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Teamwork as an Essential Component of High-Reliability Organizations

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Organizations are increasingly becoming dynamic and unstable. This evolution has given rise to greater reliance on teams and increased complexity in terms of team composition, skills required, and degree of risk involved. High-reliability organizations (HROs) are those that exist in such hazardous environments where the consequences of errors are high, but the occurrence of error is extremely low. In this article, we argue that teamwork is an essential component of achieving high reliability particularly in health care organizations. We describe the fundamental characteristics of teams, review strategies in team training, demonstrate the criticality of teamwork in HROs and finally, identify specific challenges the health care community must address to improve teamwork and enhance reliability.

Key Words. High-reliability organization, teams, teamwork, health care, patient safety, training

A healthy 38-year-old woman was admitted to a major medical center to deliver her first child. Although she was a low-risk patient with only mildly elevated blood pressure, her admission ended tragically when she underwent an emergency cesarean after a failed forceps delivery. Once inside the abdominal cavity, the uterus was found to have ruptured, and the placenta was in the abdomen. She delivered a stillborn fetus. After an unsuccessful attempt to repair her uterus, she received a full hysterectomy, underwent blood transfusions, and endured endless complications resulting in a 3-week hospital stay, including 18 days in intensive care. What went wrong? According to root cause analyses, lack of teamwork played a significant role. Specifically, communication was poor; there was a lack of mutual performance cross-monitoring, inadequate conflict resolution, poor situational awareness, and work overload. A major response to the tragedy was the initiation of team training at the medical center (Sachs 2005).

Safety is a fundamental patient right, though not a certainty (Knox and Simpson 2004). When patients arrive at a health care organization, they expect to leave that institution in equal or better health. Patients and their families do not expect physicians, nurses, and other hospital staff to make mistakes, or worse yet cover up as opposed to communicate errors. The publication of *To Err Is Human* by the Institution of Medicine (IOM) highlighted the fact that the delivery of care is not error free. The report concluded that medical errors cause up to 98,000 deaths annually. The IOM report brought national focus to this important issue and has since spawned significant research on the causes of medical errors and the effectiveness of different strategies for making health care a more reliable system (Kohn, Corrigan, and Donaldson 1999).

The IOM issued a number of recommendations designed to move health care institutions toward high reliability. HROs are institutions that operate in complex, hazardous environments making few mistakes (i.e., medical errors) over long periods of time. Recommendations related to voluntary error reporting, systems changes, safety systems design, and standard for health care professionals were presented in *To Err Is Human.* The IOM also pointed toward the need for enhanced teamwork. Historically physicians, nurses, and other health care professionals have functioned as discrete parts. The IOM recommended that interdisciplinary team training programs be established, based on sound principles of team management, to improve coordination and communication among health care staff (Kohn et al. 1999).

The Agency for Healthcare Research and Quality (AHRQ) is the lead federal agency in supporting and implementing the recommendations of the IOM in its effort to reduce medical error and improve patient safety. As part of this agenda, AHRQ established the HRO network to support patient safety leaders by providing them with a forum for learning about promising practices and identifying new and innovative ways to implement research findings. AHRQ's goal is to create high-reliability health care organizations. In support of that goal, AHRQ will launch Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) during 2006 and distribute this team training curriculum to members of the HRO network (Alonso et al. 2006).

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The purpose of this paper then is to demonstrate that teamwork is an important component of HROs. While moving health care toward team-based work will not automatically result in high reliability, there are many parallels between teams and HROs (Knox and Simpson 2004; Wilson et al. 2005). To justify our argument, we begin by providing an overview of teams, teamwork, and strategies for promoting team effectiveness. Much has been written about these topics in domains where high reliability is critical because the consequences of error are great (e.g., the military, commercial aviation, and air traffic control) (Salas and Cannon-Bowers 2000; Davies 2001; Baker et al. 2003; Salas, Sims, and Klein 2004). Later in this document, we describe the key characteristics of HROs. The concept of HROs has been around for more than 20 years, but has only recently begun to take hold in health care with the publication of *To Err Is Human* and AHRQ's patient safety agenda. In this section, we compare the fundamental features of teamwork and the critical characteristics of HROs and demonstrate how these characteristics are interwoven as well as how and why the HRO environment demands teamwork. Finally, although the science of teamwork has been around for over 30 years, it is only recently that this concept has begun to take hold in health care. In the last section we present a series of challenges researchers and practitioners need to address to advance the health care community's understanding of team performance and instantiate these practices as part of health care's quest to achieved high reliability.

