Abstract

A 1999 report by the Institute of Medicine (IOM) suggests that medical errors are responsible for as many as 98,000 deaths annually. In response to this crisis, then President Clinton established the Quality Interagency Coordination (QuIC) Task Force to develop a Federal plan for reducing the number and severity of medical errors. One of the QuIC's primary recommendations was the adaptation of Crew Resource Management (CRM) training—a sub-domain of team training—to medicine.

This paper will present evidence to support the relation between team training and patient safety. It extends earlier work by Pizzi and colleagues who argue that CRM training has a great deal of potential as a safe patient practice. Training medical professionals to operate as a well-coordinated team should enhance patient safety and lead to a reduction in medical errors. We begin the paper by presenting background information related to teamwork, including the nature of effective teamwork, teamwork-related knowledge, skills, and attitudes, and contextual issues surrounding teamwork. We then provide further confirmation of team training effectiveness, taken from high-risk domains such as commercial aviation and the military. Details are provided on existing medical team training programs, including Anesthesia Crisis Resource Management, MedTeams™, Medical Team Management, Team-Oriented Medical Simulation, Dynamic Outcomes Management, and Geriatric Interdisciplinary Team Training, and the effectiveness of each is discussed. Finally, we offer specific recommendations to guide future medical team training research.

Summary

In 1999 the Institute of Medicine (IOM) published *To Err is Human: Building a Safer Health System*, a revealing indictment of the inadequate safety that the United States medical establishment too often provides its patients. Extrapolating from data gathered through the Harvard Medical Practice Study (HMPS) and the Utah-Colorado Medical Practice Study (UCMPS), the IOM report concluded that medical errors cause between 44,000 and 98,000 deaths annually—more than result from automobile accidents (43,458), breast cancer (42,297), or AIDS (16,516).

Since the IOM report, the health care community has had a renewed and continual focus on medical errors, patient safety, and the development of evidenced-based practices to improve the quality of care. At the federal level, the Agency for Healthcare Research and Quality (AHRQ) has assumed the lead role in the patient safety movement, funding dozens of grants on topics related to error reporting, working conditions, technology applications, and the like. One of AHRQ's first efforts was to commission Evidence Report 43 entitled, *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*, which reviewed existing data on practices within and outside of health care that are regarded as having the potential to improve patient safety. As part of Evidence Report 43, Pizzi et al reviewed the evidence for Crew Resource Management (CRM)—a sub-domain of team training—and its medical applications and concluded that CRM has tremendous potential, based on its success in the aviation industry, though future research into its health care role is warranted.

This report extends and updates the Pizzi et al review and contends that the training of health care providers as teams constitutes a pragmatic, effective strategy for enhancing patient safety and reducing medical errors. The report is comprised of six substantive sections. The first reviews the recent patient safety initiatives and associated recommendations, many of which point to the need for improved teamwork in the delivery of health care. The second section reviews the key characteristics of a team and discusses the principles that underlie successful teamwork and effective team training. Next, the available research concerning the relation between teamwork and safety in real-world, high-risk settings is reviewed and evaluated. Fourth, the current trends and issues in medical team training are presented and the most well-known medical team training programs are summarized. Fifth, we offer a detailed set of conclusions and recommendations that are drawn from the literature review. Finally, we present directions for future research.

We began by searching the PsycARTICLES®, PsycINFO®, and the Sociological Collection® databases through January of 2003 for articles on teams, teamwork, and Crew Resource Management (CRM) training with relevance to commercial or military aviation. In addition, we conducted searches for journal articles involving medical team training, or key terms such as "crew resource management," "cockpit resource management," "medical error," "team training and aviation," and "team training and medicine," using the same databases, as well as MEDLINE® and HealthSTAR®.

Other key terms used in document searches included “team training” and medical specialties such as “anesthesiology,” “obstetrics,” “gynecology,” “emergency medicine,” and “geriatrics.” Searches also were conducted using specific medical team training program names, such as MedTeams™, Medical Team Management, Anesthesia Crisis Management, and Dynamic Outcomes Management. Parallel searches, using the same key terms, also were conducted with the aid of internet search engines to uncover any unpublished studies on these topics. The reference lists from each of the relevant articles then were used to identify additional resources, after which we contacted experts in the field to obtain unpublished technical reports and in-press manuscripts. It is important to note that particular domains of team performance and training literature have been emphasized in the development of this report. Specifically, we focused our attention on research involving parallel, high-stress, and high-risk environments (e.g., military and commercial aviation) where the consequences of error are extreme.

Teamwork is described traditionally using systems theory, which posits that team inputs, team processes, and team outputs are arrayed over time. Team inputs include the characteristics of the task to be performed, the elements of the context in which work occurs, and the attitudes brought forth by its members to a team situation. Team processes are the interactions and coordination necessary on the part of team members to achieve specific goals. Team outputs consist of the products derived from the team’s collective efforts. Thus, teamwork occurs in the process phase, during which designated members interact and collaborate to achieve the desired outcomes.

Effective team performance requires a willingness on the part of team members to cooperate in the service of a shared goal, such as the goal of improving patient safety and the creation of a treatment environment free from medical errors. Moreover, effective teamwork depends on effective communications within the team, along with adequate organizational resources and support.

The researchers identified three types of competencies that are critical for effective teamwork: (1) teamwork-related knowledge, (2) teamwork-related skills, and (3) teamwork-related attitudes.

Team knowledge competencies are the principles and concepts that underlie a team’s effective task performance. Broadly speaking, selected members should know the range of skills required, when particular behaviors are appropriate, and how the skills and behaviors are manifested in a team setting, if they are to function as a team.

Team skill competencies, defined by Cannon-Bowers and colleagues as the learned capacity to interact with other team members at some minimal level of proficiency, have received considerable research attention. But the same scientists contend the spectrum of literature regarding skill labels and definitions is confusing, contradictory, and plagued with inconsistencies.

Team attitude competencies have been defined as internal states that influence a team member’s decision to act in a particular way. Positive attitudes toward teamwork and a mutual trust among team members are critical to successful team processes.

A team's utility and efficiency is tied directly to its team members and their ability to integrate various personal and situational characteristics. Each team member must understand the technical and tactical considerations of the assigned task, as well as the strengths and weaknesses of their teammates. In addition to carrying out their own responsibilities and altering them when necessary, each member must also monitor their teammates' activities and diffuse potential team conflicts. Effective teams exhibit these competencies while maintaining a positive emotional attitude toward the team itself.

Team training could be described as the application of instructional strategies based on well-tested tools (e.g., simulators, lectures, videos) to a specific set of competencies. Effective team training reflects general learning theory principles, presents information about requisite team behaviors, affords team members the necessary skills practice, and provides them with remedial feedback.

Much research has been devoted to effective strategies and techniques for training specific team knowledge, skills, and attitude competencies. A comprehensive review of this research has resulted in an extensive collection of principles and guidelines concerning the design and delivery of team training. For example, guidelines exist for assertiveness training, cross-training, stress-management training, and team self-correction.

To design training strategies that will improve teamwork skills on the job is a challenge. Teams operate in complex and dynamic environments that are characterized by multi-component decisions, rapidly evolving and ambiguous situations, information overload, severe time constraints, and harsh consequences for mistakes.

In summary, this report merits the medical community's attention because it assesses the status of relevant team-training research from other domains in addition to aviation and, for the first time, applies this research to the field of medicine. Second, the report provides a comprehensive review and evaluation of the effectiveness of current *medical* team training initiatives.

Key Conclusions

1. The science of team performance and training can help the medical community improve patient safety.

A general science of team performance and training has evolved and matured over the last 20 years. This science has produced a number of principles, lessons learned, tools, and guidelines that will serve the patient safety movement.

2. Research has already identified many of the competencies that are necessary for effective teamwork in medical environments.

The science of team performance and training has identified the competencies that are required for effective team functioning in a number of complex settings. Many, if not most, of these competencies apply to the medical community.

3. A number of proven instructional strategies are available for promoting effective teamwork.

The science of team performance and training has also developed and validated numerous training strategies that can provide requisite competencies to teams who perform in complex environments. These strategies extend beyond CRM training and could easily be adapted to health care.

4. The medical community has made considerable progress in designing and implementing team training across a number of settings.

Our review of existing medical team training programs clearly shows that the health care community is striving to implement CRM training across a number of medical domains. We recommend that this trend be continued. However, the extent to which these programs are being implemented with the help of what we know from the science of learning, of team performance and of training is less clear. Thus, we recommend strengthening the link between scientific knowledge and medical-team training.

5. The institutionalization of medical-team training across different medical settings has not been addressed.

To make teamwork a common, effective practice throughout the delivery of health care, there is an imperative need to embed team training in professional development. By “embedding” we mean implementing and regulating team training throughout a healthcare provider’s career.

Chapter 1. Introduction

This report will examine the empirical evidence concerning the relation between teamwork and patient safety. The available evidence suggests that organizing and training health care providers as a team constitutes a pragmatic, effective strategy for enhancing patient safety and reducing medical errors. We have adopted the Institute of Medicine's (IOM) definition of both *patient safety* and *error*, for the purposes of this report. Specifically, the IOM defines *patient safety* as "freedom from accidental injury"; conversely, *error* constitutes "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim."[1]

Background

The Impact of the Institute of Medicine Report

In 1999 the IOM published *To Err Is Human: Building a Safer Health System*, a revealing indictment of medical care throughout the United States, with an emphasis on the frequent inadequacy of safety practices used in the treatment of patients.[1] Extrapolating from data gathered as part of the Harvard Medical Practice Study (HMPS) and the Utah-Colorado Medical Practice Study (UCMPS),[2] the IOM report estimates that medical errors result in 44,000 to 98,000 deaths annually—more than automobile accidents (43,458), breast cancer (42,297), or AIDS (16,516).[1]

The report also notes that in addition to causing human suffering and death, medical errors are costly. The IOM estimates the direct costs of inpatient medication errors in U.S. hospitals at approximately $2 billion annually. There are other indirect costs, such as higher insurance premiums and copayments, as well as lost opportunities for the use of funding that instead must be spent to correct mistakes. In addition, such errors exact a price from the society-at-large, in the form of diminished employee productivity, decreased school attendance, and a lower state of public health. The IOM estimates the sum indirect costs of medical errors leading to patient harm at $17 billion to $29 billion annually. Finally—and equally perilous in the long run—medical errors undermine the collective confidence of patients and health professionals in the health care system itself.

To reduce the spiraling incidence of medical errors, the IOM recommended a four-tiered approach:

1. Establish a national focus on leadership, research, tools and protocols to enhance the safety knowledge base.

2. Identify and learn from errors through the use of immediate and strong mandatory reporting efforts.… (while encouraging)…. improved voluntary reporting, leading to steady and systemic patient safety improvements.

3. Elevate standards and expectations for safety improvements with the help of oversight organizations, group purchasers, and professional groups.

4. Create fail-safe systems within (health care) organizations, through the introduction of best practices at the delivery level. This level is the ultimate target of all the recommendations.

Key to the present document's orientation towards teamwork-related research, the IOM further noted that the majority of medical errors are the result of health care *system* failures, rather than substandard performance on the part of individual caregivers. Thus, in conjunction with its drive to build organizational safety systems around best-use treatment practices, the IOM recommended establishing interdisciplinary team-training programs.[1]

The results of the IOM's source studies (i.e., the HMPS and the UCMPS) had been published previously in scientific journals. But the findings had not galvanized a national call to action.[3] In contrast, *To Err Is Human* generated a demand for new standards of care that was heeded by the Federal Government, the media, health care professionals, and the research community. In the service of this mandate, the Federal Government established agencies and task forces to radically improve patient safety. In turn, these groups are funding private–public research partnerships to investigate safety risks and propose scientifically sound, evidence-based methods for reducing the number and severity of medical errors.

The Role of the Quality Interagency Coordination (QuIC) Task Force

Shortly after the IOM published its medical errors report, President Clinton established the Quality Interagency Coordination (QuIC) Task Force. The QuIC comprises representatives from the Department(s) of Health and Human Services (DHHS), Labor (DOL), Defense (DoD), and Veterans Affairs (VA), along with other federal agencies. The Coordinating Officer represents the Agency for Healthcare Research and Quality (AHRQ). The Task Force responds to the IOM's recommendations by sponsoring scientific research into the causes of medical errors and proposals for improving patient safety in a variety of health care settings.

As noted previously, the IOM's fourth recommendation—implementing organizational safety systems—is particularly relevant to our study of utility teams in medical settings. The QuIC's support for this recommendation includes:

- Promoting a plan to increase VA spending on patient safety programs—by more than $47 million in FY2000 alone—including increased training for personnel, VA Quality Scholars fellowships for 10 physicians, individual awards for patient safety, and the posting of Patient Safety Checklists in the operating rooms of every hospital in the United States.

