MEDICAL TEAMWORK AND PATIENT SAFETY: THE EVIDENCE-BASED RELATION

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CHAPTER 1: INTRODUCTION

This report reviews the empirical evidence concerning the relation between teamwork and patient safety. The available evidence suggests that training teams of health care providers constitutes a pragmatic, effective strategy for enhancing patient safety by reducing medical errors. Throughout our discussion, we adopt the Institute of Medicine's (IOM) definition of both *patient safety* and *error*. 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 frightening indictment of the inadequate safety that the United States medical establishment too often provides its patients [1]. Extrapolating from data gathered through the Harvard Medical Practice Study (HMPS) and the Utah-Colorado Medical Practice Study (UCMPS) [2], 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) [1].

The report also noted that, in addition to causing human suffering and death, medical errors are financially costly. With regard to direct costs, the IOM estimated that, among U.S. hospital inpatients, *medication* errors alone cost approximately two billion dollars annually. With regard to indirect costs, errors result in opportunities lost, given that funds spent in correcting mistakes cannot be used for other purposes, as well as in higher insurance premiums and co-payments. In addition, due to their effect on diminished employee productivity, decreased school attendance, and a lower state of public health, such errors exact a price from the society-at-large. Specifically, the IOM estimated that the total indirect cost of medical errors that result in patient harm lies between 17 and 29 billion dollars annually. Finally, and equally perilous in the long run, medical errors undermine patients' and health professionals' confidence in the healthcare system itself.

To alleviate this unacceptable prevalence of medical errors, the IOM recommended "a four-tiered approach:

1) establishing a national focus to create leadership, research, tools and protocols to enhance the knowledge base about safety;

2) identifying and learning from errors through [establishing] immediate and strong mandatory reporting efforts … [and encouraging] … voluntary efforts, both with the aim of making sure the system continues to be made safer for patients;

3) raising standards and expectations for improvements in safety through the actions of oversight organizations, group purchasers, and professional groups; and

4) creating safety systems inside [healthcare] organizations through the implementation of safe practices at the delivery level. This level is the ultimate target of all the recommendations" (Kohn et al., 1999, p. 5).

The IOM's stated goal was to facilitate sufficient program research and implementation to reduce the rate of medical errors by 50 percent over a five-year period.

Key to the present document's orientation towards teamwork-related research, the IOM also noted that the majority of medical errors result from healthcare *system* failures, rather than from individual providers' substandard performance. Thus, in conjunction with its drive to implement organizational safety systems by delivering safe practices (Tier 4), the IOM recommended establishing interdisciplinary team-training programs [1].

The results from the IOM's source studies (i.e., the HMPS and the UCMPS) had previously been published in scientific journals; however, these reports had not galvanized a widespread national reaction [3]. In contrast, *To Err is Human* generated a demand for action that was heeded by the Federal government, the media, the healthcare profession, and the research community. In the service of this mandate, the Federal government established agencies and task forces whose directive is to improve patient safety radically. In turn, these groups have funded private-public research collaborations to investigate 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 report, President Clinton established a Quality Interagency Coordination (QuIC) Task Force. The QuIC comprised participants from the Department(s) of Health and Human Services (DHHS), Labor (DOL), Defense (DoD), and Veterans Affairs (VA), among other agencies. The Coordinating Officer represented the Agency for Healthcare Research and Quality (AHRQ). The QuIC's charge was to respond to the IOM's advice and to propose specific actions for improving patient safety and reducing medical errors.

As previously noted, the IOM's Tier 4 recommendation—to implement organizational safety systems—is particularly relevant to our investigating the utility teams in medical settings. The QuIC's support for this recommendation comprised three specific courses of action:

- ensuring that, in the year 2000, the VA would (1) invest more than 47.6 million dollars in increasing staffs' patient-safety training from 15 to 20 hours per year; (2) provide a VA Quality Scholars fellowship for each of 10 physicians; (3) implement a program to award patient safety; and (4) place a Patient Safety Checklist in the operating rooms of every hospital in the U.S.;

- ensuring that, in the fall of 2000, the DoD would invest 64 million dollars in implementing, over a three-year period, a computerized medical record in all DoD facilities; and

- ensuring that the QuIC Task Force member agencies (DoD, VA, AHRQ, and HCFA [subsequently renamed the Center for Medicare and Medicaid Services (CMS)] would collaborate with the QuIC Task Force and the Institute for Healthcare Improvement to decrease the occurrence of errors in "high hazard areas," specifically emergency and surgical rooms, intensive care units, and labor and delivery facilities (Report of the Quality Interagency Coordination Task Force (QuIC) to the President, February 2000).

Of these initiatives, the proposed research collaboration between the QuIC Task Force and its member agencies, targeted at high-hazard medical specialties, has been most germane to AHRQ's subsequent involvement in assessing whether team-training, properly conceptualized and effected, might well have the potential to reduce medical errors, thereby increasing patient safety.

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

The primary responsibility for conducting and supporting research and for developing public-private collaborative efforts currently rests with the Director of AHRQ. This responsibility, drawn from the IOM's recommendations and the QuIC's action items, encompasses three broad areas: (1) identifying the causes of errors and injuries in healthcare delivery; (2) developing, demonstrating, and evaluating error-reduction and patient-protection strategies; and (3) distributing effective strategies throughout the U.S. healthcare community [4]. To emphasize further its role in promoting patient safety, AHRQ's formerly-named Center for Quality Measurement and Improvement has been re-christened the Center for Quality Improvement and Patient Safety (CQuIPS) [4].

Following the National Summit Meeting on Medical Errors and Patient Safety, held in Washington, DC in September 2000, AHRQ developed a program of research designed to, among other things, "apply evidence-based approaches to the improvement of patient safety" [4]. Particularly relevant to the present effort was AHRQ's desire for research that would evaluate and assess the patient safety initiative that involves "extend[ing] the capabilities of patient safety staff" [4]. In light of this focus and given the centrality of training in expanding professional skills,

the ensuing discussion conceptualizes team training as a subset of professional training generally.

Moreover, to reiterate a previous point that further supports our emphasis on team training, the healthcare and research communities know that "systemic failures" cause far more errors than does the poor performance of individuals [1]. Thus, the crux of patient-safety training might reasonably be assumed to lie in improving the coordination, interaction, and communication among individuals who, whether or not they represent disparate medical specialties, are accountable for the same patients' welfare. For purposes of the following evaluation, these responsible individuals comprise a *medical team*.

The following discussion of teamwork and team training extends and expands an earlier review conducted by Pizzi and colleagues as part of AHRQ Evidence Report 43. Evidence Report 43 entitled, *Making Health Care Safer: A Critical Analysis of Patient Safety Practices,* presents the existing data on practices within and outside of health care that are viewed as having the potential to improve patient safety. Pizzi and colleagues focused specifically on Crew Resource Management (CRM) – a sub-domain of team training – and its applications in medicine [5]. These researchers concluded that the application of CRM in medicine has tremendous potential based on its success in aviation, though future research on this patient safety practice in health care is warranted. After a more comprehensive review of the relevant literature and the evidence-base, this report describes the research questions that must be answered. Therefore, this report merits the medical community's attention for several reasons. First, this review addresses the present state 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, we provide a comprehensive review and evaluate the effectiveness of current *medical* team-training initiatives. Finally, we describe specific requirements for future research.

The Structure of the Evaluation

The next chapters review the evidence concerning the extent to which training medical personnel as teams is likely to improve patient safety outcomes. Chapter 2 defines the key characteristics of a team and discusses the principles that underlie successful teamwork and effective team training. Chapter 3 describes and evaluates research concerning the relation between teamwork and safety in real-world, high-risk settings. Chapter 4 introduces current trends and issues in medical-team training *per se*. Chapter 5 offers the conclusions and recommendations that we have drawn from the review. Finally, Chapter 6 suggests directions for future research. Prior to turning to Chapter 2, we briefly overview the approach we used to conduct our literature search and review.

Methodology

To conduct this review, we relied on systematic methods for gathering and reviewing relevant documentation. First, we searched the PsycARTICLES®, PsycINFO®, and Sociological Collection® databases for published studies on teams, teamwork, and Crew Resource Management (CRM) in commercial aviation and the military. Specific searches using these databases, along with the MEDLINE® and HealthSTAR® databases, were also conducted on medical team training and other relevant topics. Specific key terms that were searched include "crew resource management," "cockpit resource management," "medical error," "team training and aviation," and "team training and medicine." Other terms that were used include "team training" and medical specialties, such as "anesthesiology," "obstetrics," "gynecology," "emergency medicine," and "geriatrics." Searches were also 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 on the Internet to uncover any unpublished studies on these topics. We also reviewed the reference lists of each article to identify additional resources. To complete the review, 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. However, little information was found specifically about "medical team training." Articles were found on team training efforts in geriatrics and anesthesia and on specific programs such as MedTeams, Medical Team Management, Anesthesia Crisis Management, and Dynamic Outcomes Management. We also found articles about simulators used in medicine, particularly in anesthesia.