Teams, Teamwork, and Training

Teams and Teamwork

There is a general consensus in the research literature that a *team* consists of two or more individuals, who have specific roles, perform interdependent tasks, are adaptable, and share a common goal (Salas et al. 1992). To work effectively together, team members must possess specific knowledge, skills, and attitudes (KSAs), such as the skill in monitoring each other's performance, knowledge of their own and teammate's task responsibilities, and a positive disposition toward working in a team. Such KSAs comprise teamwork (Cannon-Bowers et al. 1995; Sims, Salas, and Burke 2004).

Based on its definition alone, it is easy to see how teamwork is critical for the delivery of health care. Physicians, nurses, pharmacists, technicians, and other health professionals must coordinate their activities to deliver safe and efficient patient care. As specified in our definition of a team, health care

workers perform interdependent tasks (e.g., a surgeon cannot operate until a patient is anesthetized) while functioning in specific roles (e.g., surgeon, surgical assistant, anesthesiologist) and sharing the common goal of safe care. However, despite the importance of teamwork in health care, most clinical units continue to function as discrete and separate collections of professionals (Knox and Simpson 2004). This is partially due to the fact that members of these teams are rarely trained together; furthermore, they often come from separate disciplines and diverse educational programs.

Given the interdisciplinary nature of the work and the necessity of cooperation among the workers who perform it, teamwork is critical for ensuring patient safety. Teams make fewer mistakes than do individuals, especially when each team member knows his or her responsibilities, as well as those of other team members (Smith-Jentsch, Salas, and Baker 1996; Volpe et al. 1996; Sims et al. 2004). However, simply installing a team structure does not automatically ensure it will operate effectively. Teamwork is not an automatic consequence of co-locating people together and depends on a willingness to cooperate for a shared goal. Teamwork does not require that team members work together on a permanent basis. Teamwork is sustained by a commitment to a shared set of team KSAs rather than permanent assignments that carry over from day to day (Morey et al. 2002).

Critical Components of Teamwork

Extensive research on teamwork during the past 20 years (McIntyre, Salas, and Glickman 1989; Howard et al. 1992; Helmreich and Foushee 1993; Holzman et al. 1995) suggests that teamwork is defined by a set of interrelated KSAs that facilitate coordinated, adaptive performance (Cannon-Bowers et al. 1995; Salas, Bowers, and Cannon-Bowers 1995; Baker et al. 2003). Teamwork is distinct from taskwork (e.g., surgical skill) but both are required for teams to be effective in complex environments (Morgan et al. 1986). Furthermore, in health care, knowledge and skill at the task are not enough. Teamwork depends on each team member being able to anticipate the needs of others; adjust to each other's actions, and have a shared understanding of how a procedure should happen (e.g., knowing the steps in an appendectomy).

Recently, researchers have begun to identify skills that define team performance in health care. This line of research began with the work of Gaba et al. (2001) who developed Anesthesia Crisis Resource Management (ACRM). ACRM was designed to help anesthesiologists effectively manage crises by working in multidisciplinary teams that include physicians, nurses,

technicians, and other medical professionals (Howard et al. 1992; Gaba et al. 1998, 2001). ACRM uses patient simulators to provide training in specific technical and generic teamwork skills. The simulated anesthesia environment consists of a real operating room with standard equipment and situations requiring actual performance of clinical interventions. A life-like mannequin with appropriate breath and heart sounds permits team members to perform clinical procedures such as endotracheal intubation and infusion of intravenous drugs. Scenarios presented include overdose of inhalation anesthetic, cardiac arrest, and complete power failure (Holzman et al. 1995). The team skills trained in this simulated environment include making inquiries and assertions, communicating, giving and receiving feedback, exerting leadership, maintaining a positive group climate, and reevaluating actions.

In addition to anesthesia, a number of researchers have recently begun to identify the KSA requirements of teamwork in other health disciplines. For example, Healey, Undre, and Vincent (2004) have developed the Observational Assessment for Teamwork in Surgery (OTAS) to assess cooperation, leadership, coordination, awareness, and communication in surgical teams (Healeyet al. 2004). Thomas, Sexton, and Helmreich (2004) developed 10 behavioral markers for teamwork in neonatal resuscitation teams and Flin and Maron (2004) have identified nontechnical skill requirements for teams in acute medicine.