- Recommending a plan to install a computerized medical records system in all DoD hospitals and clinics, over a 3-year period (beginning in FY2001), at a cost of more than $64 million.

- Endorsing a collaboration between several QuIC member agencies (DoD, VA, AHRQ, the Center for Medicare & Medicaid Services [CMS]), the Institute for Healthcare

Improvement, and the Task Force, to decrease the incidence of medical errors in hospital emergency and operating rooms, intensive care units, and labor and delivery facilities.

Of these initiatives, the work of QuIC Task Force member agencies to mitigate medical errors in high-risk specialties, has been the most germane to AHRQ's subsequent involvement with medical team-training and the associated potential for improved patient safety.

The Role of the Agency for Healthcare Research and Quality (AHRQ)

As the lead Federal agency charged with supporting research and developing public-private partnerships for improving health care, AHRQ's patient safety responsibilities span three broad areas: (1) identifying the causes of errors and injuries in health care delivery; (2) developing, demonstrating, and evaluating error-reduction and patient-protection strategies; and (3) distributing effective strategies throughout the U.S. health care community.[4]

Following the National Summit Meeting on Medical Errors and Patient Safety, held September 2000, in Washington, D.C., AHRQ developed a research portfolio[4] designed to, among other things, "apply evidence-based approaches to the improvement of patient safety." Of particular relevance was AHRQ's desire for research that would evaluate and "extend the capabilities of patient safety staff." In light of this focus, and given that training is central to the development of professional skills, the ensuing discussion presents team training as a subset of professional training.

Given the IOM's assertion that systemic failures in the delivery of health care are responsible for many more errors than the poor performance of individuals, it could be reasonably argued that the crux of patient safety training is the coordination, interaction, and communication among individuals who, despite different medical specialties, all are accountable for the same patients' welfare. For purposes of the following evaluation, these responsible individuals comprise a *medical team*.

This discussion of teamwork and team training extends and expands an earlier review conducted by Pizzi and colleagues as part of AHRQ Evidence Report No. 43, *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*. The report presents the relevant data on practices within and outside of health care with a potential for improving patient safety. Pizzi focused specifically on Crew Resource Management (CRM)—a sub-domain of team training—and its implications for health services.[5] These researchers concluded that the application of CRM to medicine has tremendous potential, based on its successes in the aviation industry, though additional research on this patient safety practice in health care is warranted. This review will address the full spectrum of team training research and, for the first time, its application to the field of medicine. Furthermore, it presents a comprehensive review and evaluation of the efficacy of current *medical* team training initiatives. Finally, it will present an overview of specific requirements for future research.

The Structure of the Evaluation

Subsequent chapters in this report will examine the evidence concerning patient safety outcomes and the potential impact of training personnel as medical teams. Chapter 2 defines the key characteristics of a team and describes the principles that serve as a foundation for successful teamwork and effective team training. Chapter 3 summarizes and evaluates research on the interrelationship between teamwork and safety in high-risk settings. Chapter 4 introduces current trends and relevant issues in medical-team training. Chapter 5 provides a conclusion and makes recommendations based on the materials used to frame the review. Finally, Chapter 6 suggests directions for future research into the realm of medical-team training.

Methodology

Systematic methods for gathering and reviewing relevant documentation were employed in the course of this review. We began by searching the PsycARTICLES®, PsycINFO®, and Sociological Collection® databases for those articles on teams, teamwork, and Crew Resource Management (CRM) training with relevance to commercial or military aviation. Additionally, we conducted searches for journal articles involving medical-team training, or key terms such as “crew resource management,” “cockpit resource management,” “medical error,” “team training and aviation,” and “team training and medicine”, using the same databases, as well as MEDLINE® and HealthSTAR®.

Other key terms we used in searches included “team training” and medical specialties, such as “anesthesiology,” “obstetrics,” “gynecology,” “emergency medicine,” and “geriatrics.” Searches also were conducted using specific medical team training program names, such as MedTeams™, Medical Team Management, Anesthesia Crisis Management, and Dynamic Outcomes Management. Parallel searches, using the same key terms, were conducted with the aid of Internet search engines to uncover any unpublished studies on these topics. The reference lists from each of the articles were used to identify additional resources, after which we contacted experts in the field to obtain unpublished technical reports and in-press manuscripts.

These searches resulted in numerous journal articles and book chapters on teams, teamwork, team training, CRM training, and aviation. At the same time, little information about “medical team training” was revealed. Articles on team training efforts in geriatrics and anesthesia settings were uncovered, as were references to copyrighted programs such as MedTeams, and proprietary programs such as Medical Team Management, Anesthesia Crisis Management, and Dynamic Outcomes Management. We also found articles on the use of simulators in medicine, particularly in anesthesia.

The findings from these searches are presented in the following chapters. It is important to note that particular domains of team performance and training literature have been emphasized in the development of this report. Specifically, we focused our attention on research involving parallel, high-stress, and high-risk environments (e.g., military and commercial aviation) where the consequences of error are extreme.

We believe these environments to be the most comparable to that of medicine. For example, the operating room, labor and delivery, and the emergency room are all high-stress, high-workload, dynamic decision-making, technology-intensive environments where errors could result in death. These environments are quite similar to those of a commercial airliner cockpit during a complicated landing approach, a Navy Combat Information Center (CIC) during an air-threat exercise, or a P-3 submarine hunter aircraft on a mission to identify and track subsurface threats. Therefore, we have placed much less emphasis on the large volume of writings centered on teams and their critical contributions to organizational effectiveness—these can be found in the management literature.

While important lessons can be learned from reviewing organizational studies, the most relevant and most appropriate evidence-based literature for improving patient safety through medical team training is represented in the review that follows.

Chapter 2. Training Teams

Definitional Issues Concerning Teams and Teamwork

Teams and teamwork strategies have received an increased amount of attention over the past 20 years.[6–10] Numerous articles and books have specifically addressed issues critical to team performance.[7, 9, 11–14] In fact, organizations that do not rely on teams—at least to some extent—are scarce.

The research literature reflects the prevalence of teams in the workplace, with a substantial agreement as to their defining characteristics. Inconsistencies in the various definitions are due, at least in part, to the reality that the team concept serves a variety of purposes (e.g., learning, producing a product, solving problems, gaining acceptance), it takes on numerous forms (e.g., virtual, co-located), it is adjustable in its size, and equally versatile in its longevity (e.g., *ad hoc*, long term).[15]

What is a "Team"?

We reviewed several often-cited definitions of a team, as well as other relevant literature, to identify the key features for the purposes of this project.[7, 16–18] The definition we adopted is the embodiment of these five characteristics:

1. Teams consist of two or more individuals.

2. Team members have specific roles, perform specific tasks, and interact or coordinate to achieve a common goal or outcome.[7, 18, 19]

3. Teams make decisions.[20]

4. Teams possess specialized knowledge and skills and often function under conditions of high workload.[20–22]

5. Teams differ from small groups in that teams embody a collective action arising out of *task interdependency*.[23] Teamwork characteristically mandates an adjustment on the part of team members to one another, either sequentially or simultaneously, in an effort to accomplish team goals.[24]

Examples of teams that fit this definition include military command-and-control teams, aircraft flight crews, police SWAT teams, fire/rescue teams, and management teams. This same definition also is applicable to health care providers, describing medical emergency teams, intensive care units, labor and delivery units, neonatal care units, and operating room teams, to name a few.

Defining the essence of a "team" is a necessary first step in the creation of a value system that reflect team inputs, team processes, and team outcomes. In turn, these same quantifiable values provide a framework of principles on which any specific training program is based, and against which the program's effectiveness will be assessed.

The Nature of Effective Teamwork

Teamwork is traditionally described using systems theory, which posits that team inputs, team processes, and team outputs are arrayed over time. Team inputs include the characteristics of the task to be performed, the elements of the context in which work occurs, and the attitudes brought forth by its members to a team situation. Team processes are the interactions and coordination necessary on the part of team members to achieve specific goals. Team outputs consist of the products derived from the team's collective efforts.[25–27] Thus, teamwork occurs in the process phase, during which designated members interact and collaborate to achieve the desired outcomes. Finally, teamwork does not require team members to work together permanently; it is a sustained effort performed using a shared set of teamwork skills, not by permanent assignments that carry over from day to day.[28]

Conversely, the installation of a team structure in an organization does not automatically result in effective teamwork. Effective team performance requires a willingness on the part of team members to cooperate in the service of a shared goal, such as the goal of improving patient safety and the creation of a treatment environment free from medical errors. Moreover, effective teamwork depends on effective communications within the team, along with adequate organizational resources and support. In short, teamwork requires a shared acknowledgement of each participating member's roles and abilities. Without this acknowledgement, adverse outcomes may arise from a series of seemingly trivial errors that effective teamwork could have prevented.

Extensive research has yielded numerous models of effective teamwork.[29–33] Historically, the literature focused on the identification of generic teamwork skills associated with most teams. That focus has shifted more recently, however. Newer studies seek to identify the specific competency requirements exhibited by individual team members.[21, 31, 34] Although the term *competency* holds a variety of meanings, it is generally used to denote the qualities needed by a jobholder.[35] More specifically, Parry[36] defined *competencies* as a cluster of related knowledge, skills, and attitudes that (1) affect a major part of one's job (i.e., one or more key roles or responsibilities); (2) correlate with successful job performance; (3) can be measured against well-accepted standards; and (4) can be improved through training and development.

Generally speaking, team competencies are the attributes team members need to possess, if they are to engage successfully in teamwork. Cannon-Bowers and colleagues[21] further suggest, "… It is essential to understand the nature of competencies required to function in a team as a means to define selection criteria, design and conduct training, and assess team performance." The researchers identified three types of competencies that are critical for effective teamwork: (1) teamwork-related knowledge, (2) teamwork-related skills, and (3) teamwork-related attitudes. Table 1 lists and defines primary competencies in each of these categories.

Table 1. Primary teamwork competencies

Knowledge competencies	
Competency	**Definition**
Cue/strategy associations	The linking of cues in the environment with appropriate coordination strategies.
Shared task models/situation assessment	A shared understanding of the situation and appropriate strategies for coping with task demands.
Teammate characteristics familiarity	An awareness of each teammate’s task-related competencies, preferences, tendencies, strengths, and weaknesses.
Knowledge of team mission, objectives, norms, and resources	A shared understanding of a specific goal(s) or objective(s) of the team as well as the human and material resources required and available to achieve the objective. When change occurs, team members’ knowledge must change to account for new task demands.
Task-specific responsibilities	The distribution of labor, according to team members’ individual strengths and task demands.
Skill competencies	
Mutual performance monitoring	The tracking of fellow team members' efforts, to ensure that the work is being accomplished as expected and that proper procedures are followed.
Flexibility/adaptability	The ability to recognize and respond to deviations in the expected course of events, or to the needs of other team members.
Supporting/back-up behavior	The coaching and constructive criticism provided to a teammate, as a means of improving performance, when a lapse is detected or a team member is overloaded.
Team leadership	The ability to direct/coordinate team members, assess team performance, allocate tasks, motivate subordinates, plan/organize, and maintain a positive team environment.
Conflict resolution	The facility for resolving differences/disputes among teammates, without creating hostility or defensiveness.
Feedback	Observations, concerns, suggestions, and requests, communicated by team members in a clear and direct manner, without hostility or defensiveness.
Closed-loop communication/information exchange	The initiation of a message by a sender, the receipt and acknowledgement of the message by the receiver, and the verification of the message by the initial sender.
Attitude competencies	
Team orientation (morale)	The use of coordination, evaluation, support, and task inputs from other team members to enhance individual performance and promote group unity.
Collective efficacy	The belief that the team can perform effectively as a unit, when each member is assigned specific task demands.
Shared vision	The mutually accepted and embraced attitude regarding the team’s direction, goals, and mission.

Table 1. Primary teamwork competencies (continued)

Team cohesion	The collective forces that influence members to remain part of a group; an attraction to the team concept as a strategy for improved efficiency.
Mutual trust	The positive attitude that team members have for one another; the feeling, mood, or climate of the team's internal environment.
Collective orientation	The common belief that a team approach is more conducive to problem solving than an individual approach.
Importance of teamwork	The positive attitude that team members exhibit with reference to their work as a team.

Teamwork-related Knowledge

Team knowledge competencies are the principles and concepts that underlie a team's effective task performance. Broadly speaking, selected members should know the range of skills required, when particular behaviors are appropriate, and how the skills and behaviors are manifested in a team setting, if they are to function as a team. Furthermore, each member should know the team's mission and goals, as well as an awareness of each member's roles and responsibilities in achieving them. This shared knowledge enables team members to better communicate and coordinate the different tasks they need to accomplish, thereby achieving successful team performance.