The results from this search are presented in the following chapters. As you progress through this information, you will notice that we have drawn upon particular domains of the team performance and training literature in developing this report. Specifically, we have focused our attention on the research that has been conducted in other, parallel, high-stress, high-risk environments such as the military and commercial aviation where the consequences of error are extreme. We believe that these environments are most comparable to 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 result in life and death. These environments are quite similar to that of a cockpit of commercial airliner in which the crew is flying a complicated approach, a Navy Combat Information Center (CIC) team responsible for monitoring and tracking air threats, or a P-3 aircrew responsible for identifying and tracking subsurface threats. Therefore, we have placed far less emphasis on the vast amount of literature that exists on teams and their critical contributions to organizational effectiveness, which can be found in the management literature. We believe that although lessons can be

learned from reviewing such information, the most relevant literature and the most appropriate evidence-base for improving patient safety exist in the review that follows.

CHAPTER 2: TRAINING TEAMS

Definitional Issues Concerning Teams and Teamwork

Teams and teamwork have received an increasing amount of attention over the last twenty years [6,7,8,9,10]. Numerous articles [7,9] and books [11,12,13,14] have specifically addressed critical issues related to team performance. In fact, organizations that do not rely on teams, at least to some extent, are scarce.

Given the prevalence of teams in the workplace, the research literature reflects substantial agreement regarding their defining characteristics. Any inconsistencies among definitions is due, at least in part, to the reality that teams reflect a variety of purposes (e.g., learning, producing a product, solving problems, gaining acceptance), of forms (e.g., virtual, co-located), of sizes, and of longevity (e.g., ad hoc, long term) [15].

What is a "Team"?

To identify the key features of a team for the purpose of this project, we reviewed several often-cited definitions [7,16,17,18], as well as other relevant literature. The definition we adopted for this discussion comprises the following five characteristics:

1) Teams consist of a minimum of two or more individuals.

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

3) Teams make decisions [20].

4) Teams have specialized knowledge and skills [21] and often work under conditions of high workload [22,20].

5) Teams differ from small groups [23] because teams embody the coordination that results from *task interdependency*; that is, teamwork characteristically requires team members to adjust to one another other, either sequentially or simultaneously, to achieve team goals [24].

Examples of teams that fit this definition include military command-and-control teams, cockpit crews, SWAT teams, fire rescue teams, and management teams. Pursuant to the present topic, this definition also fits healthcare teams, such as medical emergency teams; intensive care units, labor and delivery units, neo-natal unit teams, and operating-room teams, to name a few.

Defining what constitutes a "team" is a preliminary step towards identifying measurable variables that reflect team inputs, team processes, and team outcomes. In turn, specifying these team-input, team-process, and team-outcome variables yields a framework that guides the design of a given training program and the manner in which the program's effectiveness will be assessed.

The Nature of Effective Teamwork

Teamwork has traditionally been described in terms of classical systems theory, which posits that team inputs, team processes, and team outputs are arrayed over time. In particular, team *inputs* include the characteristics of the task to be performed, the elements of the context in which work occurs, and the attitudes team members bring to a team situation. Team *process* constitutes the interaction and coordination that is required among team members if the team is to achieve its specific goals. Team *outputs* consist of the products that result from team performance [25,26,27]. Thus, teamwork *per se* occurs in the process phase, during which team members interact and work together to produce team outputs. Finally, teamwork does not require team members to work together permanently; it is sustained by a shared set of teamwork skills, not by permanent assignments that carry over from day-to-day [28].

However, simply installing a team structure in an organization does not automatically result in effective teamwork. Effective team performance requires team members' willingness to cooperate for a shared goal, such as the health field's goal of improving patient wellbeing in a safe, error-free environment. Moreover, effective teamwork depends on effective within-team communication and adequate organizational resources and support. In short, teamwork requires team members to develop a shared awareness of one another's roles and abilities. Without this awareness, serious but avoidable adverse outcomes may result from a series of seemingly trivial errors that effective teamwork would have prevented.

Extensive research has yielded numerous models of effective teamwork [29,30,31,32,33]. Historically, this literature has sought to identify generic teamwork skills that are associated with most teams. However, the focus has more recently shifted towards identifying the specific *competency requirements* that team members exhibit [21,34,31]. Although the term *competency* signifies a variety of meanings, it is generally used to denote the qualities needed by a jobholder [351]. Specifically, Parry defined the term "competencies" as a cluster of related knowledge, skills, and attitudes that (1) affects a major part of one's job (i.e., one or more key roles or

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[1] Boyatzis (1982), in his seminal work on competencies, defines a job competency as "an underlying characteristic of a person, which results in effective or superior performance in a job."

responsibilities); (2) correlates with successful job performance; (3) can be measured against well-accepted standards; and (4) can be improved through training and development [36].

Generally speaking, team competencies are the attributes team members need to engage successfully in teamwork: As has been suggested, "… 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" [21]. To explicate this understanding, Cannon-Bowers and colleagues identified three types of competencies that are critical for effective teamwork: (1) teamwork-related knowledge, (2) teamwork-related skills, and (3) teamwork-related attitudes. Exhibit 1 lists and defines primary competencies in each of these categories.

EXHIBIT 1. ESSENTIAL TEAM KNOWLEDGE, SKILL AND ATTITUDE COMPETENCIES—ADAPTED FROM [13]

KNOWLEDGE COMPETENCIES	
Competency	**Definition**
Cue/Strategy Associations	Linking 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	Knowing the Task-related competencies, preferences, tendencies, strengths, and weaknesses of teammates.
Knowledge of Team Mission, Objectives, Norms, and Resources	Meaningful for responding to a specific team and task—when change occurs, knowledge must be adjusted to incorporate new team members and task demands
Task-Specific Responsibilities	Integrating task inputs according to team and task demands

SKILL COMPETENCIES	
Mutual Performance Monitoring	Tracking fellow team members' performance to ensure that the work is running as expected and that proper procedures are followed
Flexibility/Adaptability	Ability to recognize deviations from expected course of events to readjust one's own actions accordingly
Supporting/Back-Up Behavior	Providing feedback and coaching to improve performance or when a lapse is detected; assisting teammate in performing a task; and completing a task for the team member when an overload is detected.
Team Leadership	Ability to direct / coordinate team members, assess team performance, allocate tasks, motivate subordinates, plan / organize, and maintain a positive team environment.
Conflict Resolution	Ability to resolve differences / disputes among teammates, without creating hostility or defensiveness
Feedback	Ability for team members to communicate their observations, concerns, suggestions, and requests in a clear and direct manner, without creating hostility or defensiveness
Closed-Loop Communication / Information Exchange	The initiation of a message by the 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 tendency to enhance individual performance through coordinating, evaluating, and using task inputs from other group members while performing group tasks
Collective Efficacy	The belief that the team can perform effectively as a unit when given specific task demands

Shared Vision	Commonly held attitude regarding the direction, goals, and mission of a team
Team Cohesion	The total field of forces that influence members to remain in a group; an attraction to the team as a means of task accomplishment
Mutual Trust	A positive attitude held by team members regarding the aura, mood, or climate of the team's internal environment
Collective Orientation	The belief that a team approach is better than an individual one
Importance of Teamwork	The positive attitude that team members exhibit toward working as a team

Teamwork-Related Knowledge

Team knowledge competencies are defined as the principles and concepts that underlie a team's effective task performance. Broadly speaking, the competencies described in Exhibit 1 denote that, to function effectively in a team, team members should know what team skills are required, when particular team behaviors are appropriate, and how to manifest these skills and behaviors in a team setting. Further, team members should know the team's mission and goals and be aware of one another's roles and responsibilities in achieving them. Such knowledge enables team members to form appropriate strategies for interaction and to coordinate with their teammates, thereby effecting successful team performance.

Teamwork-Related Skills

Team skill competencies, defined as a learned capacity to interact with other team members at some minimal proficiency, have received considerable research attention [21]. However, Cannon-Bowers and colleagues reported that the literature on team skills is confusing, contradictory, and plagued with inconsistencies in terms of skill labels and definitions. Across studies, different labels are used to refer to the same teamwork skills, and the same labels are used to refer to different skills.

To avoid this confusion in future medical-team research, our research recommendations will address the necessity of developing a standard competency nomenclature. 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 decision-making. Previous investigations have shown these skills to be directly related to effective team performance [19,37,38].

Nevertheless, a number of investigations have demonstrated the difficulty of measuring more than four distinct skill competencies during scenario-based training [39,40,41]. In light of this finding, the best skills to include in an assessment are those that are not only crucial, but also trainable and measurable. One research study that exemplified this principle identified four teamwork skill competencies related to the performance of air traffic control (ATC) teams—information exchange, supporting behavior, team feedback skill, and flexibility [42]. A subsequent study by the same research group reliably and accurately measured these competencies during Navy combat-information-center team-training scenarios [41].

Teamwork-Related Attitudes

Team attitude competencies are defined as internal states that influence a team member's choices or decisions to act in a particular way [21,43]. Attitudes toward teamwork can exert a significant effect on the application of teamwork skills. Positive attitudes toward teamwork and mutual trust among team members are critical to successful team process [44,45,46].

