Culture, Systems, and Human Factors—Two Tales of Patient Safety: The KP Colorado Region's Experience

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Abstract

An estimated 80% of medical errors are system-derived. Given the complexity of medical care, engineering systems for safety are crucial and must be adapted to an ever-changing environment of risk. Meaningful improvement in patient safety must address not only the systems in which we deliver care but also the culture of medicine. This culture is critically important because it affects our expectations of performance as well as our attitudes about medical error, which is a predictable and inevitable outcome of complicated systems operated by humans. We describe our efforts and our progress in two patient safety projects conducted in the Kaiser Permanente (KP) Colorado Region: the cardiac treadmill project and the perioperative beta blockade project. We believe that major improvement in both areas will be achieved through 1) application of human factors training that takes into account cultural issues, and 2) evolution and application of safer systems for delivering care.

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Medical care is extremely complicated. On a daily basis, highly trained people working alone or in teams deal with complex systems, uncertainty, and risk. High-reliability industries, such as the aviation industry, have benefited greatly from implementing human factors training to improve safety and teamwork, especially given that human error causes 70% of all commercial aviation accidents.[1] An important study reported that 80% of anesthesia-related mishaps are the result of human error.[2]

Many accidents (medical and otherwise) have resulted from poor communication among team members. A classic example is the 1978 crash of a United Airlines DC-8 airliner in Portland, Oregon: While the plane circled the airport, its crew focusing their attention on a minor malfunction of the landing gear, the plane ran out of fuel! The very senior captain was technically expert, but he was also hierarchical and autocratic; consequently, the two junior crewmembers, aware they were dangerously low on fuel, felt too intimidated to question the captain's management of the situation. They attempted to convey their concern only obliquely, and the captain became aware of the problem only after the first of four engines flamed out. Eleven people died in the ensuing crash. Ironically, the landing gear was fully operational.[3]

One Industry's Response to Human Error

That a highly trained flight crew would run a perfectly good aircraft out of fuel and cause it to crash was a huge wakeup call for the commercial aviation industry. A concerted process of examining human factors was launched; and for the past 20 years, crew resource management (CRM) has focused on effective communication, teamwork, minimizing hierarchy, and management of error.[4] Operating on the premise that people make mistakes, the aviation industry and other high-reliability environments engineer their systems to buffer, trap, and mitigate error.[5] Factors including stress, fatigue, and multitasking increase the likelihood of human error. As a result, the systems are engineered to provide protection and to emphasize open communication within teams, identification of potential problems, and a collective style of managing these problems. In medical practice, at least 80% of medical mistakes are system-derived.[6]

Medical practice can benefit greatly from this type of training. Indeed, the aviation industry's experience with human factors training is a valuable example of how an organizational culture similar to that of medical practice and structured on the expertise and hierarchy of a single individual evolved to include open and collective team effort.

The Treadmill Unit: A Study in Improving Group Processes

Knowing that we were interested in applying the human factors approach to clinical care, staff in one of our outpatient units—the cardiac treadmill unit—asked us to work with them. The unit consists of three expert nurses and a pool of ten supervising internists who evaluate about 6500 patients annually, many of whom are at clini-

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cally significant risk for cardiac events. Our initial assessment of the unit's work processes was gleaned from direct observation of the unit team and from talking with team members. The assessment process revealed the following situations:

- A major opportunity existed for improving the way nurses and supervising physicians worked together as a team. The nurses, who are quite expert, perceived wide variation in attitude, behavior, and clinical skill among the supervisory physicians who rotated through the unit.
- Conflict was created between nurses and physicians when they disagreed on test results. The nurses—and occasionally, the physicians—would go upstairs to the cardiology department to have their particular opinion affirmed. Conflict resolution was not consistently successful.
- Members of the unit could not agree on what constituted a positive test result of treadmill testing. Some subjectivity is inherent in this type of testing, but the clinicians had made no effort to find agreement among themselves.
- Treadmill rooms contained both suboptimal equipment and a suboptimal physical layout. Two rooms were on the south side of the building, whereas the nuclear treadmill room was on the north side, in the middle of the radiology department. Communication between the treadmill rooms required improvement.
- Patient referral criteria were inconsistent, and patient information was incomplete. This situation resulted in about 500 same-day cancellations per year. In addition, lack of standardized referral criteria had resulted in treadmill testing being prescribed for low-risk patients (in whom this testing is useless) and in potentially dangerous examination (ie, the treadmill test) being administered to high-risk cardiac patients who needed cardiac catheterization.