Teamwork-related Skills

Team-skill competencies, defined by Cannon-Bowers and colleagues as the learned capacity to interact with other team members at some minimal level of proficiency, have received considerable research attention. But the same scientists contend the spectrum of literature regarding skill labels and definitions is confusing, contradictory, and plagued with inconsistencies.[21] Across studies, different labels are used to reference the same teamwork skills, while identical labels are used to describe different skills.

Our study recommendations will address the necessity of developing a standard competency nomenclature, in an effort to mitigate this confusion in future research. For example, in an attempt to resolve earlier inconsistencies, Cannon-Bowers and colleagues found that 130 skill labels could be sorted into eight major categories: adaptability, situation awareness, performance monitoring/feedback, leadership, interpersonal relations, coordination, communication, and decisionmaking. Previous investigations have shown these skills to be directly related to effective team performance.

Nevertheless, a number of investigations have demonstrated the difficulty of measuring more than four distinct skill competencies during scenario-based training.[39–41] In light of this finding, the best skills to include in an assessment are those that are crucial, teachable and measurable. One research study exemplifying this principle[42] involves the identification of four teamwork skill competencies related to the performance of air traffic control (ATC) teams—information exchange, supporting behavior, team feedback skill, and flexibility. A subsequent study by the same research group[41] reliably and accurately measured these competencies during Navy combat-information-center team-training scenarios.

Teamwork-related Attitudes

Team attitude competencies have been defined as internal states that influence a team member's decision to act in a particular way.[21, 43] Positive attitudes toward teamwork and a mutual trust among team members are critical to successful team processes.[44–46]

For example, Vaziri and colleagues[47] found that higher levels of mutual trust among team members led to a more harmonious and productive team environment. A later study[6] reported a difference between independent-minded members of a team, who tend to equate success with competition, and group-oriented team members, who tend to endorse the opposite view. In this study, the group-oriented team members performed a team decisionmaking task significantly better than did their independent-minded peers because of the labor-sharing benefits of teamwork. Furthermore, the group-minded workers were permitted to consider other team members' behavior and believed that a team approach was superior to a solo approach. Thus, as Eby and Dobbins suggest, membership in a team (i.e., a collective orientation) contributes to a positive team attitude.[48]

Contextual Factors

Effective teams do not function in a vacuum. Tannenbaum and colleagues[49] have proposed an integrative model of team effectiveness that includes individual characteristics (e.g., ability, motivation) and team characteristics (e.g., power distribution, cohesiveness) relevant to successful team performance. It should be noted that this model also takes into consideration the importance of organizational characteristics, such as reward systems and organizational climate; task characteristics, such as task type; and work structure characteristics, such as team norms.

Summary

In summary, teams know things, do things, and experience things; moreover, they know, do, and experience within the context of specific environments. A team's utility and efficiency is tied directly to its team members and their ability to integrate various personal and situational characteristics. Each team member must understand the technical and tactical considerations of the assigned task, as well as the strengths and weaknesses of his or her teammates. In addition to carrying out their own responsibilities and altering them when necessary, all members also must monitor their teammates' activities and diffuse potential team conflicts. Effective teams exhibit these competencies while maintaining a positive emotional attitude toward the team itself.

Training Teams

Team training could be described as the application of instructional strategies based on well-tested tools (e.g., simulators, lectures, videos) to a specific set of competencies.[50, 51] Effective team training reflects general learning theory principles, presents information about requisite team behaviors, affords team members the necessary skills practice, and provides them with remedial feedback.

Much research has been devoted to effective strategies and techniques for training specific team knowledge, skills, and attitude competencies. A comprehensive review of this research has resulted in an extensive collection of principles and guidelines concerning the design and delivery of team training. For example, guidelines exist for assertiveness training, cross-training, stress-management training, and team self-correction.[41, 52–54]

The team competencies presented in Table 1 are a useful supplement to the team-training research and practical guidance, in the design of team-training programs. Cannon-Bowers and colleagues contend that team knowledge, skill, and attitude competencies should serve as the starting point for training needs analyses.[21] Trainers then must specify appropriate training strategies, as their second priority. To meet this requirement, Cannon-Bowers and colleagues offer detailed information on the development of particular team competencies and strategies that are likely to be successful. For example, they suggest that groups employing team-specific competencies should train as intact teams. Furthermore, this training should include a feedback component that encourages team members to share their task-performance expectations. Team members also should be encouraged to explain the rationale behind their behaviors, as they perform specific tasks. Such strategies provide useful insight into the way each team member processes information, while enabling their peers to better predict one anothers' behavior and information needs.

Finally, the success of a team-training program depends on more than the development of team members' knowledge, skills, and attitudes. For example, the influence of organizational factors above and beyond a training program mandates a needs analysis be conducted to determine the best delivery method or instructional strategy for a given training intervention. In addition, training aides, such as outlines, diagrams, graphic organizers, may be used in conjunction with preparatory information, prepractice briefs, attentional advice, goal orientation, and meta-cognitive strategies, for additional practice opportunities.[55] Table 2 provides an overview of various strategies, each matched with the most appropriate level of training.

Table 2. Individual and team-level training strategies

Strategy	Definition	Level	Sources
Assertiveness training	Uses behavioral modeling techniques to demonstrate both assertive and nonassertive behaviors; provides trainees with practice and feedback opportunities.	Individual	Smith-Jentsch, et al, 1996
Meta-cognitive training	Develops those skills that regulate cognitive thinking abilities, such as inductive and deductive reasoning.	Individual	Jentsch, 1997
Stress Exposure Training (SET)	Provides coping strategies to help trainees better respond to various stressors.	Individual and team	Driskell, Johnston, 1998
Simulator training	Reproduces in a classroom environment the same conditions, equipment, and performance demands that trainees will experience on the job.	Individual and team	Salas, Dickinson, Converse, et al, 1992
Team training	Provides interventions that (a) convey information; (b) demonstrate teamwork behaviors and skills; (c) encourage practice, and; (d) include feedback to help trainees achieve the necessary proficiencies, at the individual and team levels.	Team	(a) Salas, Cannon-Bowers, 2000; (b–d) Salas, et al, 1997

Table 2. Individual and team-level training strategies (continued)

Cross-training	Trading roles and tasks among team members, so that each may develop a better appreciation and facility for coworkers' responsibilities and overall team goals.	Team	Salas, et al, 1997; Volpe, Cannon-Bowers, Salas, et al, 2001
Team coordination training/Crew Resource Management	Training to improve task management skills and communication (both explicit and implicit), to encourage backup behaviors, and to provide practice opportunities for members of a particular workplace community.	Team	Entin, Serfaty, 1999; Bowers, Blickendersfer, Morgan, 1998
Team building	Focuses on improved role clarification, goal-setting exercises, problem solving skills, and interpersonal relations.	Team	Salas, Rozell, Mullen, et al, 1999
Self-correction training	Helps individuals and teams monitor, evaluate, and revise deficient behaviors, through instructive feedback.	Individual and team	Smith-Jentsch, et al, 1998; Blickensderfer, Cannon-Bowers, Salas, 1997

We turn now to a brief description of some of the most commonly used training strategies. A thorough training program might incorporate multiple methodologies.

Simulator-based Training

The similarity of the training environment to the actual conditions under which the team will perform is an important factor in team training design. Training environments should reflect one or more of three conditional elements: stimulus fidelity (i.e., trainees are exposed to the same "behavioral trigger" they will experience on the job); response fidelity (i.e., trainees react to triggers with the same behaviors that they will perform on the job); and equipment fidelity (i.e., trainees use the same materials and equipment that they will use on the job).[18] Simulator training is especially well-suited to medical fields like surgery, emergency medicine, neonatal care, etc., because the realism of the training environment closely mirrors the work environment. In fact, some researchers suggest that training be conducted under the same stressful operating conditions that the team will encounter in the field.[54]

Realistic simulations do not translate directly to training effectiveness. But the best simulations reproduce realistic tasks and afford trainees the sort of practice that enhances learning.[56] Simulators also allow users the opportunity to practice both team- and task-related skills. Context-specific information, imbedded within the simulations, cue specific learned behaviors in the trainees. In addition, simulators provide opportunities for feedback on the actions, activities or strategies performed or overlooked by team members. Simulation training also benefits training instructors, enabling them to identify performance decrements and particular situations in which further training is needed.

Finally, a strategy that might be considered a subset of simulation training—scenario-based training (SBT)/event-based approach to training (EBAT)—has been shown to improve the performance of individuals and teams working in technology-rich environments. SBT/EBAT presents the training exercise itself as the curriculum, and is based on the systematic linkage aspects of scenario design, development, implementation, and analysis. It relies on controlled exercises or vignettes, in which the trainee is presented with cues that are similar to those found in the actual task environment. The SBT/EBAT training objectives are accomplished by embedding specific "trigger" events into the scenario or exercise, and trainees receive feedback reflective of their responses.

The primary goal of SBT/EBAT is to provide trainees with critical competencies, developed through practice in simulated environments modeled on actual operational conditions, and feedback linked to specific training events. SBT/EBAT has been tested empirically and demonstrated in a variety of team-training environments.[57, 58] This scenario- or vignette-based technique shows great promise as a strategy for training care providers who must coordinate their efforts—especially in environments with multiple patient safety threats (e.g., emergency rooms, intensive care units).

Team Coordination Training

Another widely used strategy for training groups of workers is team coordination training (TCT). TCT emphasizes the basic processes underlying teamwork and typically involves several team skills necessary for a successful outcome in a particular performance environment. This type of training usually is delivered by means of a combination model, using formal instruction, demonstrations (e.g., video examples), and practice-based methods (e.g., role-playing). Research supports its effectiveness in measures of positive reactions, enhanced learning, and behavioral change.[9, 39] When used in the aviation industry, this strategy also is referred to as Crew Resource Management (CRM) training. CRM (to be discussed more throughly in the next chapter) is a family of instructional strategies that seeks to improve teamwork in the aircraft flight deck setting through the introduction of simulators, lectures, and videos targeting specific content (i.e., teamwork knowledge, skills, and attitudes).[38] Additionally, CRM has served as a model for much of the existing medical-team training.

Team Self-correction Training

The previous three training methods noted here—self-correction training, cross-training, and stress-exposure training—each involve strategies that trainers can incorporate at their discretion. Self-correction is a naturally occurring process for effective teams. It often occurs at a meeting following a performance episode and involves discussions of individual and team errors, as well as tactics for preventing the same errors in the future. As this process focuses on error identification and correction, it has particular relevance to medical team performance in a patient safety context.[59]

Self-correction training—delivered through a combination of lectures, demonstrations, practice, and feedback—analyzes the error identification and correction process and trains teams to practice it. Team members learn to observe their collective performance, categorize effective and ineffective behaviors, and present them in a structured format. They can then evaluate each aspect of the performance and provide one another with constructive feedback.[55] When guided by a competent instructor, this method of team training has been demonstrated to improve team performance.

Cross-training

Cross-training exposes team members to the basic tasks, duties, and responsibilities of their peers, and is intended to promote coordination, communication, and team performance. Ideally, this training alleviates the decline in performance that is likely to follow personnel changes; it has the secondary benefit of improving implicit coordination (i.e., directing various activities without the need for explicit communication). The training is centered on shared cross-role information (teammates, task, equipment, situation); enhanced understanding of the team members' roles, responsibilities, and interdependencies; and cross-role task practice and feedback. Research has demonstrated that cross-trained teams better anticipate the informational needs of their teammates, commit fewer errors, and display a higher quality of team process, compared with their counterparts who were not cross-trained.[53] Again, these advantages are germane to medical teams and their performance in a manner conducive to patient safety.

Stress-exposure Training

Stress can be a considerable negative influence on individual or team performance, especially in high-stress environments characterized by ambiguous goals and severe time limitations (e.g., military operational environment, medical emergency departments). Stress-exposure training (SET) emphasizes a three-phase methodology designed to reduce the debilitating effects of stress through trainee instruction, skills training, and practice. SET improves performance by providing a safe-but-stressful training environment similar to that in which the users will work. There, skills are practiced under graduated exposure to different stressors. Documented SET outcomes include reduced anxiety in stressful situations, increased confidence, and improved cognitive and psychomotor performance under stress.[54] Given the life-altering nature of decisions routinely required of emergency medical teams, successful stress coping would seem to be an especially pertinent skill for these care providers.