For example, Vaziri and colleagues found that higher levels of mutual trust among team members led to a more harmonious and productive team environment [47]. A later study reported a difference between individually-oriented individuals, who tend to believe that success is more a function of competition than of cooperation, and collectively-oriented individuals, who tend to endorse the opposite view. In this study, collectively-oriented individuals performed significantly better than did individually-oriented team members because the collectively-oriented individuals took advantage of the benefits offered by teamwork [6]. Furthermore, the collectively oriented individuals were able to consider other team members' behavior and believed that a team approach was superior to an individual one. Thus, as Eby and Dobbins suggest, an attraction to being part of a team (i.e., a collective orientation) is a desirable aspect of a positive team attitude [48].

Contextual Factors

Finally, effective teams do not function in a vacuum. Tannenbaum and colleagues have proposed an integrative model of team effectiveness that identifies individual characteristics (i.e., ability, motivation) and team characteristics (i.e., power distribution, cohesiveness) that are relevant to successful team performance [49]. However, this model also emphasizes the

importance of organizational characteristics, such as reward systems and organizational climate; task characteristics, such as task type; and work structure characteristics, like team norms.

Summary

In summary, teams know things, do things, and feel things; moreover, they know, do, and feel within specific environments. Thus, their effective performance depends upon their integrating a host of inter-related personal and situational characteristics. Further, the personal competencies requisite of team members encompass their understanding both the technical and strategic aspects of the assigned task and the strengths and weaknesses of their teammates. Similarly, their requisite skills include, not only performing their own responsibilities and adjusting them when necessary, but also monitoring their teammates' activity and diffusing potential team conflicts. In addition, effective teams exhibit these competencies while maintaining an emotionally positive attitude towards the team itself. Finally, organizational and task characteristics that facilitate and reward the expression of these competencies are likely to enhance teamwork efficacy.

Training Teams

Team training can be defined as applying, to specific competencies, a set of instructional strategies that rely on well-tested tools (e.g., simulators, lectures, videos) [50,51]. Effective team training reflects general principles of learning theory, presents information about requisite team behaviors, affords team members the opportunity to practice the skills they are learning, and provides remedial feedback.

A great deal of research has been devoted to the most effective strategies and techniques for training specific team knowledge, skill, and attitude competencies. A comprehensive review of this research has presented an extensive collection of principles and guidelines concerning the design and delivery of team training [53]. For example, guidelines exist for assertiveness training [52], cross-training [53], stress management training [54], and team self-correction [41].

In addition to the available team-training research and practical guidance, the team competencies presented in Exhibit 1 provide an excellent resource for designing team-training programs. Cannon-Bowers and colleagues contend that team knowledge, skill, and attitude competencies should serve as the starting point for conducting training needs analyses. After establishing a team's specific competency requirements, trainers must specify appropriate training strategies. To meet this requirement, Cannon-Bowers and colleagues offered detailed information on the nature of training required for developing particular team competencies and the strategies that are likely to be successful. For example, they suggest that teams requiring team-specific competencies will benefit from training as intact teams. Furthermore, this training should incorporate feedback that leads team members to share their expectations for task performance. Team members should also be encouraged to explain why they behave as they do

in accomplishing a task. Such strategies enable team members to gain a better understanding of their teammates and to predict other team members' behavior and information needs [21].

Finally, a successful team-training program constitutes more than developing team members' knowledge, skills, and attitudes. For example, because organizational factors outside the training program itself affect the program's success, conducting a needs analysis prior to designing a training intervention is essential to determining the best delivery method or instructional strategy. In addition, training developers should take advantage of the increased practice opportunities provided by certain training tools, such as advance organizers (e.g., outlines, diagrams, graphic organizers), preparatory information, pre-practice briefs, attentional advice, goal orientation, and meta-cognitive strategies [55]. Exhibit 2 provides an overview of strategies matched to the level of training for which each is most appropriate.

EXHIBIT 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 multiple practice and feedback opportunities for trainees	Individual	Smith-Jentsch et al., 1996
Meta-cognitive Training	Targets trainee's executive monitoring and self- regulatory cognitive processes for development; training develops meta-cognitive skills that regulate cognitive abilities like inductive and deductive reasoning	Individual	Jentsch, 1997
Stress Exposure Training (SET)	Provides information regarding links between stressors, trainee affect, and performance; provides coping strategies to help trainees deal with stressors	Individual and Team	Driskell & Johnston, 1998

Simulator Training	Training in a constructed environment that safely reproduces the conditions, equipment, and performance demands that trainees will experience on the job	Individual and Team	Salas, Dickinson, Converse, & Tannenbaum, 1992
Team Training	Provides interventions that facilitate (a) information presentation, (b) demonstration of teamwork behaviors and skills, (c) opportunities to practice, and (d) diagnostic feedback to help trainees develop the necessary competencies, at both the individual and team level, to complete their assigned tasks safely and effectively	Team	Salas & Cannon-Bowers, 2000a; Salas et al., 1997
Cross-Training	Giving team members practice in performing other team members' roles and tasks; teammates develop an understanding for the tasks, duties and responsibilities of coworkers; strategy develops team members' inter-positional knowledge and shared mental models; increases team coordination and reduces process loss from change in personnel	Team	Salas et al., 1997; Volpe, Cannon-Bowers, Salas, & Spector, 2001
Team Coordination Training/ Crew Resource Management	Training to improve team coordination and communication (both explicit and implicit), to encourage backup behavior, and to provide practice opportunities for other KSAs that lead to effective coordination; focuses on teaching team members the basic process underlying teamwork; widely applied in aviation, military, and medical communities	Team	Entin & Serfaty, 1999; Bowers, Blickendersfer, & Morgan, 1998

Team Building	Focuses on improved role clarification, goal setting, problem solving or interpersonal relations; however, recent meta-analytic evidence suggests that team building only increases performance on subjective criteria, such as role clarification.	Team	Salas, Rozell, Mullen & Driskell, 1999
Self-Correction Training	Helps individuals correct and evaluate own and team behavior (e.g., initiative, communication); teaches techniques for monitoring and then categorizing effectiveness of own behavior; generates instructive feedback so that team members can review performance episodes and correct deficiencies	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 well incorporate more than one methodology.

Simulator-Based Training

The fidelity of the training environment to the actual conditions under which the team will perform is an important factor in designing team training. Training-environment fidelity comprises any or all of three elements: stimulus fidelity (i.e., trainees experience the same "behavioral trigger" that they will experience on the job); response fidelity (i.e., trainees perform 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]. Because a high level of training-environment fidelity is particularly useful in training teams that will perform under stressful conditions, simulator training is especially appropriate in medical fields, like surgery, emergency medicine, neonatal care, etc. In fact, some researchers suggest that training be conducted under the same stressful conditions that the team will encounter operationally [54].

Although high-fidelity training simulations do not automatically yield effective training, simulations, at their best, reproduce realistic tasks and afford trainees practice that enhances learning [56]. In a team setting, simulators allow teams the opportunity to practice both team- and task-related skills. Context-specific cues imbedded within the simulation provide trainees with signals that activate trained behaviors. In addition, simulators provide opportunities for team members to receive feedback on the actions, activities or strategies performed or not performed. A supplementary benefit of simulation training is that it allows training instructors to identify

performance decrements and particular situations that require further training. As highlighted in a later discussion, anesthesiology has been a major proponent of the use of simulation to train team skills.

Finally, a training strategy that might be considered a subset of simulation training--scenario-based training (SBT)/event-based approach to training (EBAT)--enhances the performance of individuals and teams in technology-rich environments. SBT/EBAT presents the training exercise itself as the curriculum. It is based on the systematic linkage among all aspects of scenario design, development, implementation and analysis and 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. Trainees are given feedback regarding their responses. The training objectives are accomplished by embedding specific "trigger" events into the scenario or exercise.

The primary goal of SBT/EBAT is to provide opportunities for trainees to develop critical competencies by receiving practice in simulated environments that are representative of actual operational conditions and receiving feedback linked to specific events that occur during training. SBT/EBAT has been empirically tested and operationally demonstrated in a variety of team-training environments [57,58]. Thus, like other simulator-based training, this scenario-or vignette-based technique shows great promise as a strategy for training medical providers who must coordinate their efforts, especially in situations that constitute a high risk of jeopardizing patient safety (e.g., emergency rooms, intensive care units).

Team-Coordination Training

Another technique widely used for team training is team-coordination training (TCT). TCT concentrates on teaching team members about the basic processes underlying teamwork. It typically targets several team competencies needed for successful performance in a particular environment. TCT is usually delivered through a combination of information, demonstration (e.g., video examples), and practice-based methods (e.g., role plays) over two to five days. Research supports its effectiveness in terms of positive reactions, enhanced learning, and behavioral change. When applied in aviation, this strategy is also referred to as Crew Resource Management (CRM) training. CRM, discussed in detail in the next chapter, is a family of instructional strategies that seeks to improve teamwork in the cockpit by applying well-tested training tools (e.g., simulators, lectures, videos) targeted at specific content (i.e., teamwork knowledge, skills, and attitudes) [38]. Additionally, as emphasized in a later discussion, CRM has provided the model for much of the current medical-team training.