The treadmill unit scheduled a half-day group meeting to address these issues. In the interim, we gave a presentation on patient safety and on the aviation industry's experience. Much of the session centered on the critical need for clinicians in high-risk environments to communicate well and to function as a team. We focused the discussion on common goals—a desirable achievement—for the treadmill unit. By depersonalizing the conversation, the main issue was no longer that of who was right and who was wrong. Instead, the group was able to concentrate on perceived barriers to delivering optimal levels of care. Discussion was productive and led to progress being made in several areas:

- The equipment rooms were relocated to be adjacent, a new defibrillator with external pacing capability was acquired, and new treadmill monitors were installed.
- A physician with both extensive treadmill experience and keen interest agreed to assume leadership of the unit. This physician reviewed recent medical literature pertinent to the unit's activities, and the group agreed to use four criteria for interpreting a positive result of treadmill testing instead of a single marker (ie, ST analysis only). For their quick reference, the group agreed to maintain lists of these four markers on the walls of the treadmill rooms.
- The nurses and physicians in the treadmill unit filled out the University of Texas Medical Attitudes Questionnaire (MAQ),[7] a tool used by many medical environments to assess attitudes about teamwork, hierarchy, communication, and error.[3] This baseline measurement will show areas requiring improvement. Repeat surveys will be used periodically to gauge the group's progress.
- The group agreed to develop referral criteria for treadmill testing as well as related education for physicians who refer patients for treadmill testing. The group agreed that standardized criteria would increase safety for patients and for clinicians while improving utilization of treadmill testing as a clinical resource. The group also agreed on their intent in standardizing the criteria: to refer the right patient to the right place to receive the right test.
- Reports sent to the referring physicians were standardized to facilitate better care and to reduce variation in clinical information transmitted from the treadmill unit.
- Briefing sessions were implemented so that the group could minimize the discomfort and sense of risk they felt at not knowing what potential problems they would face throughout the day. They agreed to have a morning briefing so they could approach the day's schedule as a team.

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- The group agreed to use checklists so that the information required by the team for every patient (eg, laboratory test results, recent results of electrocardiographic testing, medical history) would be complete before the patient was sent for treadmill testing. Unit team members also agreed that the wall of every treadmill room would display a list of absolute and relative contraindications to starting and continuing a treadmill test.
- The group agreed to disagree, ie, they decided to work on creating mechanisms for openly discussing disagreement about test results. This open approach is far healthier than privately seeking another opinion.
- The group agreed on the importance of being team players acting in patients' best interest. The group began work to better define expectations of each member of the unit as well as how to address unacceptable behavior.

In addition, the group agreed to gauge their progress by using several outcome measures:

- changes in the University of Texas MAQ over time;
- results of patient satisfaction surveys;
- rates of satisfaction among referring physicians, guidelines for these physicians, and standardized reporting;
- outcome criteria for treadmill tests;
- rates of canceling appointments for treadmill testing;
- stratification of patients seen in the treadmill unit to assess whether those with too little or great cardiac risk are being triaged appropriately for other types of clinical care;
- tracking absolute number of "near-miss" events and debriefing the treadmill unit team on their perception of their response to these events.

Having a constructive mechanism for taking a fresh look and approaching perceived problems from a systems perspective has started us on a highly constructive path.

Discussion

Application of Human Factors to the Treadmill Unit

We have described the application of human factors training to a complex medical environment that requires teamwork and involves risk. Framing the discussion nonjudgmentally in a way that focuses on desired outcomes and common goals was highly productive. Depersonalizing the conversation removed the issue of who would be judged to be right or wrong. Taking a systems perspective enabled team members to identify several major barriers to providing optimal care: flawed physical layout of facilities, the need for upgraded equipment, lack of agreement on how to work as a team and resolve conflict, lack of important clinical patient information, and lack of a formal process for the supervising physician and the nurses to discuss potential problems with patients in advance of the problems occurring. Many of the problems in this clinical unit stemmed from informal evolution of behavior and practices over the years, ie, the "we've always done it this way" approach. Having a constructive mechanism for taking a fresh look and approaching perceived problems from a systems perspective has started us on a highly constructive path.

