knowledge-intensive, complex and dynamic environments. People are always solving problems, noticing difference in situations, assessing and reassessing, and making adjustments to avoid problems or to manage emergent problems.

Norms of clinical communication and decision-making in health care systems are dominated by a powerful, strongly steeped tradition of individual accountability and personal responsibility – of autonomous decision-making and action. While a strong sense of personal responsibility and accountability is desired in any profession, the persistence of decision-making practices that emphasize independent action at the expense of coordinated action leads to:

- differing understandings among personnel engaged in shared work;
- associated errors of omission and commission;
- inadequate surveillance or capture of information that may permit proactivity;
- intervention to improve the safety and quality of care **before** an accident occurs.

Fragmented interaction among members of small groups co-managing high-consequence processes is patently dangerous. Effective management of cooperative, safety-critical work hinges on communication, collaborative decision-making and close coordination. These are the principal mechanisms of mindfulness, and a means of cultivating and reinforcing a focus on safety and outcome reliability.(14, 23)

In other industries such as aviation, much has been learned about how to structure communication and interaction to limit error and to provide continuous feedback on latent failure conditions so that they may be corrected.(24) These are teaming methodologies that differ from traditional management team training in that they are expressly designed to improve the safety of high-risk/high-consequence activities. These methods have been implemented in health care with promising results.(25, 26)

Implications for risk managers

The U.S. health care system's transition from high consequence, low reliability to high consequence, high reliability will involve careful attention to five major categories of human performance vulnerability and accident causation factors:(27)

Cognitive

These factors in human performance relate to thinking … how we assess, decide and act. Example considerations include limitations of short-term memory, problems remembering intentions in dynamic activities and pitfalls in making decisions under conditions of uncertainty and informational ambiguity.

Physiological

These factors affecting human performance include fatigue, illness, nutrition, substance abuse, aging, sensory capabilities, mental acuity, and the use of both prescription and non-prescription medications.

Psychosocial

These factors in human performance relate to interpersonal dynamics – how well people interact, communicate, make decisions, coordinate activities and adapt their activities. For example, the reluctance of juniors to speak up to seniors is a problem among professions characterized by steep, role-based hierarchy. Fear of rebuke or harm to career could limit the willingness of a novice, for example, to point out an error to an expert, resulting in a missed opportunity to prevent an injury or death.

continued on next page

Ergonomic
These factors include the fit of machines and tools to human operators. Are tools easy to operate and do they protect the operator from injury? Additional considerations include equipment/device design, alert and alarm functions on safety-critical equipment, and the design of information displays in human-computer interfaces. Do the attributes and functions of tools and machines work for or against reliable human performance?

Organizational
Examples of these factors in human error and adverse events include side effects of decisions about resource allocation, equipment acquisition, maintenance routines, policy and procedures, etc.

As seen in **Cases 1 and 2,** changes in the resources, technology and processes can have unexpected deleterious effects on frontline human performance.

Safeguards and countermeasures against human performance failure and accidents can be grouped into three interdependent categories (**Figure 5**). No one or two of these categories of safeguards and countermeasures is sufficient alone to manage the risk of accidents. Yet only recently have behavioral safeguards and countermeasures such as team-based methods to limit error and report unsafe conditions made inroads in health care. Much remains to be learned about how best to implement these practices so that they are effective and sustainable.(28, 29)

FIGURE 5
Safety and Outcome Reliability

- **Consistent activity and action**
  Checklists, standard operating procedures, pattern monitoring and statistical process control
- **Technological safeguards and countermeasures**
  Alert, alarm, stops; subsystem automation, information systems
- **Behavioral safeguards and countermeasures**
  Teaming, communication and knowledge processes; cognitive reliability; adaptive activity and action

A significant challenge and opportunity for risk management professionals, safety scientists and safety practitioners will be to learn from their collective efforts to monitor and improve safeguards and countermeasures against failure.

Currently, many important lessons for safety improvement are learned in isolation. This leaves everyone at risk of "recreating the wheel" and, potentially, to experience adverse events in organizations that might have been prevented by knowledge sharing. Utilizing professional organizations such as ASHRM as vehicles for learning, information exchange and brainstorming remains imperative.

It is also important to begin looking outside of health care to other high-risk/high-consequence industries.

Increasing numbers of health care professionals are joining the Crew Resource Management Developers discussion group, for example, to learn more about what aviation educators and practitioners around the world are doing to improve team-based safety (http://s92270093.onlinehome.us/crmdevel/). The Safety Across High Consequence Industries Conference, hosted by St. Louis University, is another important opportunity to share and learn with professionals in kindred industries (http://parks.slu.edu/msasm/profile_msasm_conf.html).

We can only speculate as to the future appearance and form of health care organizations. It seems reasonable to think that progress toward the future state of health care organizations as highly reliable systems can be accelerated by opening up dialogue on safety methods and lessons with colleagues in a variety of high-risk/high-consequence industries.

NEXT ISSUE: MORE ABOUT TEAMS

The next Journal of Healthcare Risk Management (Vol. 24, No.3) will include a discussion of team-based safety. How does teamwork serve safety? Which roles should be represented? What makes a team function well?