Team Self-Correction Training

The last three training methods noted here--self-correction training, cross-training, and stress-exposure training--reflect strategies that trainers can incorporate wherever appropriate. First, team self-correction is the naturally occurring tendency for effective teams, following a performance episode, to review events, correct errors, discuss strategies and plan for the future

(i.e., to debrief themselves). Because this process focuses on identifying and correcting errors, it is particularly relevant to medical-team performance as it relates to patient safety [59].

Self-correction training, delivered through a combination of lecture, demonstration, practice, and feedback, analyzes this tendency and trains teams to practice it. Team members learn to observe their performance, to categorize their effective and ineffective behavior into a structured format, and to use this information to give each other feedback [55]. When guided by a competent instructor, this method of team training has been demonstrated to improve team performance.

Cross-Training

Second, cross-training exposes team members to the basic tasks, duties, and responsibilities of the positions held by other members of the team; the purpose is to promote coordination, communication and team performance. Ideally, this training alleviates the decline in performance that is likely to follow personnel changes; it also increases implicit coordination (i.e., being able to coordinate without the need to communicate explicitly). The training comprises sharing cross-role information (teammates, task, equipment, situation); enhancing team members' understanding of interdependencies, roles and responsibilities; and providing cross-role practice and feedback. Research has demonstrated that, compared their counterparts who were not cross-trained, cross-trained teams better anticipate the information needs of their teammates, commit fewer errors, and display a higher quality of team process [55]. Again, these advantages are germane to training medical teams to perform in a manner that ensures patient safety.

Stress-Exposure Training

Stress can exert a significant negative influence on an individual or a team's ability to perform effectively, especially in high-stress environments that are characterized by ambiguous situations and severe time pressure (e.g., military operational environment, medical emergency departments). Stress-exposure training (SET) reduces stress through a three-phase program designed to provide trainees with information, skills training, and practice. SET improves performance by providing team members with experience in the stressful environment, thereby helping them learn what to expect. Practice takes place under graduated exposure to stressors. Documented outcomes of SET include reduced anxiety in stressful situations, increased confidence, and improved cognitive and psychomotor performance under stress [54]. Given that few circumstances are as potentially stressful as the life-and-death decisions and demands that may face a medical team, successfully coping with stress would seem to be an especially pertinent aspect of medical-team training.

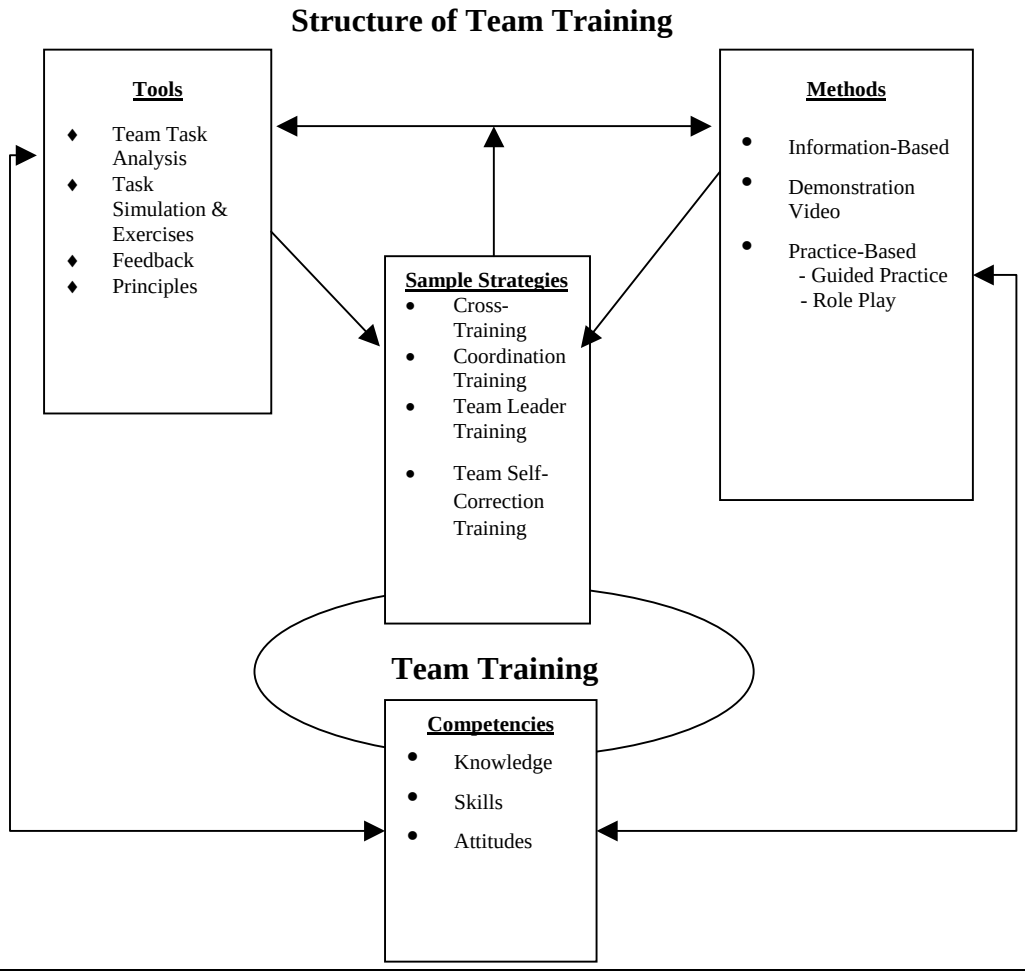
Meta-Cognition Training

Finally, meta-cognition training teaches team members to monitor and modify their decision-making *processes*, rather than focusing solely on the results of individual decisions. Such training enables team members to develop reasoning and problem-solving strategies that they can apply to the challenges the team encounters. This strategic aspect of decision-making is particularly useful in managing stressful situations [60].

Method Conclusions

As our discussion of the above strategies demonstrates, team training is a set of tools, methods, and content that focuses on enhancing teamwork. Team training is not a place; rather, it is an intervention that is based upon sound instructional principles and carefully crafted instructional strategies. Exhibit 3 provides an overarching framework that illustrates the factors needed to design and deliver an effective training program (Cannon-Bowers & Salas, 2000).

EXHIBIT 3. FRAMEWORK FOR DESIGNING AN EFFECTIVE TEAM TRAINING PROGRAM--ADAPTED FROM (53)



Summary

The preceding chapter has discussed the elements that typify effective teamwork and effective team training. With respect to effective teamwork, high-performing teams exhibit a sense of collective efficacy. They recognize that they are dependent upon each other and believe that, working together, they can solve complex problems. Moreover, effective teams are dynamic: they optimize their resources, engage in self-correction, compensate for each other by providing back-up behaviors, and reallocate functions as necessary. Because they can often coordinate without communicating overtly, effective teams can respond efficiently in high-stress, time-restricted environments. Finally, effective teams recognize potential problems or dangerous circumstances and adjust their strategies accordingly.

To design training that will improve teamwork skills on the job is a challenge. In virtually any field, team training requires a comprehensive, sustained strategy that targets many aspects of teamwork. Teams operate in complex and dynamic environments that are characterized by multi-component decisions, rapidly evolving and ambiguous situations, information overload, severe time pressure, and severe consequences for error.

Yet team training is charged with improving trainee competencies (e.g., knowledge, skills, attitudes) and facilitating desirable performance outcomes (e.g., safety, timely and accurate responding, patient welfare) under these demanding conditions. This chapter has proposed that effective training programs (1) systematically represent sound theory and 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 aviation constitutes a field in which mistakes can cause an unacceptable loss of life and property, the flight industry has been in the forefront of developing teamwork training to reduce risk. Among the team-training programs that have evolved within aviation, the best known is Crew Resource Management (CRM) training. For over 30 years CRM training has endeavored to improve the margin of safety in aviation.

Recent research suggests that CRM training results in heightened safety-related attitudes; improved communication, coordination, and decision-making behaviors; and enhanced error-management skills [61,14]. CRM training has also demonstrated consistently positive results across a wide range of team structures, including pilot crews, maintenance crews, dispatch crews, and air traffic control teams [62,63,64].

As documented by Helmreich and colleagues, CRM training has advanced through five different generations [65]. Across these generations it has grown from focusing solely on awareness and attitude change, to incorporating behavioral-skills training, to integrating training in teamwork with training in technical flying skills, as is the case with the FAA's new Advanced Qualification Program (AQP). Recent reviews suggest that CRM training results in positive reactions to teamwork concepts, increased knowledge of teamwork principles, and improved teamwork performance in the simulator [66]. In addition, pilots trained under the AQP paradigm report liking training, as well as perceiving it as function-oriented and useful [67,68].

CRM's effect on the ultimate criterion – a reduction in the number of accidents – has yet to be empirically established [66]. However, accidents represent a poor criterion methodologically because they exhibit an extremely low base rate [62]. Thus, researchers have relied on surrogate measures – like improvements in teamwork-related knowledge and skills, behavioral demonstrations of CRM skills on simulated flights, instructor evaluations of trained versus untrained crews, and changes in an organization's safety culture – to demonstrate the effectiveness of CRM training [69,62,70,71,72].