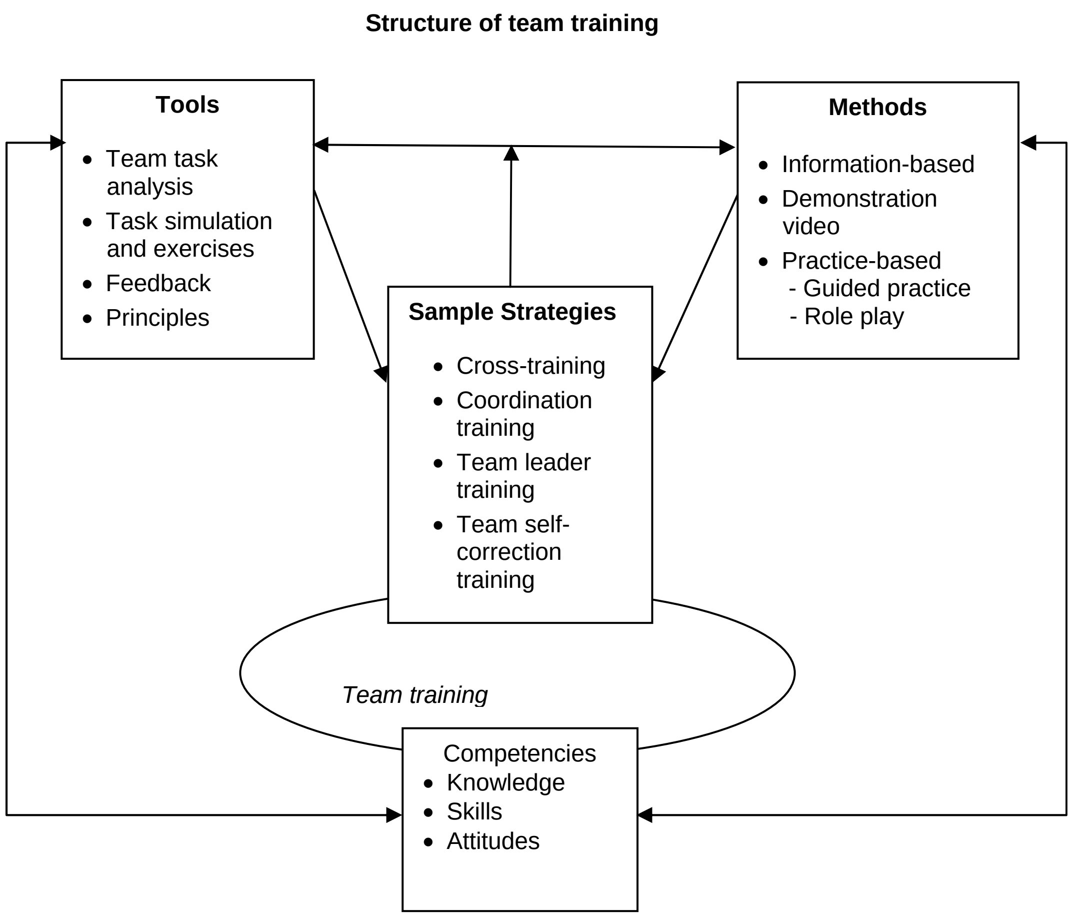
Meta-cognition Training

Finally, meta-cognition training teaches team members to monitor and modify their decisionmaking processes, rather than focusing on the outcomes of individual decisions. Such training develops reasoning and problem-solving strategies applicable to the challenges encountered by the team. This strategic aspect of decisionmaking is particularly useful in managing stressful situations.[60]

Methodology Conclusions

As our discussion of the aforementioned strategies demonstrates, team training is not a destination; rather it is a journey and an intervention based upon sound instructional principles and carefully crafted instructional strategies. Figure 1 provides an overarching framework that illustrates the factors necessary to the design and delivery of an effective training program.[55]

Figure 1. Framework for designing an effective team training program*



**Adapted from Cannon-Bowers, Salas[55]*

Summary

Well-organized and high-performing teams exhibit a sense of collective efficacy. Their members recognize a dependence upon one other, and share the belief that they can solve complex problems by working together. Moreover, effective teams are dynamic: the members optimize their resources, engage in self-correction, compensate for one another with back-up behaviors, and reallocate functions as necessary. Because they often can coordinate without overt communication, effective teams can respond efficiently in high-stress, time-restricted environments. Finally, effective teams possess the means to recognize potential difficulties or dangerous circumstances and adjust their strategies accordingly.

To design training strategies that will improve teamwork skills on the job is a challenge. Teams operate in complex and dynamic environments that are characterized by multi-component decisions, rapidly evolving and ambiguous situations, information overload, severe time constraints, and harsh consequences for mistakes.

Yet team training is charged with improving trainee competencies (e.g., knowledge, skills, attitudes) and achieving desirable performance outcomes (e.g., timely and accurate response, reduced patient safety risks, improved quality of care) under these demanding conditions. This chapter makes the argument that effective training programs (1) blend evidence-based theory with a thorough needs analysis; (2) provide trainees with information, demonstrations, guided practice and timely diagnostic feedback; and (3) reflect organizational cultures that encourage the transfer of the trained competencies to the task environment.

Chapter 3. Team Training in High-risk Contexts

Team Training in Commercial Aviation

Because it is an industry where mistakes can lead to an unacceptable loss of life and property, commercial aviation has been at the forefront of risk reduction through teamwork training. Among the best-known team training strategies to emerge from the aviation setting is Crew Resource Management (CRM) training. CRM training has endeavored to improve the margin of aviation safety for more than 30 years.

Recent research suggests that CRM training has led to heightened safety-awareness attitudes; improved communication, coordination, and decision-making behaviors; and enhanced error-management skills.[14, 61] CRM training also has demonstrated consistently positive results across a wide range of team structures, including flight crews, maintenance teams, dispatchers, and air traffic control teams.[62–64]

Furthermore, CRM training has advanced significantly through different generations.[65] Once focused solely on awareness and attitude changes, the field of CRM has expanded to blend behavioral skills and teamwork training concepts with technical flying techniques, as seen in the Federal Aviation Adminstration's (FAA) new Advanced Qualification Program (AQP). Recent studies suggest that CRM training cultivates positive reactions to teamwork concepts, increased knowledge of teamwork principles, and improved teamwork performance in a situational simulator.[66] In addition, pilots trained using the AQP model claim to better enjoy training, perceiving it as function-oriented and useful activity.[67]

CRM's impact on the most important criterion—the number of human-attributed accidents—has yet to be empirically established.[66] Moreover, accidents are a poor benchmark for comparison because of their extremely low rate of occurance.[62] Researchers instead have relied on surrogate measures, such as improvements in teamwork-related knowledge and skills; demonstrations of CRM skills during flight simulations; flight instructor evaluations; and changes in an organization's safety culture to demonstrate CRM training effectiveness.[62, 66, 69–72]

Viewed in isolation, each piece of evidence concerning the effectiveness of CRM training can be disputed. Nevertheless, the pattern of results suggests that CRM training does improve the margin of aviation safety. In short, the scientific evidence appears to support a reasonable inference that gains achieved during training in critical teamwork-related competencies can transfer directly to actual flights and flight safety, provided the application of learned skills by the trained individuals is consistent.

Evolution of the CRM Model in Commercial Aviation

Many commercial airlines actively recruited individuals who previously had flown for the military, to meet the demand for qualified pilots. These pilots brought with them a culture that valued respect for authority and reluctance to question orders, even in situations where the orders contradicted standard operating procedures. The earliest CRM training programs, developed during the 1980s, were designed to offset this military mindset. They were structured in such a way as to decrease authoritarianism among flight crew captains, while at the same time encouraging assertiveness among the first officers.[65]

Many of these programs were based on a leadership development course that was popular at the time, the Managerial Grid.[73] Drawing on research from the manufacturing industry, this model called upon managers to direct their subordinates' task-related efforts, while at the same time remaining considerate of the workers' feelings.[74, 75] The early CRM programs did much to educate pilots about the importance of teamwork in a cockpit setting**,** but because the programs focused on generalized CRM concepts, rather than specific behavioral skills, they were not universally accepted.[65]

The National Aeronautics and Space Administration (NASA) hosted an aviation industry conference in 1986 aimed at identifying the best practices in CRM training.[76] The participants identified a number of strategies with the potential to improve CRM training effectiveness. One such strategy emphasized behavior-based training for specific teamwork skills including communications, situational monitoring, decisionmaking, and stress management. Another recommendation involved the use of behavioral models to contrast effective and ineffective teamwork behaviors in the cockpit. These changes helped the pilots to accept the validity of CRM training.[65]

Several aircraft manufacturers made automated navigation and propulsion controls a standard cockpit feature in the early 1990s—an advance that fundamentally changed the nature of flying. Flight crews began to control the aircraft through the use of electronic systems, abandoning the old-fashioned steering yoke and rudder pedals. In essence, pilots became information managers who intervened only when changes were necessary or when unanticipated situations arose.[77, 78]

The advent of automation ushered in a new series of problems, among them mode-awareness errors (i.e., the automation does something that the crew had not expected) and complacency errors (i.e., the crew fails to monitor the automation).[77, 78] The airlines began offering their flight crews special courses in automation management and combined CRM training with technical skills training to remedy these problems. At present, all commercial airlines are required by the FAA to provide their flight crews with CRM skills training, including the high-fidelity Line Operational Simulations (LOS) that mimic realistic flight conditions.[79, 80] These programs are part of a federally recommended approach that provides trainees with the instructional information, practice and feedback, and recurrent training opportunities necessary to become safe pilots.[81] This approach has a proven track record and remains the hallmark of CRM training, wherever it is implemented.

The FAA initiated the Advanced Qualification Program (AQP) in the 1990s, as a voluntary alternative to standardized pilot flight certification.[82, 83] AQP differs from traditional airline pilot training in its less regimented, skills-based training strategy. The standardized flight training formally used across all airlines requires trainees to devote a specific number of hours to practicing each skill or set of skills. AQP requires trainees to demonstrate proficiency in a skill, regardless of how few or many hours necessary to achieve the standard. Moreover, AQP blends CRM techniques and technical skills throughout the training curriculum; conventional training includes CRM as a stand-alone topic. AQP training culminates with whole cockpit crews flying a simulation-based evaluation of CRM and technical skills, rather than the standard maneuvers check used to certify pilots for passenger flying. Most of the nation's major air carriers presently train some or all of their fleets using the AQP. Recent research suggests that AQP-trained pilots enjoy their training more and perceive it as more realistic and more useful, than do their conventionally trained counterparts.[67, 68]

CRM Summary

CRM training, as it is currently practiced, focuses on trainable, measurable skills crucial to successful performance outcomes. As such, the component theories of CRM are applicable to any medical domain in which effective teamwork has been shown to reduce errors and enhance patient safety.

Team Training in the Military

A second high-risk context in which the consequences of error can be dire is military service. Not surprisingly, the armed forces have contributed significantly to the growth and advancement of team training concepts.

The History of Military Team Training

Despite the fact that teamwork has long been recognized as one of an armed fighting unit's most important assets, structured team training has been adopted only recently by our military services. Team training originally focused on the role of the team leader. Team spirit and teamwork were regarded as the unit commander's responsibility.[84, 85] The trend toward more distributed team training began with work by Briggs and his colleagues in the mid-1960s and early 1970s.[86] These researchers distinguished team or unit skills from individual, task-related skills**,** and in doing so demonstrated the military potential of coordinated team training. The Navy and the Army sponsored similar research into team performance.[87, 88]

A watershed moment for military team training research came in 1988, after the naval warship USS Vincennes fired inadvertently on an Iranian commercial airliner over the Persian Gulf. In the wake of the tragic shootdown, the Navy began a multiyear, multimillion dollar research program to formally study teamwork and team training interventions. The program, known as Tactical Decision Making Under Stress (TADMUS), began in 1990 and led the Navy to breakthrough advances in team training. As noted by William Howell, then head of the Science Directorate of the American Psychological Association, "By almost anyone's standard, TADMUS has turned out to be an unqualified success."[89] Results of the Navy's program have brought about new approaches to team training. Interpositional knowledge training (cross-training), mental-model training, and team self-correction training all have become essential components of the current team training model.

Later, in the 1990s, the Air Force and the Army also commissioned theoretical and applied research into team performance and team training.[90, 91] Both programs spurred further advances in team training techniques.[91] In fact, as Salas, Bowers, and Cannon-Bowers pointed out in 1995, "Much (had) been accomplished since Dyer's (1984) seminal review."

Military Team Training in the Present

Most branches of the U.S. Armed Forces currently invoke some type of team training approach. For example, all branches of the Armed Forces provide pilots and other aircrew members with military CRM training, ranging from Fighter Resource Management (FRM) for single-seat fighter pilots to CRM training for the large crews that fly transport and patrol aircraft.[92] Military aviation team training is again coopting the best practices of civil aviation—including the Advanced Qualification Program—and combining them with traditional training and cutting-edge technology.

Pilots and other aircraft crewmembers are not the only ones to benefit from team training techniques. Sailors, soldiers, airmen, and Marines also are learning to function in highly coordinated teams. For example, the Navy has tested several team-training approaches and recently adopted an approach called Team Dimensional Training (TDT), an outgrowth of the TADMUS program.[41] TDT helps teams to analyze and correct their operational mistakes, while at the same time teaching team leaders to guide their members through the self-correction process. The techniques have been introduced in settings as diverse as submarine attack center teams, seamanship and shipboard damage control teams, naval aircrews, and surface warfare teams.