These studies encapsulate the core KSA requirements for physicians, nurses, and other health care professionals to function effectively in a wide variety of health care teams. Although different researchers use different terminology to define these KSA requirements (e.g., Thomas et al. 2004) identify one of their behavioral markers as "Information Sharing," while others identify a requirement for "Communication" (Leonard and Tarrant 2001; Flin and Maron 2004; Healey et al. 2004), we argue, much as have Salas and colleagues, that these generic KSAs can be clustered into eight broad competencies of teamwork (Sims et al. 2004). These competencies must be possessed by health care professionals so they can perform (1) in the variety of teams of which they are part and (2) a variety tasks requiring coordination in day-to-day practice. Table 1 presents each KSA, its definition, and behavioral examples.

Characteristics of Effective Teams

Teams whose members possess a shared commitment to the KSAs presented in Table 1 have been shown to out perform teams whose members do not possess these attributes (Smith-Jentsch et al. 1996; Leonard and Tarrant 2001;

Table 1: Team KSA Competencies and Outcomes

Teamwork	*Definition*	*Behavioral Examples*
Team leadership (Cannon-Bowers et al. 1995; Sims et al. 2004; Barach and Weingart 2004)	Ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team KSAs, motivate team members, plan and organize, and establish a positive atmosphere	Facilitate team problem solving Provide performance expectations and acceptable interaction patterns Synchronize and combine individual team member contributions Seek and evaluate information that impacts team functioning Clarify team member roles Engage in preparatory meetings and feedback sessions with the team
Mutual performance monitoring (a.k.a., situation monitoring) (McIntyre and Salas 1995)	The ability to develop common understandings of the team environment and apply appropriate task strategies in order to accurately monitor teammate performance	Identifying mistakes and lapses in other team members actions Providing feedback regarding team member actions in order to facilitate self-correction
Backup behavior (a.k.a., mutual support) (McIntyre and Salas 1995; Porter et al. 2003)	Ability to anticipate other team member's needs through accurate knowledge about their responsibilities	Recognition by potential backup providers that there is a workload distribution problem in their team
	The ability to shift workload among members to achieve balance during high periods of workload or pressure	Shifting of work responsibilities to under-utilized team members Completion of the whole task or parts of tasks by other team members
Adaptability (Cannon-Bowers et al. 1995; Kozlowski et al. 1999; Klein and Pierce 2001)	Ability to adjust strategies based on information gathered from the environment through the use of compensatory behavior and reallocation of intrateam resources. Altering a course of action or team repertoire in response to changing conditions (internal or external)	Identify cues that a change has occurred, assign meaning to that change, and develop a new plan to deal with the changes Identify opportunities for improvement and innovation for habitual or routine practices Remain vigilant to changes in the internal and external environment of the team

continued

Table 1: *Continued*

Teamwork	*Definition*	*Behavioral Examples*
Shared mental models (Klimoski and Mohammed 1994; Mathieu et al. 2000; Stout, Cannon-Bowers, and Salas, 1996)	An organizing knowledge structure of the relationships between the task the team is engaged in and how the team members will interact	Anticipating and predicting each other's needs Identify changes in the team, task, or teammates, and implicitly adjusting strategies as needed
Communication (McIntyre and Salas 1995)	Exchange of information between a sender and a receiver irrespective of the medium	Following up with team members to ensure message was received Acknowledging that a message was received Clarifying with the sender of the message that the message received is the same as the intended message sent
Team/collective orientation (Driskell and Salas 1992; Shamir 1990; Wagner 1995)	Propensity to take other's behavior into account during group interaction and the belief in the importance of team goal's over individual member's goals	Taking into account alternative solutions provided by teammates and appraising that input to determine what is most correct Increased task involvement, information sharing, strategizing, and participatory goal setting
Mutual trust (Bandow 2001; Webber 2002)	The shared belief that team members will perform their roles and protect the interests of their teammates	Information sharing Willingness to admit mistakes and accept feedback

Salas et al. 2001; O'Shea et al. 2003). One important fact to note about these KSAs is that they are all individual as opposed to team-level competencies. In other words, team members bring these KSAs to each team task they engage in; the competencies are not unique to the task or the team. When team members work together on a more permanent basis, these competencies are refined over time (they are tailored within the team) and some additional competencies emerge (e.g., knowledge of teammate characteristics).