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, in fact, improve the margin of aviation safety. In short, the reasonable inference is that if trainees demonstrate improvement in critical teamwork-related competencies during training and if they consistently apply these skills in the post-training environment, the ultimate outcome will be safe flights.

Evolution of the CRM Model in Commercial Aviation

To meet the demand for qualified pilots, many commercial airlines actively recruited individuals who had previously flown in the military. These pilots brought with them a culture that valued respect for authority and reluctance to question orders, even when orders contradicted standard operating procedures. To offset this military mindset, the earliest CRM training programs, developed during the 1980's, were designed to decrease authoritarianism among Captains and to encourage assertiveness among First Officers.

Many of these programs were based on a popular leader development course known as the "Managerial Grid" [73]. Drawing on research from the manufacturing industry, the Managerial Grid demonstrated that effective leaders direct their subordinates' task-related efforts while simultaneously remaining considerate of their feelings [74,75]. The early CRM programs did much to educate pilots about the importance of teamwork in the cockpit. Nevertheless, because these programs focused on general CRM concepts – rather than on specific, behavioral skills – they were not universally accepted [65].

In 1986, the National Aeronautics and Space Administration (NASA) hosted an industry-wide conference to identify the best practices in CRM training [76]. The participants identified a number of strategies for improving the effectiveness of CRM training. One strategy was to provide behavior-based training in specific teamwork skills, such as communication, situational monitoring, decision-making, and stress management. Another recommendation was to use behavioral models that demonstrate effective and ineffective teamwork behaviors in the cockpit. Once implemented, these changes greatly increased pilots' acceptance of CRM training [65].

In the early 1990's several airplane manufacturers included automation as a standard feature in their navigation and propulsion systems, an advance that fundamentally changed the nature of flying. Rather than using the yoke and rudder to control the aircraft directly, pilot crews now controlled it through automated tools. In essence, they became information managers who intervened only when changes were necessary or when unanticipated situations arose [77,78].

The introduction of automation ushered in a series of new problems, among which were mode-awareness errors (e.g., the automation does something that the crew had not expected) and complacency errors (e.g., the crew fails to monitor the automation) [77,78]. To remedy these problems, the airlines began offering special courses in automation management and began integrating CRM skills training with technical skills training. To reinforce these CRM principles, a handful of airlines also integrated specific CRM behaviors – like establishing bottom-line safe criteria and backup plans during pre-flight briefings – within their standard operating procedures [57]. Some airlines even provided joint CRM training for both cockpit and cabin crews [65]. At present, all commercial airlines are required to provide CRM skills training, including the use high-fidelity Line Operational Simulations (LOS) that mimic realistic flight

conditions [79,80]. These programs all embody a three-phase approach that has been recommended by the FAA [81]. These phases—providing trainees with knowledge information, providing trainees with practice and feedback, and providing trainees with recurrent training opportunities—remain the hallmark of CRM training wherever it is implemented.

In the 1990's, the Federal Aviation Administration launched the Advanced Qualification Program (AQP), a voluntary alternative to traditional pilot training under 14 CFR Part 121 [82,83]. Unlike Part 121 training, which is standardized across airlines, AQP allows substantial flexibility in fleet-specific training programs. The difference underlying this standardization-flexibility distinction reflects a basic difference in training strategy. Whereas Part 121 traditionally requires trainees to expend a specific number of *hours* practicing each skill or set of skills, AQP requires trainees to demonstrate skill *proficiency*, regardless of how few or many hours they spend in achieving a proficient level. Moreover, AQP, unlike Part 121, integrates CRM and technical skills throughout the training curriculum; Part 121 includes CRM but it is a stand-alone event. AQP training culminates with intact aircrews flying a Line Operational Evaluation (an simulation-based evaluation of CRM and technical skills) rather than a standard maneuvers check to certify pilots for line flying. Most of the nation's major air carriers now train some or all of their fleets under AQP guidelines. Recent research suggests that, compared to the reactions of their Part 121-trained counterparts, AQP-trained pilots like their training more, as well as perceiving it as more line-oriented and more useful [67,68].

CRM Summary

As practiced currently, CRM training meets the criteria we mentioned in our discussion of assessing team competencies. That is, CRM focuses on trainable, measurable skills that are crucial to successful performance. As such, its methodologies theoretically apply to virtually any medical domain in which effective teamwork minimizes error and enhances patient safety.

Team Training in the Military

A second high-risk context in which the consequences of error can be dire is military service. Thus, not surprisingly, the military has also contributed significantly to the growth and advancement of team training.

The History of Military Team Training

Despite the fact that teamwork has long been recognized as one of the most important ingredients of a military unit's fighting power, the military's adoption of structured team training approaches has occurred fairly recently. Team training originally focused on the role of the team leader. Team spirit and teamwork were seen as the commander's responsibility [84,85]. The trend towards more formal team training began with work by Briggs and his colleagues [86] in the mid-1960's and early 1970's. These researchers provided the initial breakthrough in military team

research by distinguishing team skills from individual, specifically task-related, skills. The Navy and the Army sponsored similar research on team performance [87,88].

The watershed for military team and team-training research was USS Vincennes' accidentally shooting down an Iranian Airbus in the Persian Gulf in 1988. In response to this incident, the Navy began a multi-year, multi-million dollar research program to formally study teamwork and team training interventions. The program, called Tactical Decision Making Under Stress (TADMUS), began in 1990 and led to breakthrough advances in the science and practice of team training in the Navy: "By almost anyone's standard, TADMUS has turned out to be an unqualified success" [89]. Results of the program have highlighted new approaches to team training, such as inter-positional knowledge (cross-) training, mental-model training, and team self-correction training, all of which have become part of current team training approaches.

Following the Navy's lead, in the 1990s the U.S. Air Force and the U.S. Army also supported theoretical and applied research on team performance and team training [90,91], with both programs' leading to new and improved team training [91]. In fact, as Salas, Bowers, and Cannon-Bowers pointed out in 1995, "Much [had] been accomplished since Dyer's (1984) seminal review" [9]. These research and practice results were incorporated into what has become the current state of military team training.

Military Team Training in the Present

Some type of formal team training is now a major component of training in most branches of the U.S. Armed Forces. For example, all branches of the Armed Forces give pilots and other aircrew a military version of CRM, ranging from Fighter Resource Management (FRM) for single-seat fighter pilots to CRM training for the large crews that staff transport and patrol aircraft [92] et al., 1998). Current military aviation team training is again adopting the best practices of civil aviation, such as the Advanced Qualification Program (AQP), and combining these practices with traditional military training and cutting-edge technology.

In addition to pilots and other aircraft crew members, many sailors, soldiers, airmen, and Marines also receive team training. For example, the Navy, having tested several team-training approaches [93], has recently adopted an approach called Team Dimensional Training (TDT), which resulted from the TADMUS program [55]. TDT, addresses team-related knowledge and skills, provides practice in briefing and debriefing, and trains trainers and team leaders to evaluate and critique team skills [94]. It has been tested in teams as different from one another as submarine attack center teams, seamanship and shipboard damage control teams, naval aircrews, and surface warfare teams. In short, TDT trains teams to correct themselves, as well as training team leaders to guide their members through the self-correction process [41].

Given the current military trends towards increased combined-arms operations, improved communications and control, and higher complexity of weapons and materiel, the importance of team training in the military will continue to grow. New training-development and training-

delivery technology, such as scenario generation software, Virtual Environment simulations, and advanced distributed-simulation facilities, have made it possible for personnel and units across widely dispersed locales to train together and to exchange feedback. In response to these innovations, team training and team-training research must sharpen its focus, to combine results from research on teams with existing and emerging technology [95].

Additionally, measuring team performance [96] and adopting advanced training technologies [97] will give rise to new issues. For example, the military will face the challenge of incorporating into team training such emerging research topics as metacognition [98], team adaptation [99], and stress management [54]. Finally, given the constraints, budget limitations, and personnel issues (e.g., turnover) that exemplify the real world, building transitions between research findings and real-world applications will continue to be a challenge.

Summary

This chapter has examined the empirical evidence concerning team performance and team training in high-risk contexts, whether "risk" is conceptualized as physical or economic failure. Given that serious misfortunes resulting from human error are relatively rare in aviation and in military forces not involved in warfare, empirically linking team performance to the "ultimate criterion" of reducing these errors is difficult. Nevertheless, taken as a whole, research on teams has evinced a strong relation between effective team performance and desirable "proxy" criteria, such as flexibility, adaptability, ability to reallocate resources, and resistance to stress. Additionally, teams yield valuable process-oriented benefits, like cohesion, retention, and morale [100,101].

Given the pervasiveness of these findings, inferring that successful teamwork might substantially reduce severe life-threatening medical errors is not unreasonable. Thus, we view the relations documented in this chapter—as well as the more general team and team-training information presented in Chapter 2—as relevant to medical team training. The next chapter turns to a discussion of existing medical team-training programs *per se*.