The importance of military team training will continue to grow, given the current trends toward combined-arms operations, improved communications and control, and increasingly complex weaponry. New training development and delivery technology—including scenario-generation software, virtual environments, and distributed-simulation facilities—has made it possible for widely dispersed personnel and units to train together and to exchange feedback. In response to these innovations, team training and team-training researchers must sharpen their focus, to combine results from research on teams with existing and emerging technologies.[95]

Additionally, team performance measurements and the adoption of advanced training technologies will give rise to new issues.[96, 97] The military, for example, will face the challenge of incorporating into team training such emerging research topics as meta-cognition, team adaptation, and stress management.[54, 98, 99]

Summary

Given that serious misfortunes resulting from human error are relatively rare in commercial aviation and in military forces not involved in warfare, empirically linking team performance to the “ultimate criterion” of reducing these errors is difficult, at best. Nevertheless, the literature represents a strong argument for the interrelationship between well-coordinated, effective team performance and important proxy criteria, such as adaptability, resourcefulness, readiness, mutual trust, and stress resistance. Additionally, teams yield valuable process-oriented benefits, including cohesion, retention, peer respect, and positive morale.[100, 101]

Given the pervasiveness of these findings, the inference that successful teamwork might substantially reduce severe life-threatening medical errors is not unreasonable. Therefore, we consider the relationships presented as the foundation for this chapter—as well as the more generalized information presented in Chapter 2—to be entirely relevant to medical team training.

Chapter 4. Medical Team Training

The Case for Medical Team Training

Small groups of individuals work together throughout the health care community, in intensive care units (ICU), operating rooms, labor and delivery wards, and family-medicine practices. Physicians, nurses, pharmacists, technicians, and other health professionals must coordinate their activities, if safe and efficient patient care is to be a priority. Teams make fewer mistakes than do individuals, and this is especially true when every member of a team is as aware of their teammates' responsibilities as they are their own.

But the members of these teams are rarely trained together. Moreover, they often come from distinctly different disciplines and diverse educational backgrounds, even though the myriad conditions addressed by health care professionals require interdisciplinary teamwork. The varied nature of the work and the necessity for cooperation among those who perform it make team training an ideal tool in the drive to improve patient safety and reduce medical errors.

As the lead Federal agency supporting research into health care quality and patient safety improvements, the Agency for Healthcare Research and Quality (AHRQ) is advocating a shift in the health care community's attitude toward medical errors. The Agency is promoting a medical culture in which potentially life-threatening mistakes are acknowledged for their gravity and analyzed, after which interventions are put in place to prevent their future reoccurrence. In fact, AHRQ awarded grants totaling $50 million in FY2003 to fund a portfolio of research projects aimed at reducing medical errors and improving patient safety practices in clinical settings.[1]

These funds support investigative research into such topics as adverse drug events, infection control, surgery and anesthesia, pain management, organizational/cultural issues, human factors, and information technology.[102] Team training programs and CRM—which fall under the domain of human factors—are one means for bringing about this revised cultural mindset regarding medical errors.

Moreover, AHRQ is not the only group to acknowledge the value of teamwork in the professional medical environment. The Accreditation Council for Graduate Medical Education (ACGME) recently required surgical residents-in-training to demonstrate their mastery of several teamwork-related competencies. These competencies include effective communications with patients and their families, patient counseling and education, cooperative work-sharing with other health care professionals, and the ability to instruct students and other health care professionals.[103]

Similarly, the Association of American Medical Colleges (AAMC) recently funded an investigation to identify successful and unsuccessful behaviors (e.g., critical incidents) that regularly emerge during medical school and residency. The results underscored the importance of teamwork-related competencies, such as interpersonal skills and professionalism, interacting with patients and family, fostering a team environment, and mentoring/teaching other students.[104]

CRM-based medical team training programs began with the introduction of Anesthesia Crisis Resource Management (ACRM) training at the Stanford University School of Medicine and at

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[1]More on the AHRQ patient safety portfolio and the associated grant awards is available at http://www.ahrq.gov.

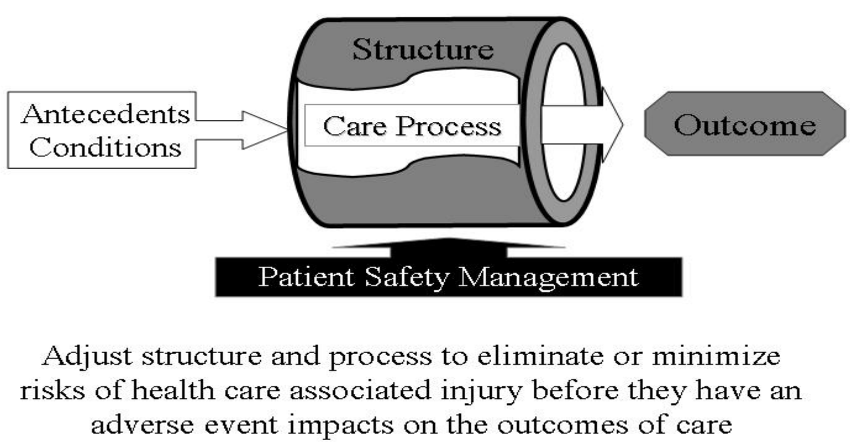
the Palo Alto Veteran Affairs Medical Center.[105] It should be noted that AHRQ's 2001 review of in-place patient safety practices included a critique of the ACRM model, commending the overall impact but**,** at the same time**,** noting a lack of evidence supporting its effectiveness.[5] The Department of Defense (DoD) also has funded several other CRM-derived team training initiatives. The MedTeams™ program[106], in particular, has been implemented in a number of Army and Navy hospitals, while the Medical Team Management (MTM)[10] program has been introduced in several Air Force facilities.

Although some preliminary research has addressed the effectiveness of the ACRM and MedTeams products, research into the competencies needed for effective teamwork in a health care setting and their evaluation remains in a formative stage. This chapter evaluates the state of the art in CRM-derived medical team training and associated best practices. We begin by presenting two theoretical models of patient safety to guide our overview of research issues.

The Donabedian Model of Patient Safety

Donabedian's structure–process–outcome model has long served as a unifying framework for examining health services and assessing patient outcomes.[107] Donabedian defines *structure* as the physical and organizational properties of the settings in which care is provided, while *process* is the treatment or service being provided to the patient**,** and *outcomes* are the results of the treatment. From the standpoint of patient safety, Donabedian's model (shown in Figure 2) provides a patient safety framework, and permits an examination of how risks and hazards embedded within the structure of care have the potential to cause injury or harm to patients. For example, individual or team failures in a health care delivery setting are consistently identified as a leading cause of negative patient outcomes.

Figure 2. The Donabedian Model of Patient Safety[2]



[2] Adapted from Donabedian, 1980.[107]

Coyle and Battles modified the Donabedian model in 1980 to include important antecedent conditions that can affect patient outcomes.[108] Specifically, they suggest that patient and environmental factors are critical to understanding the effectiveness of any new strategies or modifications introduced into the care process. They further emphasize the idea that improved patient outcomes are the **"**ultimate criterion**"**; that is, a change in process must lead to a corresponding positive change in patient outcomes before a strategy can be deemed successful. Under the heading of patient factors, Coyle and Battles include genetics, socio-demographics, health habits, beliefs and attitudes, and preferences. Environmental factors include the patients' cultural, social, political, personal, and physical characteristics, along with factors related to the health profession itself.

These patient safety models, both of which call for processes to be evaluated in accordance with the outcomes they generate, have considerable support within the health care community. Moreover, we believe that the perspective they offer is as vital to the effect of teamwork and team training as it is to the assessment of any other treatment process. As we review the primary medical team training programs currently in use, these two patient safety models will continue to underscore our focus on improved patient outcomes as a measure of effectiveness.

Structure of Review

A number of medical team training programs have been developed in recent years. Some of these programs have been used in military settings, while others were developed more for commercial medicine. Certain programs are domain-specific (e.g., anesthesia), whereas others are multidisciplinary. Some rely heavily on state-of-the-art simulators, while others rely primarily on classroom instruction. Despite their differences, however, each of these programs was inspired by CRM concepts and all share the common goal of reducing the number and severity of medical errors.

The following discussion will compare the purpose, strategy, and effectiveness in three of the best-known medical team training programs: Anesthesia Crisis Resource Management (ACRM), MedTeams, and Medical Team Management (MTM). Since purpose and strategy are closely linked, we will examine both issues simultaneously. We will also describe the extent to which each program incorporates the three defining CRM elements: informational instruction, practice and feedback, and recurrent training opportunities.

Finally, we will also review three lesser-known training programs—Team-Oriented Medical Simulation (TOMS), Dynamic Outcomes Management (DOM), and Geriatric Interdisciplinary Team Training (GITT)—to further highlight the involvement of CRM-derived team training in health care.

Anesthesia Crisis Resource Management (ACRM) Program

ACRM Purpose and Training Strategy

The Anesthesia Crisis Resource Management (ACRM) program is derived from CRM principles, as are the MedTeams and Medical Team Management (MTM) programs. Unlike MedTeams and MTM, however, ACRM encompasses a family of training programs and bears a greater resemblance to CRM aviation training models than do the other two programs.

Developed by David Gaba and his colleagues at Stanford University and the Palo Alto Veteran Affairs (VA) Medical Center, ACRM is designed to help anesthesiologists better manage crises by working in multidisciplinary teams that include physicians, nurses, technicians, and other medical professionals.[58, 105, 109] ACRM training provides trainees with precompiled responses to a vast array of critical incidents and, in turn, the trainees refer to these responses as needed.[110] Training in 10 teamwork skills better enables trainees to learn from adverse occurrences in the clinical environment, and to work effectively with different personality types.[111] The teamwork skills on which the ACRM program focuses are development of a thorough case orientation, proper inquiries and assertions, communications and constructive feedback, leadership, appropriate group climate, anticipation and planning, workload management and distribution, vigilance, and reevaluation actions.

ACRM training takes place in a simulated operating room (OR) environment, apart from the reading assignments that precede each module. The OR simulator includes actual monitoring equipment, a full-body patient simulator, a video station for recording team performances, and a debriefing room equipped with a variety of audiovisual equipment. The full-body patient simulator incorporates a series of complex mathematical models and pneumatic devices to simulate the patient's breathing, pulses, heart and lung sounds, as well as exhaled CO_2, thumb twitches, and other physiological reactions.[58, 112]

The ACRM curriculum is comprised of 3 full days of simulation training. Day One serves as an introduction to ACRM principles and basic skills. Day Two begins with a skills refresher, after which trainees learn to analyze clinical events from the technical and teamwork perspectives, as well as the systemic viewpoint. Day Three emphasizes leadership training, debriefing skills, and procedural adherence in the face of adverse clinical events. Training topics are organized into modules consisting of assigned preparatory readings, introductory material reviews, simulator familiarizations, case study analyses and videotape reviews. Six hours of different simulator scenarios are followed by instructor-led debriefing and a post-course data collection session. Each simulator training scenario is approximately 45 minutes long and each debriefing session lasts about 40 minutes.[58]

Several instructors are needed to properly facilitate the ACRM training scenarios. They may include an active or retired operating room nurse playing the role of a circulating nurse, and an anesthesiologist instructor who plays the role of an operating surgeon. In addition, a simulation director monitors and videotapes the simulation from another room, communicating with the role-playing instructors via two-way radios. The trainees rotate through various roles during the simulator scenarios, including "first responder," "scrub technician," and "observer."[58]

ACRM training—including an annual refresher training component—is used currently at several major teaching institutions, including Harvard University. Some institutions offer ACRM training for experienced practitioners and for trainees. Moreover, it is sufficiently well respected that some malpractice insurers have lowered their premium structure for ACRM-trained anesthesiologists. The three centers that codeveloped ACRM training also have established the Working Group on Crisis Management Training in Health Care, which provides additional guidance and establishes training standards.[58]

ACRM training was structured around the best practices from CRM training in commercial aviation, including an adaptation of crew performance functions such as the Line/LOS checklist.[109, 113] It should be noted, however, that ACRM focuses solely on the second phase of CRM advocated by the FAA—skills practice and feedback—while the awareness and recurrent training phases have yet to be incorporated.

ACRM has a number of desirable qualities. First, it provides trainees with 3 days of hands-on skills practice in a simulated operating room environment. Second, each scripted training event is followed by a detailed instructor-led debriefing that identifies lessons learned and recommends tactics for further improvement. Because it takes place in a simulator, ACRM training allows trainees to experience situations—including the "death scenario"—that are impossible to replicate in an actual OR. Finally, ACRM uses cross-training to allow each participant to experience the learning process from different perspectives.[58]

Nevertheless, ACRM training evinces certain program limitations that future iterations would do well to address. First, the training is not multidisciplinary in the truest sense. Instructors, not fellow trainees, play the roles of nurses and physicians; in other words, trainee teams do not practice teamwork in ACRM simulations.[110] Given the importance of teamwork skills, we believe that ACRM would benefit from a training strategy that embodies genuine interdisciplinary team training.