Regardless of whether a team has consistent membership or not, when team members possess the KSAs in Table 1 they are able to perform as a highly reliable and efficient system. Table 2 presents a list of characteristics of effective teams that make them reliable and efficient. These characteristics are similar to the properties that embody HROs, which we describe in the next

Table 2: Characteristics of Effective Teams

Team Knowledge, Skills, and Attitudes	*Characteristics of Effective Teams (Salas, Sims, and Klein 2004)*
Team leadership	Have a clear common purpose
	Team member roles are clear but not overly rigid
	Involve the right people in decisions
	Conduct effective meetings
	Establish and revise team goals and plans
	Team members believe the leaders care about them
	Distribute and assign work thoughtfully
Backup behavior	Compensate for each other
	Manage conflict well-team members confront each other effectively
	Regularly provide feedback to each other, both individually and as a team ("debrief")
	"Deal" with poor performers
	Are self-correcting
Mutual performance monitoring	Effectively "span" boundaries with stakeholders outside the team
	Members understand each others' roles and how they fit together
	Examine and adjust the team's physical workplace
	Periodically diagnose team "effectiveness," including its results
Communication	Communicate often "enough"
Adaptability	Members anticipate each other
	Reallocate functions
	Recognize and adjust their strategy under stress
	Consciously integrate new team members.
Shared mental models	Coordinate without the need to communicate overtly
Mutual trust	Trust other team members' "intentions"
Team orientation	Select team members who value teamwork
	Strongly believe in the team's collective ability to succeed

section. However, before our review of HROs, we describe the mechanisms by which effective team performance can be achieved.

How to Promote Teamwork

There are three basic strategies by which effective teamwork can be achieved. First, specific individuals, who have the correct KSAs, can be selected to participate in a team or to perform team-based work (Klimoski and Mohammed 1994). This strategy requires precise measurement of individual-level team competencies and a correct balancing of task-oriented and team-oriented KSAs among team members. Second, teamwork can be enhanced by modifying tasks, workflow, or structure (Campion, Medsker, and Higgs 1993; Campion, Papper, and Medsker 1996). In other words, one can examine the environmental conditions in which team-based work occurs and reengineer these conditions accordingly. Finally, individual team member competencies can be developed through training (Cannon-Bowers et al. 1995, 1989; Cannon-Bowers and Salas 1997; Leonard, Graham, and Bonacum 2004). Team training has been the most widely applied strategy to improve team performance.

Team training is defined as applying a set of instructional strategies that rely on well-tested tools (e.g., simulators, lectures, videos) (Salas et al. 1999; Salas, Rhodenizer, and Bowers 2000). Effective team training reflects general principles of learning theory, presents information about requisite team behaviors, affords team members the opportunity to practice the skills they are learning, and provides remedial feedback.

A great deal of research has been devoted to the most effective strategies and techniques for training specific team KSAs. A comprehensive review of this research has presented an extensive collection of principles and guidelines concerning the design and delivery of team training. For example, guidelines exist for assertiveness training (Smith-Jentsch et al. 1996), cross-training (Volpe et al. 1996), stress management training (Driskell and Johnston 1998), and team self-correction (Smith-Jentsch et al. 1998).

Team training programs have been an essential component of the airline industry's efforts to achieve high reliability. For over 30 years, crew resource management (CRM) has been a critical part of most airlines' efforts to improve their margin of safety. Recent research suggests that CRM training results in heightened safety-related attitudes; improved communication, coordination, and decision-making behaviors; and enhanced error-management skills (Wiener, Kanki, and Helmreich 1993; Helmreich and Merritt 1998). CRM

training has also demonstrated consistently positive results across a wide range of team structures, including pilot crews, maintenance crews, dispatch crews, and air traffic control teams (Helmreich and Foushee 1993; Oser et al. 2001; Smith-Jentsch et al. 2001).

Interestingly, CRM's effect on the ultimate criterion—a reduction in the number of accidents—has yet to be empirically established (Salas et al. 2001). However, accidents represent a poor criterion methodologically because they exhibit an extremely low base rate (Helmreich and Foushee 1993). Thus, researchers have relied on surrogate measures—like improvements in team-related knowledge and skills, behavioral demonstrations of CRM skills on simulated flights, instructor evaluations of trained versus untrained crews, and changes in an organization's safety culture—to demonstrate the effectiveness of CRM training (Helmreich and Foushee 1993; Hansberger, Holt, and Boehm-Davis 1999; Ikomi et al. 1999; Incalcaterra and Holt 1999; Holt, Boehm-Davis, and Hansberger 2001).