CHAPTER 4: MEDICAL-TEAM TRAINING

The Case for Medical-Team Training

Throughout the healthcare community small groups of individuals work together in intensive care units (ICU), operating rooms, labor and delivery wards, and family-medicine practices. To make safe and efficient patient care a priority, physicians, nurses, pharmacists, technicians, and other health professionals must coordinate their activities. However, even though a myriad of the conditions addressed by healthcare professionals require interdisciplinary teams, members of these teams are rarely trained together; furthermore, they often come from separate disciplines and diverse educational programs.

Given the interdisciplinary nature of the work and the necessity of cooperation among the workers who perform it, team training is critical to ensuring patient safety and avoiding errors. As previous chapters have noted, teams make fewer mistakes than do individuals, especially when each team member knows his or her responsibilities, as well as those of other team members. Consistent with healthcare's increased emphasis on team training, the Agency for Healthcare Research and Quality (AHRQ) advocates a cultural shift from denying the presence of medical errors to openly discussing, learning about, and preventing them. In fact, AHRQ has taken the lead in coordinating these efforts: during fiscal year 2003, AHRQ allocated 50 million dollars to fund a systematic program of research geared towards reducing errors and improving patient safety (http://www.ahrq.gov/research/oct01/1001ra25.htm). These funds support programs on such topics as adverse drug events, infection control, surgery and anesthesia, pain management, organizational/cultural issues, human factors, and information technology [102]. CRM or team training programs – which fall under the domain of "human factors" – are one means for helping to bring about this cultural shift.

Moreover, AHRQ is not alone in recognizing the importance of teamwork for improving the performance of medical professionals. In concert with AHRQ's goals, the Accreditation Council for Graduate Medical Education (ACGME) recently identified several teamwork-related competencies that surgical-training residents must master. These competencies include communication with patients and significant others, patient counseling and education, working with other healthcare professionals, and facilitating the learning of students and other healthcare professionals [103].

Similarly, the Association of American Medical Colleges (AAMC) recently funded a "critical incident" analysis to investigate the behaviors that result in successful and unsuccessful performance during medical school and residency. The results revealed the importance of a number of teamwork-related competencies, including interpersonal skills and professionalism,

interacting with patients and family, fostering a team environment, and mentoring/educating other students [104].

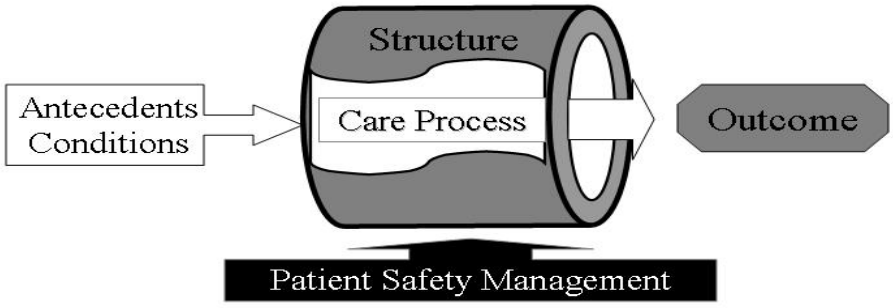
Medical-team training programs derived from CRM began with the introduction of Anesthesia Crisis Resource Management (ACRM) training at Stanford University School of Medicine and at the Anesthesiology Service at the Palo Alto Veteran Affairs Medical Center [105]. It might be noted that AHRQ's 2001 review of in-place patient safety practices critiqued the ACRM model, citing it as high in impact but low in evidence supporting its effectiveness [5]. More recently, the Department of Defense (DoD) has funded several other CRM-derived team-training initiatives. Specifically, MedTeams™ [106] has been implemented in a number of Army and Navy hospitals, whereas Medical Team Management (MTM) [10] has been introduced into several Air Force facilities.

Although some preliminary research has addressed the effectiveness of ACRM and MedTeams, research on defining and training the necessary competencies for effective healthcare teamwork, as well as research on evaluating the results, is still in a formative stage. This chapter evaluates the state of the art in CRM-derived medical-team training and documents its best practices. We begin by presenting two theoretical models of patient safety to guide our consideration of research issues.

Donabedian's Model of Patient Safety

Donabedian's structure-process-outcome model has 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, process as the treatments and procedures that are done for patients, and outcomes as the result that patients experience. From the standpoint of patient safety, Donabedian's model, shown in Exhibit 4, provides a framework for examining how risks and hazards that are embedded within the structure and process of care have the potential to cause injury or harm to patients. For example, individual or team failures on the part of healthcare providers have been consistently cited as leading to negative patient outcomes.

EXHIBIT 4. THE DONABEDIAN MODEL OF PATIENT SAFETY



Adjust structure and process to eliminate or minimize risks of health care associated injury before they have an adverse event impacts on the outcomes of care

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

These patient safety models, both of which denote that *processes* must be evaluated according to the *outcomes* they generate, have garnered substantial support within the healthcare community. Moreover, we believe that the perspective they offer is as vital to evaluating the effect of teamwork and team training as it is to assessing the effect of any other care-giving process. Thus, as we review the primary medical-team training programs being implemented currently, these two models underscore our ultimate focus on defining effectiveness in terms of patient outcomes, particularly as they relate to patient safety.

Structure of Review

During the past few years, the medical field has developed a number of medical-team training programs, some implemented in the military and some developed for commercial medicine. Certain of these programs are domain-specific (e.g., anesthesia), whereas others are multi-disciplinary. Some rely heavily on state-of-the-art simulators, whereas others primarily use classroom techniques. Despite these differences, all share the common characteristic of being inspired by CRM and the common goal of reducing the number and severity of medical errors via the application of teamwork-skills training.

The following discussion compares the *purpose*, *strategy*, and *effectiveness* of three of the best-known medical-team training programs: Anesthesia Crisis Resource Management (ACRM), MedTeams, and Medical Team Management (MTM). Because purpose and strategy are closely linked, we address these two issues together, in a discussion that also includes our indicating the extent to which each program incorporates the three facets that define CRM: providing knowledge information, offering opportunities for practice and feedback, and offering recurrent opportunities to sustain training.

Our effectiveness discussion addresses the evaluation research related to each program; however, as already mentioned, we are particularly concerned with documenting, or noting the absence of, team-training evaluations that rely on patient-outcome criteria. Finally, to highlight further the evidence of CRM-derived team training in healthcare, we also review three lesser-known programs—Team-Oriented Medical Simulation (TOMS), Dynamic Outcomes Management (DOM), and Geriatric Interdisciplinary Team Training (GITT).

Anesthesia Crisis Resource Management (ACRM) Program

ACRM Purpose and Training Strategy

Like MedTeams and Medical Team Management (MTM), the Anesthesia Crisis Resource Management (ACRM) program is derived from CRM. However, unlike MedTeams and MTM, ACRM encompasses a *family* of training programs, rather than a specific intervention. Thus, ACRM training bears more similarity to CRM aviation training than do the other two programs.

Developed by Gaba and his colleagues at Stanford University and at the Palo Alto Veteran Affairs (VA) Medical Center, ACRM is designed to help anesthesiologists effectively manage crises by working in multi-disciplinary teams that include physicians, nurses, technicians, and other medical professionals [109,58,105]. To facilitate this goal, ACRM training provides trainees with precompiled responses to critical incidents; trainees refer to these responses as needed [110]. More generally, ACRM provides training in specific technical skills and in generic teamwork skills. Training in the selected teamwork skills is intended to enable

trainees to learn from adverse clinical occurrences and to work effectively with different personality types [111]. Specifically, ACRM training focuses on ten teamwork skills: developing a thorough case orientation, making inquiries and assertions, communicating, giving and receiving feedback, exerting leadership, maintaining a positive group climate, anticipating and planning, managing workload distribution, maintaining vigilance, and re-evaluating actions.

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

The ACRM curriculum comprises three full days of simulation training. Day 1 provides an introduction to ACRM principles and skills. Day 2 provides a refresher on these skills and analyzes clinical events from the perspective of the clinician's technical and teamwork skills and from the perspective of the organization as a larger system. Day 3 emphasizes leadership training, debriefing skills, and adhering to the procedures established to deal with adverse clinical events. Each training module comprises a similar structure: pre-assigned readings, course introduction and review of materials, familiarization with the simulator, case study analysis and videotape reviews, and six hours of participating in simulator scenarios, followed by an instructor-led debriefing and a post-course data collection. Each scripted training scenario is approximately 45 minutes long; each debriefing session lasts about 40 minutes [58].

Several instructors are required to run the ACRM training scenarios. They may include a retired OR nurse who role-plays the circulating nurse and an anesthesiologist instructor who role-plays the operating surgeon. In addition, a simulation director monitors and records the simulation from another room, communicating with the instructors via two-way radios. Throughout the simulation, trainees rotate through various roles, such as "first responder," "scrub technician," and "observer." [58].

ACRM training, complete with yearly refresher training, is currently used at several major teaching institutions, including Harvard University. At some centers, ACRM training is offered for experienced practitioners as well as for trainees. Moreover, it is sufficiently respected that some malpractice insurers have lowered their rate structure for ACRM-trained anesthesiologists. Moreover, to continue developing ACRM's general strategy, the three centers that co-developed ACRM have also developed a Working Group on Crisis Management Training in Health Care to provide guidance and to set training standards [58].