ABOUT THE AUTHOR

Jeffrey P. Brown, M.Ed., is a principal of the System Safety Group, a firm specializing in human factors education and training based in Peterborough, NH.

REFERENCES

1. Institute of Medicine. "To err is human: Building a safer health system." Washington, D.C.: National Academies Press, 1999.
2. Davis, K., Schoenbaum, S., Collins, K.S., Tenney, K., Hughes, D.L., Audet, A. "Room for improvement: patients report on the quality of their health care." Commonwealth Fund, NY, NY. April 2002.
3. Merry, M., Brown, J. "From a culture of safety to a culture of excellence: quality science, human factors, and the future of health care quality." Journal of Innovative Management, Vol. 7(2), Winter 2001-2002.
4. Institute of Medicine. "Crossing the quality chasm: A new health system for the 21st century." Washington, D.C.: National Academies Press, 2001.
5. Crago, M. "Meeting patient expectations (ISO 9000 will do for health care what it has systematically succeeded in doing for manufacturing and services)." Quality Progress: Page 41, September 2002.
6. Bates, D., Leape, L., Cullen, D., et al. "Effect of computerized physician order entry and a team intervention on prevention of serious medication errors." Journal of the American Medical Association, 280(15): Pages 1311-1316, 1998.
7. Patterson, E., Cook, R., Render, M. "Improving patient safety by identifying side effects from introducing bar coding in medication administration." Journal of the American Medical Informatics Association, Vol. 9(5), September/October 2002.
8. Rasmussen, J. "The concept of human error: Is it useful for the design of safe systems?" Safety Science Monitor Special Edition, Article 1, Vol. 3, 1999.
9. Patankar, M., Brown, J., Treadwell, M. *Safety Ethics: Lessons from Aviation, Medicine, Occupational and Environmental Health.* Aldershot, England: Ashgate Publishing, 2005 (scheduled).
10. Patterson, E., Render, M., Ebright, P. "Repeating human performance themes in five health care adverse events." Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting, 2002.
11. Reason, J. *Managing the Risk of Organizational Accidents.* Aldershot, England: Ashgate Publishing, 1997.
12. Berwick, D. "A user's manual for the IOM's 'Quality Chasm' report." Accessed at http://www.healthaffairs.org.
13. Reason, J. *Managing the Risk of Organizational Accidents* (active failures and latent conditions: Page 10). Aldershot, England: Ashgate Publishing, 1997.
14. Weick, K. "The vulnerable system: An analysis of the Tenerife air disaster." Journal of Management 16(3): Pages 571-593, 1990.
15. Weick, K., Sutcliffe, K. Managing the Unexpected ("mindfulness" defined, Page 42). San Francisco: Jossey-Bass, 2001.
16. Roberts, K. "Managing high-reliability organizations." California Management Review, 32(4): Pages 101-113, 1990.
17. Vaughan, D. *The Challenger Launch Decision: Risky Technology, Culture and Deviance at NASA.* Chicago: University of Chicago Press, 1996.
18. Final report on Columbia Space Shuttle accident, U.S. Government Printing Office, August 2003.
19. de Leval, M., Carthey, J., Wright, D., Farewell, V. Reason, J. "Human factors and cardiac surgery: A multicenter study." Journal of Thoracic Cardiovascular Surgery, 119, 6: Pages 61-72, 2000.
20. Dodhia, R., Dismukes, K. "A task interrupted becomes a prospective memory task." Presentation before American Psychological Society, May 2003. Accessed at http://human-actors.arc.nasa.gov/flightcognition/Pubs/Dodhia_Dismukes_03.pdf
21. National Transportation Safety Board Report AAR-90-06, final summary report on crash of UAL 232, issued Oct. 8, 1992. Accessed at www.ntsb.gov.
22. Captain Al Haynes. Presentation at NASA Ames Research Center Dryden Flight Research Facility, Edwards, CA. May 24, 1991.
23. Coiera, E. "When conversation is better than computation." Journal of the American Medical Informatics Association, 7(3): Pages 277–286, May 2000.
24. Helmreich, R. "On error management: Lessons learned from aviation." British Medical Journal 320: Pages 781-785, March 18, 2000.
25. Uhlig, P.N., Nason, A., Camelio, A., Brown, J. "System Innovation: Concord Hospital, John M. Eisenberg Patient Safety Awards." JCAHO Journal on Quality Improvement, Vol. 28(12), 2002.
26. Morey, J., Simon, R., Jay, G., Wears, R., Salisbury, M., Dukes, K., Berns, S. "Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project." Health Services Research, 37(6): Pages 1553-81, December 2002.
27. Wiegmann, D., Shappell, S. "Human error perspectives in aviation." International Journal of Aviation Psychology, Vol. 11(4): Pages 341-357, 2001.
28. Thomas, E., Moore, F. "Spotlight Case: The missing suction tip." Agency for Health Care Research and Quality AHRQ WebM&M. November 2003. Accessed at http://www.webmm.ahrq.gov/spotlightcases.aspx?ic=37.
29. Lawrence, D. *From Chaos to Care: The Promise of Team-Based Medicine.* Boulder, CO: Perseus Publishing, 2002.