Similar to the airline industry, some type of formal team training is now a major component of training in most branches of the United States Armed Forces. For example, all branches of the Armed Forces give their aircrews a military version of CRM, ranging from Fighter Resource Management (FRM) for single-seat fighter pilots to CRM training for the large crews that staff transport and patrol aircraft (Spiker et al. 1998). In addition, many sailors, soldiers, airmen, and marines receive team training. For example, the Navy, having tested several team-training approaches (Serfaty, Entin, and Johnston 1998), has adopted an approach called Team Dimensional Training (TDT), which resulted from the TADMUS program (Cannon-Bowers and Salas 1998). TDT addresses team-related knowledge and skills, provides practice in briefing and debriefing, and trains trainers and team leaders to evaluate and critique team skills (Tannenbaum, Smith-Jentsch, and Behson 1998).

Teams and HROs

The characteristics of HROs dictate that teamwork is an essential component of such organizations. HROs will not achieve high reliability unless its members are able to effectively and efficiently coordinate their activities. In the previous section, we have spent considerable time clarifying what we mean by "teams" and "teamwork." In this section we define the concept of high

reliability, review the key characteristics of HROs, and demonstrate why teamwork is so critical in such organizations.

HROs are defined by their potential for causing failures that lead to catastrophic consequences. If the potential is high (thousands of dramatic failures), but the actual number of failures is low, the organization is an HRO (Roberts 1990a). For example, a nuclear power plant failure could result in horrific consequences for its surrounding community, although such failures are extremely rare. The same can be said for many U.S. hospitals—there are thousands of opportunities for major accidents everyday. Although the IOM estimated that 98,000 preventable deaths occur per year, the actual occurrence of medical error resulting in deaths is extremely low (Kohn et al. 1999).

HROs are those organizations that function in hazardous, fast-paced, and highly complex technological systems essentially error-free for long periods of time (Roberts 1990a, b). Roberts and Rousseau (1989) identified eight characteristics of HROs: (1) hypercomplexity, (2) tightly coupled, (3) extreme hierarchical differentiation, (4) many decision makers working in complex communication networks, (5) high degree of accountability, (6) frequent, immediate feedback regarding decisions, (7) compressed time factors, and (8) synchronized outcomes (Roberts and Rousseau 1989). Below we review each of these characteristics, demonstrate how teamwork is an essential component of effective performance in such organizations, and provide a health care example, where appropriate.

Hypercomplexity is defined as an extreme variety of components, systems, and levels, each having their own standard procedures, training routines, and command hierarchy (Roberts and Rousseau 1989). Based on its definition alone, successful performance in hypercomplex environments relies upon multiteam systems and teamwork is an essential component of such environments. For example, Roberts and Rousseau describe aircraft carrier operations is indicative of hypercomplexity. Pilots, air traffic controllers, dispatchers, ground crews, and many others must work collectively to launch and recover aircraft. These interdependent teams (e.g., air traffic control team, aircrews, maintenance teams, etc.), must coordinate their activities and efficiently monitor each other's performance.

Similarly, the delivery of health care occurs in a hypercomplex environment that is dependent on multiteam systems. Even though health care workers have historically operated in distinct silos and have been trained in separate professions and possess distinct expertise, these individual must coordinate to deliver safe care. At the most basic level, physicians must

accurately communicate treatment information to the nurse based, in part, on information the nurse presents to the physician regarding the patient's condition. Orders are written on the basis of this discussion and the physician's examination of the patient. These orders are distributed to the pharmacy, X-ray, labs, physical therapy, etc., so that other health care professionals can collect additional information to provide insight regarding the patients or initiate treatment.