The development of ACRM training was based on the best practices from CRM training in aviation [109], including an adaptation of crew performance functions, such as the Line/LOS

checklist [113]. However, ACRM only focuses on the second phase of CRM advocated by the FAA – skill practice and feedback – the knowledge development phase and recurrency training have yet to be incorporated.

ACRM strengths. To summarize, ACRM has a number of desirable qualities. First, it provides trainees with three days of hands-on skills practice in a simulated OR. Second, each scripted training event is followed by a detailed instructor-led debriefing that identifies lessons learned and recommends strategies for improvement. Third, because it takes place in a simulator, ACRM training allows trainees to experience situations – such as the "death scenario" – that would be impossible or unethical to replicate in an actual OR. Finally, ACRM uses cross-training to allow each participant to experience the learning process from a different perspective [58].

ACRM Limitations. Nevertheless, ACRM training evinces certain program limitations that future iterations might address. First, the training is not actually multi-disciplinary because instructors, not fellow-trainees, play the roles of nurses and physicians; in other words, trainee teams do not practice teamwork in ACRM simulations [110]. Consequently, given the importance of training teamwork skills, we believe that ACRM would benefit from developing a training strategy that encompassed genuine interdisciplinary team training.

In a related vein, to the extent that ACRM focuses on the role of teamwork skills in the OR, it emphasizes applying these skills to emergency situations and devotes substantially less attention to the role teamwork plays in non-emergency situations [110]. Thus, ACRM developers might enhance the program's purpose and strategy by incorporating a more even distribution of emergency versus non-emergency events in the training scenarios.

Third, by focusing on full-fidelity simulation, ACRM ignores other forms of learning (e.g., behavioral models using videotaped examples, classroom instruction, case studies, part-task trainers, etc.); yet such methods might be particularly useful in providing trainees with knowledge, prior to their simulator practice. Simulation works best for training the *application* of facts and theories, motor skills, and attitudinal competencies *after* trainees have acquired an initial knowledge base [112]. As a result, ACRM might place trainees in the simulated scenarios before they have mastered the factual information that is necessary for effective performance. More emphasis on developing an initial knowledge base among trainees might therefore be a worthwhile strategy to contemplate.

The final limitation involves cost. ACRM focuses exclusively on the role of the anesthesiologist in the OR, a somewhat limited application, considering that the initial cost of purchasing a commercial simulator (not to mention the cost of operating it) can exceed 200,000 dollars [112]. The magnitude of such an investment might well prohibit many institutions from implementing ACRM training.

ACRM Effectiveness

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

Most of the thousands of participants who have undergone ACRM training evaluate it favorably, even the "death scenario," which is specifically designed to assess how trainees handle losing a patient; these positive responses generally last for up to six months after training [111]. Furthermore, recent research suggests that participation in ACRM training also increases trainees' self-efficacy and decreases their self-reported anxiety [116].

Despite these positive assessments, to our knowledge, no studies have taken the next logical step of directly investigating the link between team process and patient-safety criteria. In fact, virtually no research has tested the effect of any aspect of ACRM training on actual performance outcomes. With respect to *individual* (i.e., technical) performance, this lack of outcome-related validity derives, at least in part, from the difficulties associated with quantifying the performance of anesthesiologists [114].

However, with respect to assessing the effects of *team process*, the lack of outcome-related validity cannot be explained so easily because programmed outcomes are embedded into the ACRM training scenarios (e.g., the "death scenario"). Thus, we believe that developing measures to assess the effectiveness of teamwork in facilitating positive outcomes and in successfully managing, if not avoiding, negative outcomes would constitute a constructive focus for future research. Furthermore, given the current state of simulation, devising training scenarios for which the outcome is *contingent upon* the level of trainees' demonstrated teamwork skills might also be worthwhile.

The MedTeams™ Program

MedTeams™ Purpose and Strategy

First tailored to emergency medicine, MedTeams is based on the CRM training program that was originally developed to train U.S. Army helicopter crews in specific behavioral skills [117,106]. The MedTeams developers, Dynamics Research Corporation (DRC), had noted that emergency medicine and aviation share a number of similarities, such as the need to make decisions that are based on incomplete or conflicting information, the demand to coordinate

among professionals with varied skills and ranks, and the possibility that poor team performance will lead to serious consequences, including death [118].

The sole purpose of MedTeams is to reduce medical errors through fostering interdisciplinary teamwork. It was founded on the theory that most errors result from breakdowns in systems-level processes that unfold over time [119,120]. According to the MedTeams curriculum, each team member has a vested interest in maintaining patient safety and is expected to take an assertive role in breaking the error chain [120]. Because the composition of the teams it trains varies on a day-to-day or shift-by-shift basis, MedTeams's training strategy focuses on building generic, not context-specific, teamwork skills and behaviors.

The MedTeams training was developed from an evaluation-driven course design. Based on a needs-analysis data, DRC identified five critical dimensions that were necessary for effective teamwork. They then identified 48 specific, observable behaviors that were linked to these dimensions and constructed Behaviorally Anchored Rating Scales (BARS) [121] for each behavior. Finally, to establish its content validity, they reviewed and refined the curriculum during three five-day expert panel sessions that included Emergency Department (ED) physicians and nurses from 12 hospitals of various sizes [122].

MedTeams defines a core team as a group of three to ten (average = 6) medical personnel who work interdependently during a shift and who have 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 manages several core teams, assigns new patients to the core teams, and provides additional resources as necessary. To ensure that team members can easily recognize one another, they wear visible armbands, badges, or colored scrubs that identify them as members of a particular core team [120].

The MedTeams course constitutes an eight-hour block of classroom instruction that contains an introduction module, five learning modules, and an integration unit. Supplementary materials include a 30-minute video that depicts examples of good and bad performance. After completing the classroom training, each team member participates in a four-hour practicum that involves practicing teamwork behaviors and receiving feedback from a trained instructor. Coaching, mentoring, and review sessions are also provided during regular work shifts [122].

The post-classroom component of MedTeams training lasts for approximately six months. The program employs a number of tools for sustaining effective team performance, such as trainees' monitoring one another's performance. In addition, routine team meetings ensure team members' continued focus; formalized mechanisms (e.g., status boards) are used to keep team members informed about particular patients; and refresher training is available. Finally, MedTeams requires that nurses routinely participate in meetings and that performance evaluations directly consider teamwork issues [124]. Thus, MedTeams also incorporates all three aspects of CRM training.

MedTeams™ Strengths. In summary, MedTeams evidences a number of desirable qualities. First, it was developed by conducting a needs analysis using archival records drawn from the EDs of several hospitals, a procedure that highlighted key performance dimensions and provided information for developing specific behavioral markers [125]. Second, customized versions of MedTeams are now being developed for labor and delivery units, ORs, and ICUs [125]. Third, MedTeams offers annual refresher training to maintain proficiency in teamwork skills. Fourth, MedTeams requires that trained staff members participate in development projects or practica to address specific intra- and inter-departmental teamwork issues [126]. Fifth, MedTeams provides trainees with physical tools (e.g., checklists, quick reference cards, flow diagrams) that they can periodically review and use during their daily activities. Finally, MedTeams is interdisciplinary in nature, thereby teaching physicians, nurses, technicians and other key constituencies to work together.

MedTeams™ Limitations. Nontheless MedTeams also exhibits certain limitations. First, much of the eight-hour classroom instruction focuses on mastering declarative knowledge. Substantially less time is devoted to the type of skills practice provided by ACRM training. Second, MedTeams does not employ a cultural assessment/evaluation component prior to implementing the training; as a result, it is entirely possible that MedTeams only works in hospitals that have already made a commitment to teamwork, secured upper-level management support, established an open, non-punitive atmosphere that embraces errors as an opportunity for learning, and recognized the need for change [28]. (Of course, despite its being mentioned in the literature concerning MedTeams, this objection accrues 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—whereby trainers return to their sites of origin to train their colleagues—it does not appear to provide any mechanisms for preventing performance degradation among trainers over time.

MedTeams™ Effectiveness

MedTeams's evaluation tactics are perhaps the most thorough among the three programs because it has used a quasi-experimental research design [28,106]to assess a variety of process factors (e.g., quantity of teamwork behaviors) and enabling factors (e.g., attitudes toward teamwork, staff burnout) over a one-year period. More significantly from our viewpoint, the Morey and colleagues' investigations have also demonstrated the positive effect of training on *outcome criteria* (e.g., medical errors, patient satisfaction).

The major limitation of this research was that the participating hospitals self-selected into either the experimental or control groups. To address this limitation, a subsequent evaluation of MedTeams in Labor and Delivery units is currently underway, using a randomized clinical trial design [127]. Thus, regardless of its other drawbacks, the MedTeams training developers are focusing their evaluations on criteria that Donabedian and Coyle and Battles deem most critical: patient-related outcomes [107,108].

The Medical-Team Management (MTM) Program

The impetus for the U.S. Air Force's developing Medical-Team Management (MTM) training was its recognition that the primary cause of serious negative events was poor communication and ineffective teamwork. MTM training is thus based on the Air Force's fighter pilot CRM training program, in which team communication plays a crucial role in maintaining effective team performance [128].