Another Application of Human Factors Information: Perioperative Use of Beta Blockers

Cardiac complications are the single greatest source of morbidity and mortality in patients who have noncardiac surgery. Surgery is associated with major complications: increase in circulating catecholamines, development of hypercoagulable state, and a 30-40% postoperative increase in resting heart rate. Medical literature indicates that perioperative treatment with beta blockers offers a major protective effect for at-risk patients.[8-10] In 1996, several KP Colorado clinical departments (internal medicine, cardiology, and anesthesia) collaboratively adopted the American Heart Association/American College of Cardiology Consensus Guidelines for Perioperative Evaluation.[11] This collaborative effort was a response to extensive variation in preoperative assessment of cardiac risk across the KP Colorado Region. The criteria were successfully adopted and, we believe, provided better care. In addition, a system was initiated for our hospitalists to provide follow-up for surgical patients who have clinically significant preoperative morbidity, ie, American Society of Anesthesiologists (ASA) physical status classification three or greater.[12]

Last year, we were concerned to hear our intensivists report that many patients were having perioperative myocardial infarction. Most of these patients with clinically significant cardiac risk factors were not being treated with beta blockade perioperatively. We have thus begun a program to identify and treat susceptible patients so that they receive maximal cardiac protection perioperatively.

In 1988, a report by Stone et al[8] indicated that a single dose of beta blocker reduced from 28% to 3% the incidence of transient, ischemic electrocardiographic changes associated with anesthesia induction

and emergence. In 1996, Mangano et al[9] showed a protective effect of treating surgical patients with atenolol; the effect lasted as long as two years. The 1999 Poldermans et al study[10] of vascular surgery patients with known coronary artery disease provides the strongest evidence of benefit to date. Patients who had vascular surgery and positive results of dobutamine stress testing were treated with beta blockers for a week before surgery and for one to two weeks postoperatively. The authors[10] reported an astounding 90% reduction in number of perioperative cardiac events.

The KP Colorado Region has now implemented a program to ensure that patients with cardiac disease are screened and that they are treated with beta blockade perioperatively. We have begun screening patients preoperatively by using a checklist of indications and contraindications for beta blockade. Therapy is begun by the anesthesiologist intraoperatively and is continued postoperatively in the recovery area and hospital floor through use of standardized order sheets. Concomitantly, we are setting up a system for screening patients in the surgical clinic when patients are scheduled for surgery; this procedure will allow a regimen of beta blockers to be started a week before surgery.

A dedicated electronic beeper is rotated among project members so that surgeons, nurses, physician assistants, and patients can call if they have questions. This program is being applied in both the main operating suite and in the ambulatory surgery clinics. We believe that this intervention will greatly reduce the number of adverse cardiac events among surgical patients. The key is systematic application of techniques that have been shown to provide better and safer care for our patients—and that make it easy to do the right thing. We are therefore happy to share our algorithms and standing order sheets with any clinician who requests them. ❖

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References

1. Helmreich RL, Merritte AC. Culture at work in aviation and medicine: national, organizational, and professional influences. Aldershot (England): Ashgate; 1998. p 11.
2. Cooper JB, Newbower RS, Kitz RJ. An analysis of major errors and equipment failures in anesthetic management: considerations for prevention and detection. Anesthesiology 1984 Jan:60(1):34-42.
3. Helmreich RL. Managing human error in aviation. Sci Am 1997 May;276(5):62-7.
4. Weiner EL, Kanki BG, Helmreich RL. Cockpit resource management. San Diego: Academic Press; 1993.
5. Reason J. Managing the risks of organizational accidents. Aldershot (England): Ashgate Press; 1997.
6. Leape LL. Error in medicine. JAMA 1994 Dec 21;272(23):1851-7.
7. Sexton JB, Thomas EJ, Helmreich RL. Error, stress, and teamwork in medicine and aviation: cross sectional surveys. BMJ 2000 Mar 18;320(3237):745-9.
8. Stone JG, Foex P, Sear JW, Johnson LL, Khambatta HJ, Triner L. Myocardial ischemia in untreated hypertensive patients: effect of a single small oral dose of a beta-adrenergic blocking agent. Anesthesiology 1988 Apr;68(4):495-500.
9. Mangano DT, Layug EL, Wallace A, Tateo I. Effect of atenolol on mortality and cardiovascular morbidity after noncardiac surgery. N Engl J Med 1996 Dec 5;335(23):1713-20.
10. Poldermans D, Boersma E, Bax JJ, et al. The effect of bisoprolol on perioperative mortality and myocardial infarction in high-risk patients undergoing vascular surgery. Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography Study Group. N Engl J Med 1999 Dec 9;341(24):1789-94.
11. Eagle KA, Brundage BH, Chaitman BR, et al. Guidelines for perioperative cardiovascular evaluation for noncardiac surgery. Report of the American College of Cardiology/ American Heart Association Task Force on Practice Guidelines (Committee on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). J Am Coll Cardiol 1996 Mar 15;27(4):910-48.
12. Ross AF, Tinker JH. Preoperative evaluation of the healthy patient. In: Rogers MC, Tinker JH, Covino BG, Longnecker DE. Principles and practice of anesthesiology. St. Louis (MO): Mosby; 1993. p 4.

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