Tight coupling is defined as reciprocal interdependence across many units and levels. Tight coupling relates to *task interdependence*, which is the defining characteristic of teams. That is, tasks performed by one member of the team are dependent on tasks performed by other members of the team and the performance of these tasks must be coordinated among team members for effective team performance (delivery of safe care). For example, in health care an emergency C-section is a tightly coupled event that involves several different members of the labor and delivery team. The nurse handling the case is typically the first to observe fetal distress and must communicate this information to the attending physician. The doctor must decide if a C-section is necessary based upon the information the nurse provides and review of information collected from the fetal heart rate monitor. If the attending decides to operate, appropriate staff must be notified (anesthesiologist, neonatologist, or pediatrician), and the patient must be moved to surgery. Before making the initial incision, the patient must be properly anesthetized and the staff should be briefed as to the status of the patient and the baby. This process, which involves a series of interdependent steps, can take place in a matter of minutes depending on the history of the case and the level of fetal distress observed. For such a sequence to run smoothly, teams must use effective communication and have a shared understanding of the mother's and baby's condition. The Joint Commission (JCAHO) reported that ineffective communication resulted in 70 percent of all preventable errors involving death or serious injury from 1995 to 2003 (JCAHO 2004).

Extreme hierarchical differentiation is defined as an organizational structure in which levels and roles are clearly differentiated. This characteristic is also true of most health care teams. Physicians tend to be at the top of this hierarchy with the case or treatment resulting from their directions. Therefore, a great deal of coordination is necessary to keep physicians, nurses, and technicians working together as a cohesive unit. Unfortunately hierarchy often makes it more difficult for medical teams to achieve this level of coordination and cohesiveness. In fact, research suggests that the extreme hierarchical difference between physicians and nurses in particular can contribute to

dysfunctional communication yielding less than optimal patient care (Keenan, Cooke and Hillis, 1998; Knox and Simpson 2004).

Although most medical teams are hierarchical, high-reliability teams trained in teamwork exhibit characteristics such as assertiveness and mutual trust, which reduce the negative effects of hierarchy. Mutual trust, an essential teamwork KSA, involves a shared belief that team members will protect and support the interests of their team (Sims et al. 2004). Team members with mutual trust are willing to admit to mistakes and accept and appreciate feedback (Bandow 2001; Webber 2002). This allows team members to firmly assert their concerns even to a higher-ranking team member without fear of reprisal.

Another key characteristic of HROs is that they contain *many decision makers* working in complex communication networks (Roberts and Rousseau 1989). This characteristic personifies most health care teams. First, team members continually need to make important decisions concerning patient care (e.g., start an IV, induce labor, administer narcotics, admit patient). Consequences of these decisions clearly have implications on the ultimate well being and safety of patients. As most teams in health care are comprised of four to six unique individuals, however, decisions are not always unanimous. Second, as different team members are trained separately in their respective professions (e.g., medical school and nursing school), they have learned to communicate differently and have varying styles of conveying information depending on their role. Fortunately, new and emerging techniques like the Situation Background Assessment Recommendation (SBAR) strategy have been used in health care to overcome such communication difficulties with positive results (Leonard et al. 2004). This particular strategy facilitates clear and concise communication among members of health care teams by providing an easy-to-remember acronym used for framing critical conversations.

A *high degree of accountability* in HROs is characterized by the severe consequences that can result from errors (Roberts and Rousseau 1989). Although serve consequences may be characteristic of all teams (e.g., project teams), in health care, the consequence of a mistake can often be death the patient. Preventable medical errors that result in loss of human life eternally affect the patient's family, the staff that tended to the patient, the community, and the hospital's reputation. However, even small mistakes resulting in patient harm yield grave consequences, yet not all medical team members are held equally accountable when errors do occur. More often then not, it is the physician in charge of the patient's care that gets the brunt of the blame for any mistakes made. Malpractice lawsuits or the possibility of losing one's license

are very real outcomes that add to pressures felt by already stressed physicians. Consequences may also be present for the hospital such as loss of accreditation, and negative media attention.

HROs are also characterized by "immediate feedback" resulting from their decisions; the plane crashes; there is a nuclear disaster; the patient is injured (Roberts and Rousseau 1989). In other words, there is an identifiable, measurable outcome associated with HRO performance. Such outcomes are typically an indicator of poor team and/or system processes within the HRO. For example, in aviation 60–80 percent of all accidents are attributed to human error as opposed to anything technically wrong with the aircraft. Similarly, the IOM report points to human error as a major contributor in patient deaths (Foushee 1984; Kohn et al. 1999).