On a related note, to the extent that ACRM focuses on the role of teamwork skills in the OR, it emphasizes their application in emergency situations and devotes substantially less attention to the role teamwork plays in nonemergency situations.[110] Thus, ACRM developers might enhance the program's purpose and efficacy with a more even distribution of emergency and nonemergency training scenarios.

Furthermore, the ACRM focus on full-fidelity simulation ignores other forms of learning (e.g., videotaped examples, classroom instruction, case studies, part-task trainers, etc.). Simulation has been shown to be most effective when used to reinforce a previously acquired knowledge base of facts and theories, motor skills, and attitudinal competencies.[112] Accordingly, ACRM might put trainees in the awkward position of participating in the simulator scenarios before they have a complete grasp of the necessary factual background information. Therefore, a greater emphasis on the advance transfer of concepts and information needed to perform effectively in the simulator environment might prove advantageous.

The final limitation surrounding ACRM is one of cost. The training focuses exclusively on the role of the anesthesiologist in the OR—a somewhat limited application, given the initial cost of purchasing a commercial simulator (not to mention the operational costs) can exceed $200,000.[112] The magnitude of such an investment puts an ACRM training program out of the reach of many institutions.

ACRM Effectiveness

An ACRM evaluation typically assesses a variety of process-oriented criteria. Teamwork performance is typically assessed using behavioral markers based on the 10 teamwork skills identified in the previous section.[114] One measure of these teamwork behaviors is a checklist analogous to the Line/LOS Checklist used in commercial aviation CRM programs.[113] Trained raters evaluate team performance on each behavioral dimension, using a five-point scale.[114] Measures of inter-rater agreement exhibit r_{wg} values ranging between .60 and .93;[114, 115] an r_{wg} of .70 is considered sufficiently high to reflect a satisfactory degree of agreement among the raters.[115]

Most of the thousands of ACRM training participants evaluate the experience favorably; these positive responses generally last for up to 6 months after training.[111] Moreover, recent research suggests that participation in ACRM training further increases the trainees' self-worth and decreases their reported anxiety.[116]

Despite these positive assessments, no studies to our knowledge have pursued the next logical step: a detailed investigation into the potential links between team process and patient safety criteria. In fact, virtually no research has tested the effect of any aspect of ACRM training on actual medical performance outcomes. With respect to individual (i.e., technical) performance, this lack of outcome-related validation is, at least in part, due to the difficulties inherent to quantifying the performance of anesthesiologists.[114]

With respect to the effects of the team process, however, the lack of outcome-related validation cannot be so easily explained. Programmed outcomes, such as the "death scenario," are part of the ACRM simulations. We believe that the development of measures to assess teamwork effectiveness, as it relates to facilitating positive outcomes and managing or eliminating negative outcomes, constitutes an important focus for future research. Furthermore—and given the current state of simulation—the development of training scenarios in which the outcome is contingent upon the trainee's demonstrated teamwork skills also might be worthwhile.

The MedTeams Program

MedTeams Purpose and Strategy

The MedTeams training program is based on the CRM training program originally developed to train U.S. Army helicopter crews in specific behavioral skills, and was tailored first to the emergency medicine environment.[106, 117] The MedTeams developers, Dynamics Research Corporation (DRC), had noted a number of similar responsibilities shared by emergency medicine and aviation managers. These include the need to make decisions that are based on incomplete or conflicting information, the requisite coordination among professionals with varied skills and ranks, and the direct relationship between a poor team performance and a potentially grave outcome, including death.[118]

The MedTeams program is designed solely to reduce medical errors through the use of interdisciplinary teamwork. It was founded on the theory that most errors are caused by breakdowns in systems-level processes and are revealed over time.[119, 120] According to the MedTeams curriculum, each team member has a vested interest in patient safety and is expected to take a proactive role, doing everything possible to break the chain of errors.[120] The MedTeams training strategy focuses on generic teamwork skills and behaviors, rather than context-specific competencies, since the makeup of the teams undergoing the training varies from day to day and shift to shift.

The MedTeams training curriculum is the result of an evaluation-driven course design. DRC identified five critical dimensions necessary for effective teamwork, based on needs-analysis data. They further identified 48 specific and observable behaviors linked to these dimensions and constructed Behaviorally Anchored Rating Scales (BARS)[121] for each behavior. Finally, they reviewed and refined the curriculum with the assistance of emergency department (ED) physicians and nurses from 12 hospitals of various sizes, to ensure the validity and effectiveness of the course content.[122]

MedTeams defines a core team as a group of 3 to 10 medical personnel working interdependently during a shift, each of whom has been trained to use identified teamwork behaviors in coordinating their clinical interactions. Each core team includes at least one physician and one nurse.[123] A separate coordinating team oversees several of the core teams simultaneously, assigning new patients and providing each group with additional resources as the need arises. The members of each team wear the same visible armbands, badges, or colored scrubs, to make themselves recognizable to one another and to identify them as members of a particular core team.[120]

The MedTeams course is comprised of an 8-hour block of classroom instruction and a 30-minute video depicting good and bad examples of performance, followed by a 4-hour teamwork behaviors practicum and feedback from a trained instructor. Coaching, mentoring, and review sessions are also provided during subsequent work shifts.[122]

The postclassroom component of MedTeams training lasts approximately 6 months and uses a number of tools such as peer performance monitoring to sustain effective team performance. In addition, regular team meetings reinforce learned concepts while formalized mechanisms**,** such as status boards, are used to update team members with regard to particular patients; refresher training is also made available to those who need it. Additionally, the MedTeams training structure requires nurses to participate in meetings, and performance evaluations for all team members are weighted to reflect teamwork issues.[124] Thus, MedTeams incorporates all three core aspects of the CRM training model.

In summary, MedTeams evidences a number of desirable qualities. First, it was developed through the use of a needs analysis, based on archive records from the EDs of several hospitals. This methodology underscored key performance dimensions, while providing actual patient information used in the creation of specific behavioral markers.[125] Second, customized versions of MedTeams now are being developed for labor and delivery units, ORs, and ICUs.[125] Third, MedTeams offers annual refresher training for the purpose of maintaining proficiency in teamwork skills. Fourth, MedTeams requires trained staff members to participate in development projects or practica aimed at addressing specific intra- and inter-departmental teamwork issues.[126] Fifth, MedTeams provides trainees with physical tools (i.e., checklists, quick reference cards, flow diagrams) that can be reviewed periodically or used in the workplace. Finally, MedTeams training has an interdisciplinary organizational structure, promoting cooperation and shared responsibility among physicians, nurses, technicians, and other key constituencies.

Nevertheless, MedTeams training also exhibits certain limitations. First, much of the 8-hour classroom instruction focuses on the mastery of declarative knowledge. Substantially less time is devoted to the type of skills practice provided in ACRM training. Additionally, MedTeams does not employ a cultural assessment/evaluation component, prior to training implementation. As a result, it is entirely possible that MedTeams training would prove effective only in those hospitals with a prior commitment to teamwork and upper-level management support, as well as an open, nonpunitive atmosphere that treats errors as an learning opportunity and a recognized need for change.[28] (This objection applies equally to all three programs, none of which gathers information from cultural assessments.) Finally, even though MedTeams is based on the "train the trainer" paradigm—in which certified trainers are returned to their workplace environment to train their colleagues—it does not appear to provide any mechanism for preventing trainer performance degradation over time.

MedTeams Effectiveness

The MedTeams evaluation tactics appear to be the most thorough among the three programs examined.[28, 106] A quasi-experimental design was used to assess the relations among various process factors (e.g., quantity of teamwork behaviors) and enabling factors (e.g., attitudes toward teamwork, staff burnout) over a 1-year period. More significant from our viewpoint, the Morey and colleagues' investigations showed some positive effect of training on outcome criteria (e.g., medical errors, patient satisfaction).

The major limitation of this research stems from the fact that participating hospitals were permitted to specify their inclusion into either the experimental or control groups. To address this limitation, a subsequent evaluation of MedTeams training in labor and delivery environments is currently underway, using a randomized clinical trial design.[127] Thus, the MedTeams training developers are focusing their latest evaluations on the criteria that Donabedian and Coyle and Battles deem most critical: patient-related outcomes.[107, 108]

The Medical Team Management (MTM) Program

Miscommunications and the disjointed teamwork that often arises from it led the U.S. Air Force to develop its own variation on the team training theme. Medical Team Management (MTM) training formally recognizes poor communications skills and ineffective teamwork as the primary source of many adverse medical outcomes. MTM training is based on the Air Force's fighter pilot CRM training program, in which team communication is central and tied directly to effective team performance.[128]

MTM Purpose and Training Strategy

The Air Force began to explore the realm of MTM training following an incident at an Air Force hospital involving poor teamwork and a newborn child who was subsequently diagnosed with neurological problems.[129] The structure of MTM training is similar to that of MedTeams training—interdisciplinary teams of medical professionals are provided with human-factors concepts and specialized communications skills, in an effort to reduce medical errors. In contrast to the traditional military medical culture and its focus on individual performance, MTM training attempts to create a new culture of team performance values and improved communication effectiveness, resulting in fewer medical errors.[130]

MTM training is lengthier than either of the other programs. It has two major components: a 3-day instructor-training course, and a military medical personnel course. Potential instructors must have at least 5 years of specialized clinical experience and at least 1 year of duty remaining in the Armed Forces. Furthermore, they must be competent speakers and previous training delivery experience is desirable. Graduates of the instructor training course return to their respective hospitals and clinics, where they train the remaining staff in human-factors principles.[129]

The instructor training course is taught by commissioned doctors and nurses, each of whom has extensive clinical expertise and participation in the course development. Since the MTM training is interdisciplinary, participants include physicians, nurses, medical technicians, lab technicians, pharmacists, ward clerks, and admissions clerks, from inpatient and outpatient settings.[10, 131]

The course for military medical personnel consists of three phases. Phase One is a Web-based training course that provides factual background information on human-factors principles. The course is self-paced and takes 2 to 4 hours to complete.[128, 132] It includes a series of pre- and post-training tests to assess the participant's grasp of human-factors concepts.

Phase Two takes place in a classroom environment, approximately 4 to 6 weeks after Phase One. Trainees learn with their team members, and the classroom instruction includes formal lectures, seminar participation, application discussions, behavioral modeling, and case studies designed to reinforce and build on the principles learned in Phase One.[10] The model for Phase Two is four sessions of 1 to 2 hours each week, for 4 consecutive weeks.[132]

Phase Three of MTM training introduces practice and feedback in the work environment.[133] Instructors observe each team's performance and provide objective, process-based feedback to reinforce the lessons learned. The instructor may elect to schedule additional team meetings to address specific performance issues.

As noted previously, MTM training makes use of a variety of training strategies—Web-based exercises, formal lectures, participation seminars, application discussions, behavior modeling, and case study analyses.[10, 132, 134, 135] Trainees also are required to complete a variety of homework assignments. For example, one assignment requires trainees to observe their own team, in an effort to identify obstacles to effective team performance. Another requires trainees to perform practice tasks in the workplace, using the tools they have acquired in training. They then are asked to identify their own performance strengths and weaknesses, and to discuss them at subsequent training sessions.[131]

Finally, MTM training includes a number of topics designed to reinforce and sustain the human-factors concepts disseminated to trainees. In fact, the program devotes an entire module to training knowledge retention, especially in unanticipated situations. Other topics include long-term planning, briefings, and continuous monitoring practices. Additional retention devices include periodic, scripted safety drills; periodic team leader meetings; formal teamwork recognition; and a followup progress report that must be submitted to the Air Force Patient Safety Office.[132]

MTM purports to incorporate all three elements of CRM training—knowledge formation, practice, and recurrence—much as the two previously described medical team training programs do. However, most of the training time is devoted to the transfer of factual information regarding human-factors concepts. Substantially less time is devoted to actual skills practice. Furthermore, the included skills practice typically involves low-fidelity techniques, such as behavioral modeling using videotaped vignettes. MTM does not, at present, make use of high-fidelity team training simulators, such as those used in ACRM.