Immediate feedback is also a characteristic of effective team performance. Team members must monitor each other and provide each other feedback to maximize team functioning. However, feedback here focuses on team process and its improvement rather than solely on team outcomes. To ensure that feedback occurs, team members must be trained to deliver timely, behavioral, and specific feedback to one another (using such strategies as TDT). The ability to monitor each other's performance and effectively provide feedback to other team members is a critical facet of achieving higher reliability in health care and elsewhere.

Major HRO activities often occur under *compressed time*, as in the case of naval flight operations where aircraft are launched and recovered in 48–60-second intervals (Roberts and Rousseau 1989). Somewhat different than the other characteristics, the extent to which this variable is related to team performance is a function on the environment in which the team operates as opposed to the team itself. Some teams operate under compressed time while others do not. The same is true of health care, with a slightly different twist. Routine procedures like childbirth can quickly become a stressful, time compressed situation should a problem arise with the mother or baby. In such cases, teams need to be able to quickly adapt. Team members may have to be quickly added and integrated into the team and task—anesthesiologist, emergency response team—or existing members may have to take on new roles—OB-GYN converts from coaching the mother through a normal delivery to conducting an emergency C-section.

The last characteristic of HROs is that critical *outcomes occur simultaneously* (Roberts and Rousseau 1989). As discussed earlier, team members work together on interdependent tasks. This is what separates teams from groups or individuals working in isolation. Interdependency creates the need for

synchronization of activities and outcomes. For instance, when delivering a baby, each member of a labor and delivery team is actively engaged in different aspects of the process yet their actions are synchronized.

As can be seen from the description above, the HRO environment demands teamwork. Teamwork, or the KSAs that comprise it (refer to Table 1), are critical for successful performance in organizations that are hypercomplex, tightly coupled, hierarchical, time compressed, and rely upon synchronized outcomes (Sims et al. 2004). Aviation, the military, and now health care acknowledge the criticality of teamwork in achieving high reliability despite data that show a direct relation between team training and the ultimate criterion, a reduction in errors (e.g., accidents, deaths, etc.) (Salas et al. 2001). However, the science of teamwork and team training is still evolving, particularly in health care. The IOM report did much to stimulate research on health care teams, but much of this early work relied upon direct transitions from the commercial airlines to health care. Despite the work of Gaba and colleagues, it is only within the last 3 years that the science of health care teams has really begun to emerge and take hold (Baker et al. 2003). As a result, a number of questions remain that health care must address to have a firm understanding of teamwork and its relation to patient safety and high reliability. Direct transitions from aviation without additional study are insufficient. In the next section, we outline a series challenges the health care community must address to better understand health care team performance, how to maximize this performance, and ultimately improve patient safety.

CHALLENGES

Throughout this paper we focused on three basic themes. First, the delivery of health care, by its nature, requires that organizations providing such services act as HROs. Patients expect error-free care (Knox and Simpson 2004). Second, teamwork is an essential component of HROs. Although not the sole determinant of high reliability, HROs are typically comprised of teams embedded in multiteam systems and effective teamwork is critical for success in environments that demand high reliability (Wilson et al. 2005). Finally, the easiest way of improving teamwork is through training. Team training has been effectively implemented in the commercial airlines and the military with positive results (Salas et al. 2001). Such training programs are now emerging in health care with potentially similar benefits (Baker, Beaubien, and Holtzman 2003).

Nonetheless, teamwork in health care is an emerging science. To move this science forward so that findings can be transitioned and implemented, we recommend that health researchers, quality improvement specialists, regulatory bodies, and others seek to address the following challenges.

Challenge 1: A Theoretical Model of Team Performance in Health Care Should Be Developed

To date, research has not developed a comprehensive model of team performance in medical settings; consequently, existing and emerging team training programs are not grounded in a scientific understanding of what comprises effective teamwork in health care (Baker et al. 2003, 2003). In our review of the team literature, we recommend the teamwork framework advocated by Salas and colleagues and this framework serves as the foundation for AHRQ's TeamSTEPPS training program. However, the Salas model needs to be tested in health care to determine (1) the relations among predictors of performance (team KSAs) and (2) the relations between predictors (KSAs) and outcome criteria (e.g., quality of care, error management, efficiency, etc.).

Challenge 2: Proven Instructional Strategies Should Be the Basis for Team-Training Programs in Health Care

Team training is the most practiced strategy for enhancing team performance and improving team outcomes. Most HROs provide some form of team training and the science of team training has developed and validated numerous training strategies. Through a variety of formats and objectives, these strategies extend beyond CRM training. However, health care seems to be focused on adapting CRM programs derived directly from aviation (Baker et al. 2003) and not implementing other strategies which have been shown to be effective and may by more appropriate (i.e., team dimensional training). Therefore, we challenge health care to (1) move beyond CRM and look to other validated methods, (2) use these strategies wherever possible as the foundation for team training programs, and (3) test and refine these strategies to ensure that they effectively generalize to health care teams. It is only through implementation, testing, and refinement that health care will be able to understand and demonstrate how to enhance teamwork.

Challenge 3: Team-Training Strategies Must Be Further Adapted to Specific Health Care Needs

Similar to our previous recommendation, we are convinced that no single model of team training, like CRM, can be applied across all health care services and contexts when attempting to achieve high reliability. For purposes of this discussion, we define a "service" as a medical specialty or subspecialty, such as emergency medicine, general or family medicine, intensive care, general surgery, obstetrics, etc. Medical services differ dramatically across a variety of criteria: size, purpose, duration, redundancy of expertise, decision time, and consequence of error, to name but a few.

In addition, services operate in a number of diverse contexts. As an example, emergency medicine providers function in hospital emergency departments, in emergency-response mobile units, and on battlefields. Similarly, urban and rural providers operate in independent or multipractitioner offices, as well as in community walk-in clinics. Neither the competencies that impel successful teamwork nor an optimal team-training strategy can be expected to generalize across all these contexts. And, of course, not all members within the same team will necessarily need the same KSAs.

Therefore, in addition to the core competency taxonomy, the science of teamwork in health care must seek to develop service-specific taxonomies. These putative taxonomies would not be redundant with the generic, core competency taxonomy. Rather, a specific taxonomy would denote the specific KSA requirements that are central to teamwork in a given service, thus maximizing team performance within that service. The task content and procedures that define this service would drive the identification of relevant team competencies.

Virtually no previous research has addressed the manner in which differences within and among health care services should be reflected in service-specific taxonomies and customized training. Yet we find this issue sufficiently compelling, particularly with the context of HROs, because it suggests that customized solutions are warranted to achieve high reliability. Therefore, while a generic taxonomy of team KSAs is the foundation to teamwork in health care, we argue that these competencies must be refined and training must be tailored to a specific service to maximize team performance and safety.

Challenge 4: Team Training Must Be Institutionalized throughout Health Care and Professional Training

Finally, health care must work to integrate teamwork throughout every level of training and education of health care professionals. By "integrated" we mean

instruction, measurement, and feedback on critical team KSAs occurs as part of a health care professional's technical education and training. Using this approach, team concepts become a part of everyday practice.

Several initiatives by physician education, certification, and licensing boards have already begun to move health care toward integrating team concepts. For example, the ACGME has identified several teamwork-related competencies that residents must master as part of the ACGME outcomes project (www.acgme.org). Similarly, AAMC funded a "critical incident" analysis to investigate the behaviors that result in successful and unsuccessful performance during medical school and residency (Adams et al. 2001). Although not originally targeted toward team performance, the results revealed the importance of a number of teamwork-related competencies.

Building off existing initiatives, we believe that the structure of health care, as currently conceptualized, offers appropriate junctures where teamwork skills could be evaluated. For example, like the examinations that are constructed for board certification in medical specialties, it might ultimately be useful to develop a board certification test for teamwork. Such an exam might combine a written test of knowledge and situational judgment with performance in a simulated scenario. Because the board examinations are practice-specific, their teamwork component could assess practice-specific teamwork competencies. In addition, the JCAHO currently evaluates hospitals on criteria that range from medical practices to managerial systems to facilities maintenance. At some point in the future, folding team competency criteria into the JCAHO evaluation might focus providers' attention on the importance of teamwork in medical settings, as well as yielding valuable research data.

In summary, we have argued that teamwork is an essential component of achieving high reliability for health care organizations. HRO environments demand teamwork and, as a result, the science of team training can provide great insights and proven techniques for improving performance within such organizations. In closing, we recommend that health care gain traction from the more than 20 years of research on team performance and training and that these principles be first tested and then integrated into the practice of health care and the training of health professionals. Although this will take considerable time, perhaps spanning a generation, this approach has been one of the key drivers in other industries achieving the highest reliability possible. We believe that the challenges we have presented here provide a roadmap with which health care can continue.

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