MTM does offer a number of advantages over the previously described programs. First, it uses a series of active learning techniques—formal lectures, behavioral modeling, and experiential learning—to develop the trainee's knowledge of teamwork, skills, and attitudes.[136] It also builds upon well-established learning theories, requiring the trainees to master factual material in advance of the hands-on skills practice. Third, it provides a comprehensive approach to human-factors research. That is to say, MTM training (1) explicitly distinguishes between constructive and destructive conflict resolution, (2) recognizes the workload-performance relationship is curvilinear, and (3) distinguishes between authority (based on rank) and leadership (based on skills knowledge). Additionally, MTM training focuses on specific techniques for improving team performance (e.g., constructive conflict resolution) and is interdisciplinary in nature, teaching physicians, nurses, and other key constituencies to work together. Finally, it provides trainees with a reference list for continuing education and skills refinement after completion of the training.[137, 136]

Like the aforementioned programs, MTM does have its share of disadvantages. First, there is the large amount of training time devoted to the transfer of factual knowledge and the relatively small percentage of time devoted to actual skills practice; the practice provided is of the low-fidelity, nonsimulator variety. Then there are the tools provided to MTM trainees, in an effort to reinforce and sustain their teamwork skills. Many of these aids are not tools in the strictest sense of the word (i.e., checklists, quick reference cards, flow diagrams), but rather briefings on practices or cross-check procedures. And while the MTM and MedTeams programs both focus on trainer certification, MTM does not appear to include a specific and reliable mechanism for preventing instructor performance degradation over time.

MTM Effectiveness

Relatively little information on MTM training evaluations is available, in comparison with that of the other two programs. MTM training developers seem to use a summative evaluation to determine if the training should be continued, discontinued, or redesigned. Furthermore, MTM training gathers reaction data and measures trainee knowledge during the Web-based program component.

Despite the apparent absence of MTM effectiveness data in the form of patient-relevant outcomes, it should be noted that this training program has gained wide acceptance in the Air Force. The Air Force Surgeon General made MTM a mandatory training component, beginning in 2001, for all high-risk specialties—emergency departments, operating rooms, obstetric departments, intensive care units, and neonatal care units.[129] More than 2,000 Air Force medical treatment facility personnel had received MTM training by February 2003,[128] and the program is to be made available to all Department of Defense medical staff on a voluntary basis.

Additional Medical Team Training Programs

Several other team training programs have been developed over the past few years, for a variety of medical specialties.[138–140] Unfortunately, few of these programs have been properly documented. It is, therefore, difficult to draw comparisons or evaluate their overall effectiveness. In any case, this section provides a review of several alternative programs, compared for the sake of thoroughness and in an effort to supplement our more detailed descriptions of ACRM, MedTeams, and MTM.

Team-oriented Medical Simulation (TOMS)

TOMS training provides interdisciplinary team training to surgeons, nurses, anesthesiologists, and orderlies, in an effort to reduce the number and severity of OR medical errors. The program draws heavily on CRM training from commercial aviation,[110, 139] and was developed at the University of Basel in Switzerland. TOMS training seeks to reduce and limit potential patient safety threats through better workload management, and improved problem-solving and decisionmaking skills.[3]

TOMS training can be described as a scaled-back version of ACRM training. The first hour is a pretraining brief that highlights relevant teamwork concepts (i.e., situational awareness, communication, and decisionmaking). The second hour of training is devoted to simulated laparoscopic and anesthetic procedures, with a lifelike mannequin in the role of the patient. The third hour consists of a team-led debriefing, complete with videotaped examples of the team's performance that are used to diagnose problems and identify strategies for improvement.[139]

More than 50 teams from the University of Basel Hospital had completed TOMS training as of August 1997 (See footnote this page). Evaluation data for the TOMS training program is limited, focusing almost exclusively on the participants' impressions of the training. The responses were generally favorable,[141] though a small sample size and the generalized nature of these findings make them difficult to assess. To date, we have been unable to discover any other quantifiable evidence, such as posttraining changes in the participants' knowledge or skills base, changes in organizational effectiveness, or the degree of behavioral transfer.

Dynamic Outcomes Management (DOM)

DOM training provides surgeons, nurses, and anesthesiologists with various interdisciplinary, team-building skills, adverse-situation recognition techniques, and stress-reduction tactics, in an attempt to reduce medical errors, and improve the quality of health care.[4] The program draws heavily on aviation CRM training[140] and was developed by Crew Training International (CTI), a developer of specialized training programs for various industries.

DOM, which is quite similar to the MedTeams and Medical Team Management training programs, includes 12 hours of skills-based, interactive training comprised of facilitated discussions, role-playing exercises, case studies, behavior modeling, and knowledge testing.[140] The training is divided into three 4-hour sessions. The first session provides effective team-building guidelines, techniques for recognizing adverse situations, and recommendations for constructive conflict management.

The second session, scheduled approximately 2 months later, provides guidance for mitigating the effects of stress, training in decisionmaking skills, and recommendations for providing effective performance feedback. The third session, scheduled an additional 2 months

[3]Available at http://www.medana.unibas.ch.
[4]Available at http:// www.cti-crm.com.

later, includes a course review, cross-checking and challenging guidance, and principles for mitigating the effects of fatigue.[140] High-fidelity simulators, such as those used in ACRM training, are not part of the DOM program. Instead, CTI developed a “challenge and response checklist” that trainees are required to use in the OR, to reinforce the principles of DOM training.

Data concerning the development and evaluation of DOM are limited. As of January 2003, more than 160 members of the surgical staff at Methodist University Hospital in Memphis had completed DOM training. Evaluations of DOM include documented improvements in participants’ attitudes toward the importance of OR teamwork issues, favorable reactions to the usefulness of DOM training, and a 50-percent reduction in surgical material-count errors.[140] At the same time, the small sample size and generalized nature of the findings prohibit a thorough assessment. Moreover, the lack of control groups makes a determination regarding the specific source of the improved outcomes all the more difficult.

Geriatric Interdisciplinary Team Training (GITT)

GITT provides interdisciplinary team training for physicians, nurses, nurse practitioners, social workers, pharmacists, therapists, and administrators,[142] leveraging the effects of interdisciplinary teamwork to improve patient care. The program, sponsored by the Rhode Island Geriatric Research Center, also serves as an instrument of responsive change, establishing academic–industry partnerships to address the needs of health care providers.

GITT training is also fundamentally similar to the MedTeams and Medical Team Management programs. It includes a full day of team self-evaluation and skills training. The self-evaluation exercise makes use of the Strength Development Inventory, which helps team members to recognize their preferred interpersonal styles of relating.[143] It also incorporates the Team Signatures Technology tool, which assists each team to identify the underlying system of social dynamics, using the team's cohesion, leadership, and diversity quotients, as well as other measures.[144] The team’s self-evaluation exercises are followed by formal classroom instruction in the principles of effective teamwork, the phases of team development, conflict management, leadership, and other interdependence skills.[142] A half-day followup training class is provided approximately 1 year later, to reinforce learned concepts. High-fidelity simulators, such as those used in ACRM training, are not a component of the GITT program.

Data pertinent to the development and evaluation of GITT are, again, limited. Just three of the original eight teams that took part in the GITT program—all from geriatric treatment facilities in Rhode Island—participated in the followup training 1 year later. The remaining five teams had been disbanded, following administrative reassignments. As a result, the evaluation of GITT instruction has been extremely limited. The program was assessed using a comparison of participant pre- and posttraining test scores for a variety of dimensions, including communications abilities, team cohesion, attitudes towards health care teams, and self-described skills.[142] Posttraining statistical means were higher than pretraining levels on all measured variables. But the small sample size, the high level of attrition, and the absence of control groups prohibit useful generalizations. To date, we have been unable to identify any other forms of validation evidence (i.e., posttraining changes in trainee knowledge or skills levels, changes in organizational effectiveness, or the extent of behavioral transfer) for this program.

Summary

This chapter has summarized the general state of medical team training. We focused our discussion primarily on Anesthesia Crisis Resource Management (ACRM), MedTeams, and Medical Team Management (MTM) programs, because these are the most thoroughly documented medical team training processes. Together, these programs have provided documented improvements in patient safety. Nevertheless, and despite the encouraging nature of the data, the degree to which CRM-based medical team training is an enhancement to patient safety remains in question. Our next chapter will integrate the findings into conclusions and recommendations relevant to medical team training, in an effort to provide a strategy that is useful for further investigation and comparison. The final chapter will propose avenues for future research.

Chapter 5. Conclusions and Recommendations

This chapter outlines a number of important conclusions that can be drawn from the preceding review. We further provide specific recommendations for ensuring the design and delivery integrity of medical team training programs with respect to desirable patient safety outcomes.

Conclusion 1: The medical field lacks a theoretical model of team performance.

To date, research has not developed a comprehensive model of team training performance in medical settings. As a result, medical team training programs have not been grounded in a scientific understanding of those human factors that directly influence effective teamwork in medical treatment settings. Given this gap in knowledge, the first research effort we advocate is the development of a theoretical medical team performance model that hypothesizes (1) the interrelationships among predictors of performance, and (2) the interdependencies of predictors and outcome criteria. Despite the absence of a team-performance model uniquely suited to medical treatment scenarios, however, previous research has revealed a considerable volume of relevant knowledge. The availability of this knowledge underscores several of the remaining conclusions and recommendations.

Conclusion 2: The science of team performance and training can help the medical community to improve patient safety.

As discussed in Chapter 2, the generalized science of team performance and training has evolved and matured over the past 20 years. This evolution has produced a number of principles, learned lessons, tools, and guidelines conducive to the growing patient safety movement. Our recommendations are: (1) the medical community continue to disseminate findings with regard to the progress of this science, through the use of different instruments (e.g., professional journals, specialized workshops, books, etc.), and (2) the medical community should involve the team training experts, in attempts to apply to patient safety the principles, guidelines, and learning emerging from previous research.

Conclusion 3: Research has already identified many of the competencies necessary for effective teamwork in medical environments.

Previous investigations have identified the competencies essential to effective team performance in a number of complex settings. Many, if not most, of these competencies are applicable to the environment of clinical medicine. As noted in Chapter 2, however, Cannon-Bowers and colleagues have pronounced the team skills literature confusing, contradictory, and plagued with inconsistencies. For example, different labels are used, across various studies, to describe the same teamwork skills. Conversely, different teamwork skills are labeled identically in other studies.[21] Therefore, we recommend using a two-step process for developing a taxonomy with standard nomenclature. This taxonomy would name and define teamwork-related knowledge, teamwork-related skills, and teamwork-related attitudes that constitute the core competencies related to successful teamwork in the medical domain.

The first step in developing such a taxonomy is to determine an appropriate level of explanation; the included constructs must be sufficiently broad in concept to encompass the various medical specialties, yet specific enough to facilitate valid measurement. Furthermore, this list of core competencies should reflect all relevant aspects of team training performance, while at the same time demonstrating the concise description and power of expression necessary for use in research and organizational needs analyses.

The second step involves the determination of relevant core competencies. This involves the delineation of those competencies outlined in previous research that are relevant to all medical teams. A second—and, perhaps more demanding—task is to identify those core medical team competencies that have not emerged in previous team research related to other domains. Investigators might rely, to some extent, on medical experts, such as those convened in January 2003 by the American Institutes for Research, for guidance in this area. We believe job analysis techniques (e.g., survey questionnaires, structured interviews, and nonobtrusive observations), used in conjunction with the development of a medical team performance theory, will yield the most valid information. In addition, we are emphasizing the importance of large-scale, stratified data collections and the goal of identifying generic competency requirements consistent with the medical community at large.

Conclusion 4: A number of proven instructional strategies are available for promoting effective teamwork.

The science of team performance and training has led to the development and validation of numerous strategies that can be used by teams performing in complex environments to attain necessary competencies, as evidenced in Chapter 2. With a variety of formats and objectives, these strategies extend beyond mere CRM training. We recommend that (1) the medical community use these strategies wherever possible, given that some are relatively easy to design and deliver; and (2) the community explore team-based strategies other than CRM for improving patient safety.

Conclusion 5: Team training strategies must be further adapted to suit medical needs.

We are convinced that no one existing model of team training can be applied across all medical practices and contexts. We are defining a ***practice*** as a medical specialty or sub-specialty, (e.g., emergency medicine, family medicine, intensive care, surgical medicine, obstetrics, etc.) for purposes of this discussion. Medical practices differ dramatically across a variety of criteria: size, purpose, duration, redundancy of expertise, decision time, and consequence of error, to name but a few.

Moreover, a particular practice may operate in a number of diverse contexts. For example, emergency medicine specialists work in hospital emergency departments, in emergency-response mobile units, and in battlefield environments. Similarly, urban and rural general practitioners operate out of independent or multi-practitioner offices, as well as in community walk-in clinics. No one team training strategy—or the competencies that drive successful teamwork—can be used to its best advantage across all these contexts. This is due to circumstances unique to each practice, along with the fact that not all members of the same team needs the same knowledge, skills, and attitudes.

Therefore, we further recommend developing practice-specific taxonomies, in addition to the core-competency taxonomy proposed in Conclusion 3. These highly specialized taxonomies would not overlap the generic, core-competency taxonomy. Rather, a practice-specific taxonomy would identify the specific knowledge, skill, and attitude requirements that are central to teamwork in a given practice. The medical content and procedures that define this practice would be used to determine the relevant team competencies.

For example, a successful ER team with a frequently changing membership might need to know the various roles necessary to each patient encounter, but not the strengths and weaknesses of particular team members. In addition, while some team members would need finely honed decisionmaking skills, others would be more concerned with timely equipment set-up and operation; it is also possible that none would need the skills necessary to assess long-term treatment options for a chronic condition. Furthermore, nearly all emergency team members should be possessed of an emotional detachment that allows them to function in the face of appalling injuries.

Conversely, a family-medicine practice composed of two nurses, a physician, and a receptionist may need very different competencies—knowledge of one another's strengths and weaknesses, the skill to promote and evaluate long-tem care, and an expression of empathy that signals a unified concern for each patient's welfare. In addition, the physician likely would need to articulate his or her treatment protocol to the patient, to the nurse, and/or a consulting physician. The receptionist, on the other hand, likely would need first-rate office management skills and far less medical knowledge. As a final example, the specific competencies and their relative importance may differ greatly for a hospital emergency department and a mobile responder, such as firefighter/paramedic unit or an emergency medical technician (EMT)/ambulance team.

Previous research has not addressed the differences within and between various medical care-delivery environments, and the manifestations of these differences in the treatment competencies specific to each environment. Yet we find this issue sufficiently compelling to suggest further investigation. Because these taxonomies are derived from the medical characteristics of various care-delivery settings, experts representing each type of setting might be invaluable in identifying practice-specific team competencies that do not overlap the generic core-competency taxonomy. We further suggest that researchers avail themselves of survey questionnaires, structured interviews, as well as nonobtrusive observation means to collect such information.

Conclusion 6: The medical community has made considerable progress in designing and implementing team training across a number of settings.

Our review clearly demonstrates the efforts being made in the medical community to implement CRM team training across a variety of medical domains. We recommend the support and continuance of this trend. Less clear is the extent to which these programs are being implemented, despite recent advances in learning science, team performance, and training methodologies. We are, therefore, recommending further studies into the science of medical team training, as well as continued and advancing exploration into its practical applications. Furthermore, the medical community should additionally investigate other learning techniques that might be used to enhance the effectiveness of medical team training. Specifically, we first recommend that medical team training be developed in such a way as to reflect established, foundation principles for team training research. Second, we recommend a full evaluation of the programs' quality measures, using verifiable scientific criteria (e.g., assessing the degree to which training transfers to the actual work environment).

Conclusion 7: The impact of medical CRM training on patient safety outcomes has not been determined.

Although data from other domains are encouraging and common sense would appear to support a conceptual link between CRM training and enhanced patient safety, this relation has yet to be empirically validated. Furthermore, and as mentioned in Chapter 3, data with a direct relation to the efficacy of CRM (or any other team training strategy now in use) is often difficult to obtain. This is due to the relatively low base rate at which serious errors occur in some industries. Nevertheless, supportive evidence is essential if the field is to advance. The future research outlined in the next chapter speaks to this need.

Conclusion 8: The institutionalization of medical team training across different medical settings has not been addressed.

Our final conclusion focuses on what we consider the imperative need to make team training an embedded part of professional medical education. By ***embedded***, we mean implementing and regulating team training throughout each health care provider's career. As noted in Chapter 4, the Accreditation Council for Graduate Medical Education (ACGME) has identified several teamwork-related competencies that all surgical training residents now are required to master.[103] Similarly, the Association of American Medical Colleges (AAMC) has funded a "critical incident" analysis to investigate the behaviors that result in successful and unsuccessful performance during medical school and residency.[104] Although not originally targeted towards team performance, the results of these mandates have underscored the importance of several specific teamwork-related competencies.

Simply stated, medical team training must be instilled and reiterated at every stage of a care provider's career, if it is to fully exert its potential positive impact on patient safety. Certain medical school assignments, for example, might require students to prepare projects involving the use of teamwork skills. Similarly, interns and residents might observe, participate in, and evaluate practicing teams in teaching hospitals. The larger challenge, however, occurs after physicians, nurses and technicians have completed their formal training.

The delivery of recurrent team training across all segments of the health care community is, at present, haphazard. Few structural or procedural mechanisms exist to ensure that it continues at regular intervals. Similarly, few systemwide procedures exist for reporting errors, and few organizational policies allow and encourage health care providers to report near misses, without fear of sanctions. As a result—and lip service to the contrary notwithstanding—the U.S. health care community often fails to regard medical teamwork as an important facet of medical performance. One means of correcting this systemic indifference is the implementation of a formal, mandatory error-reporting system. A second possible strategy would require all care delivery providers to take part in newly developed team training programs, or in refresher training, at specified intervals. This initiative would be similar in concept to the professional licensing requirement that obliges nurses, teachers, and other skilled workers to earn a certain number of continuing education credits, every two or three years.

The structure of health care, in its present form, offers numerous junctures for the evaluation of teamwork skills, were recurrent training to be instituted as a mandatory and ongoing process. For example, it might ultimately be useful to develop a board certification test for teamwork, similar to the board exams mandated for medical specialties. Such an exam might combine a written test of knowledge and situational judgment with performance in a simulation scenario. And since the board examinations are designed to assess the requisite body of knowledge for each medical specialty, the teamwork component also could be configured to assess teamwork competencies inherent to each specialty. In addition, the Joint Commission on Accreditation for Healthcare Organizations (JCAHO) currently evaluates hospitals on criteria ranging from medical practices and managerial systems to facilities maintenance. Folding generic team training competency criteria into the JCAHO evaluations, at some future point, might focus the attention of all health care providers on the importance of teamwork in medical settings, while at the same time yielding valuable research data.

Chapter 6. Research Needs: Where Do We Go from Here?

We believe this review advances the information provided by Pizzi and colleagues[5] in AHRQ's Evidence Report 34, and its assessment of team training and its potential for reducing medical errors and bolstering patient safety. Specifically, we have included all available findings from military programs and have provided a more comprehensive summary regarding the state of team training. In addition, and perhaps most significantly, this report provides a comprehensive look at the current state of medical team training with evaluations of the existing programs.

This chapter outlines research needs that we have identified in the course of our investigation. The common theme for these suggestions is the need for a more thorough understanding of the medical team and medical-team training performance domains than the scientific evidence currently permits.

Research Need 1: A medical team performance model.

The available research has not yielded a comprehensive model of team performance in a medical treatment context. Therefore, we propose the development of the first theoretical model for medical team performance.

The advantages of such a model are fourfold. First, the model would provide researchers with a common language useful for labeling and defining the key personal behaviors affecting medical team performance, using recommended generic and practice-specific competency taxonomies. Moreover, the available research provides a foundation for defining the environmental variables that influence effective medical teamwork (e.g., organizational climate factors, such as the sanctions resulting from reporting errors or near misses; the degree to which teamwork is supported at the executive level; the extent to which the organization mandates team training and retraining; etc.). In addition, supplemental research would lead to a universal set of process and evidence end result measures, for use in outcome comparisons. Finally, such a model would provide researchers with a common framework for describing and testing hypotheses concerning the interrelationships of various performance predictors, as well as the interdependencies of the predictors and the outcome criteria. This programmatic research effort ultimately would generate a body of applied scientific knowledge tailored to the medical community's patient safety concerns.

Research Need 2: Teamwork process and outcome measures, relative to medicine.

Given that medical teamwork and team training research are not formally linked to medical team performance theory, previous research often does not contain criteria relating it directly to error reduction and patient safety. In addition to developing valid prediction measures, future research must define and build valid measures of relevant outcomes. As mentioned in the Chapter 3 discussion of aviation CRM training, the low base rate of serious errors precludes the use of death avoidance as a viable outcome construct in CRM training research.[62] Conversely, the vast number of medical procedures performed each day makes the application of this "ultimate criterion" to the medical-team performance domain equally impractical, despite the prevalence of errors noted in our introduction.

We recommend a more theory-based perspective as a starting point for the development of medical teams and medical team training criterion measures. A theory of medical team performance, once properly defined, would suggest process criteria with a theoretical relation to the ultimate criterion, while at the same time reflecting actual performance behavior. Examples include the time needed to execute an initial decision in a hospital ER unit, the number of times operating room attendants ask for instructions to be repeated during surgery, or the regularity with which intensive-care providers apprise physicians of patients' status. The advantage of such measures, aside from their relative ease of development and implementation, is the objective performance assessment they bring to a process that is theoretically linked to patient safety outcomes. Moreover, process-oriented and behavior-based criteria provide relevant performance measures for use in comparing teams or team training programs.

A final issue that bears mention is the possible use of near-miss events as a proxy criterion for errors. Near misses are examined in aviation research, though generally not with regard to teams. Near-miss research was not mentioned in any of the medical team literature that we reviewed. Nevertheless, near misses could prove their worth as an outcome criterion with a prevalence likely greater than that of error, provided the data could be collected. Furthermore, the use of near-miss criteria suggests two worthwhile avenues of investigation: (1) an examination of the predictive factors or process outcomes that contributed to the near miss, and (2) an examination of the factors or processes that ultimately prevented the error. The findings from either investigative tact would foster valuable insight with regard to the interrelationships of teamwork and patient safety.

Research Need 3: More efficient practices for evaluating medical team training programs.

The ability to evaluate team training from the standpoint of effectiveness is a natural extension of the aforementioned need for a testable, conceptual model of medical team performance. In short, this need reflects our firm opinion that reaction criteria (in which training participants indicate their like or dislike for a training program and offer their opinion on how a program might help them do their jobs better) is not an adequate basis for determining program effectiveness. The previous discussion into the need for performance-based criteria in some ways addresses this issue. Just as important as measurement criteria, however, is the need to conduct team training program evaluations in a consistent and agreed-upon manner. Bringing a clear and uniform structure to evaluations of performance-based criteria would permit researchers to directly compare the effectiveness of diverse programs and training strategies.

Research Need 4: Team performance diagnostics.

This research need also is based on the development of a theoretical medical team performance model. That is, once research has identified the personal and environmental variables relevant to effective medical teamwork—and has linked them to performance-based criteria—any team's collective efficiency and effectiveness would be open to examination. These examinations, primarily qualitative in nature, would identify areas of performance in which the team has met or failed to meet expectations. More important, they also would reveal the potential reasons behind these outcomes.

More significant still, indepth quantitative diagnoses could be extended across teams to yield data revealing the degree to which certain outcomes are attributable to certain predictor variables. This generalized data then could be compared to a single team's scores for the same variables, to determine if the team's effective or ineffective performance is a function of personal competencies, organizational characteristics, intermediate process criteria, or a combination of factors.

Given a team's performance rating, the evaluator might find the need to conduct a qualitative case study, using personnel records or other sources to determine the team's "scores" with respect to certain predictors. Quantitative analyses of a single team would not be possible unless the team had participated in numerous team training trials (and, even then, repeated exposure to the same stimuli creates its own evaluation confound). Such scores could be compared, however, to norms established through the use of previous across-group research. In addition, case studies could include content analyses of various team behaviors. Examined in tandem, the norm and the content analysis information may provide rich insight into a particular team's performance—as well as those factors hindering it and applicable interventions.

Research Need 5: Simulation-based training applications.

The final research need to be addressed in this report is one of simulation-based training and its most effective contributions to medical team training. Previous research documented throughout this review has established the fact that simulators provide training participants with an incomparable opportunity to practice both technical and team-process skills, while receiving vital feedback on their strengths and weaknesses. Moreover, simulators provide this practice in a virtually risk-free environment. Despite their recognized value, however, high-fidelity simulators and the training they provide can be extremely expensive.

Therefore, the overall question that future research must address is “How best to achieve the optimal trade-off between training effectiveness and cost effectiveness?” Numerous subsidiary issues, including the number of specialty clinics sponsoring the training, the number of trainees involved, and the financial and personnel resources available, must be considered in arriving at a reasonable conclusion. A more important and more focused central research question is “To what degree must an effective simulation reflect physical versus psychological fidelity?” Previous simulation-training research supports the assumption that the more realistic the scenario and the more fidelity built into the simulator, the more effective the training will be.[34, 88] Nevertheless, we believe that it is often unnecessary for a simulation to replicate exactly the same *physical* environment in which the actual teamwork will take place.

Still, some degree of physical fidelity is necessary for medical team training effectiveness, whereas this might not be the case for all medical training. For example, paper scenarios—which might play a valuable role in training medical diagnostic skills—are not conducive to the acquisition of teamwork skills. In short, teams must *function* as teams during simulator scenarios for the training to be effective. The extent to which physical fidelity can be and must be sacrificed to cost and other constraints remains the ultimate simulation-related question for future research to answer.

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