MTM Purpose and Training Strategy

The Air Force developed MTM training specifically in response to an incident at an Air Force facility in which poor teamwork caused a newborn to develop neurological problems [129]. Similar to MedTeams, the primary purpose of MTM is to reduce medical errors, in this case by teaching human-factors concepts to interdisciplinary teams of medical professionals [130,10]. A secondary purpose is to change the military's traditional medical culture, which focuses on individual performance, an emphasis that creates communication barriers. In contrast, MTM specifically fosters a culture that values team performance and encourages effective communication [130]. Its theoretical position is that this new culture will facilitate teamwork, thereby reducing errors.

MTM training is more lengthily distributed than is either of the other two programs. It comprises two major components: a three-day, train-the-trainer course and a military treatment facility course. Potential trainers have at least five years of clinical experience in their specialty areas and at least one year of time remaining in the armed forces. Furthermore, they must be competent speakers. Finally, previous experience in delivering training is desirable. Graduates of the train-the-trainer course return to their respective sites to train the remaining staff in human-factors principles [129].

The train-the-trainers course is facilitated by a team of instructors who have participated in its development. All of the instructors for this course are officers and either experienced physicians or nurses. Because the MTM training is designed to be interdisciplinary, participants include physicians, nurses, medical technicians, lab technicians, pharmacists, ward clerks, and admissions clerks, from both in- and out-patient settings [131,10].

The military treatment facility course consists of three phases. Phase 1 is a web-based training course that provides background information on human factors principles. The course is self-paced and lasts from two to four hours [128,132]. It includes a series of pre- and post-tests to assess trainees' grasp of human factors concepts.

Phase 2 takes place in a classroom environment approximately four to six weeks later. During Phase 2, trainees learn with their team members. The classroom instruction uses didactic lectures, seminar participation, application questions, behavioral modeling, and case studies to

reinforce and build on the principles learned during Phase 1 [10]. The model for Phase 2 consists of four one- to two-hour sessions each week for four weeks [132].

Phase 3 incorporates practice and feedback into the post-training work environment [133]. During Phase 3, instructors observe the team's performance and provide non-judgmental, process-based feedback to reinforce the lessons learned earlier. If necessary, the instructor schedules additional team meetings to address specific performance issues.

Thus, throughout its three phases, MTM training uses a variety of training strategies—web-based training, didactic lectures, seminar participation, application questions, behavior modeling, and case study analyses [10,134,132,135]. The trainees are also required to complete a variety of homework assignments. For example, one assignment requires trainees to observe their own team to identify obstacles that hinder effective team performance. Another requires trainees to practice in the workplace the tools they have acquired in training. They then identify their performance strengths and weaknesses and discuss them at subsequent training sessions [131].

Finally, MTM has developed a number of tactics to sustain and reinforce the human-factors concepts that trainees learn. In fact, the program devotes an entire module to sustaining training, especially in unanticipated situations. Topics include long-term planning, conducting briefings, and continuously monitoring operations. Additional sustaining methods include periodic scripted safety drills; periodic team leader meetings; formal recognition of effective teamwork; and a report on implementation progress to the Air Force Patient Safety office [132].

Thus, like the other two programs, MTM purports to incorporate all three elements of CRM training—knowledge information, practice, and recurrence. However, most of the training time is devoted to providing factual information regarding human-factors principles. Substantially less time is devoted to actual skills practice. Further, what skills practice is included typically involves low-fidelity techniques, such as behavioral modeling using videotaped vignettes. At the current time, MTM does not use high-fidelity team training simulators, such as those used in ACRM.

MTM Strengths. To summarize, MTM offers a number of advantages. First, it uses a series of active learning techniques – including didactic lectures, behavioral modeling, and experiential learning – to develop trainees' teamwork-related knowledge, skills, and attitudes [136]. Second, it builds upon well-established learning theories by requiring the trainees to learn factual material prior to engaging in skills practice. Third, it provides a comprehensive approach to human-factors research. For example, MTM training (1) explicitly distinguishes between destructive and constructive conflict resolution, (2) recognizes that the workload-performance relationship is curvilinear, and (3) distinguishes between authority (which is based on rank) and leadership (which is based on skills). Fourth, MTM focuses on specific techniques for improving team performance (e.g., constructive ways to resolve conflict). Fifth, MTM training is interdisciplinary in nature, thereby teaching physicians, nurses, technicians and other key

constituencies to work together. Finally, it provides a reference list that allows participants to continue refining their teamwork skills after they have completed the training [137],[136].

MTM Limitations. Nevertheless, like the other two programs, MTM carries disadvantages. First, as already noted, far more of the training time is devoted to providing factual information than to practicing actual skills; the skills practice that is provided involves low-fidelity techniques, not the high-fidelity simulators used in ACRM. Second, although MTM provides trainees with a variety of "tools" to reinforce and sustain their teamwork skills, many of these aids are not tools in the strictest sense of the word. More often than not, the MTM materials consist of practices or procedures (e.g., briefings, cross-checks), but not tangible tools (e.g., checklists, quick reference cards, flow diagrams) that trainees can periodically review. Third, even though MTM is based on the "train the trainer" paradigm, it, like MedTeams, does not appear to provide any mechanisms for preventing performance degradation among trainers over time.

MTM Effectiveness

Compared to the evaluation strategies documented for the other two programs, little information is available concerning MTM training evaluations. Basically, MTM seems to use a summative evaluation to determine whether the training should be continued, discontinued, or re-designed. Further, MTM training gathers reaction data and measures trainees' knowledge during the web-based component.

Despite MTM's apparent absence of effectiveness criteria in the form of patient-relevant outcomes, it should be noted that this training program has gained wide acceptance in the Air Force. In 2001, the Air Force Surgeon General mandated MTM training for all high-risk specialties—emergency departments, operating rooms, obstetric departments, intensive care units, and neonatal care units [129]. As of February 2003, over 2000 medical treatment facility personnel have received MTM training [128]. Moreover, MTM training will eventually be available to, though not required for, all medical staff throughout the Department of Defense.

Additional Medical-Team Training Programs

Over the past few years, several other team-training programs have been developed for a variety of medical specialties [138,139,140]. Unfortunately, many of these programs have been poorly documented. As a result, it is difficult to evaluate their effectiveness systematically. Nevertheless, we review several of these programs to supplement our more detailed descriptions of ACRM, MedTeams, and MTM.

Team-Oriented Medical Simulation (TOMS)

The primary purpose of TOMS is to reduce the number and extent of medical errors in the OR by improving trainees' workload management, problem-solving, and decision-making skills (www.medana.unibas.ch/eng/team/hufa132.htm). TOMS provides interdisciplinary team training to surgeons, nurses, anesthesiologists, and orderlies. The TOMS program, which draws heavily on CRM training from commercial aviation [110,139], was developed at the University of Basel in Switzerland.

TOMS can best be described as a scaled-down version of ACRM training. The first hour consists of a pre-briefing that highlights relevant teamwork concepts, such as situational awareness, communication, and decision-making. The second hour is devoted to simulated laparoscopic and anesthetic procedures, using a lifelike mannequin. The third hour consists of a team-led debriefing that uses videotaped examples of the team's own performance to diagnose problems and identify strategies for improvement [139].

Data concerning the development and evaluation of TOMS are limited. As of August 1997, over 50 teams from the University of Basel Hospital had completed TOMS training (www.medana.unibas.ch/eng/team/hufa132.htm). The evaluation of TOMS has focused almost exclusively on participants' reactions to training. The responses were generally favorable [141], although the small sample size makes it difficult to assess the generalizability of these findings. To date, we have been unable to identify any other forms of validation evidence, such as post-training changes in the trainees' knowledge or skills, changes in organizational effectiveness, or the degree of behavioral transfer.

Dynamic Outcomes Management (DOM)

The primary purpose of DOM is to increase patient safety, reduce medical errors, and improve the quality of health care (www.cti-crm.com/dom/about/) by improving trainees' skills in team-building, in recognizing adverse situations, in counteracting the effects of stress and fatigue, in communication, and in decision-making (www.cti-crm.com/dom/register). DOM provides interdisciplinary team training to surgeons, nurses, and anesthesiologists. The program draws heavily on Crew Resource Management (CRM) training from aviation [140] and was developed by Crew Training International (CTI), which offers specialized training programs for aviation, construction, general business practice, and the medical industry.

DOM, which is quite similar to MedTeams and to Medical Team Management, includes 12 hours of skills-based, interactive training that incorporates facilitated discussion, role playing, case studies, behavior modeling, and knowledge testing [140]. The training is divided into three four-hour sessions. The first session provides guidelines for building an effective team, techniques for recognizing adverse situations, and recommendations for managing conflict constructively.

The second session, which occurs approximately two months later, provides guidance for mitigating the effects of stress, training in decision-making skills, and recommendations for providing effective performance feedback. The third session, which occurs an additional two months later, includes a course review, guidance in cross-checking and challenging, and principles for mitigating the effects of fatigue [140]. High-fidelity simulators, such as the type used in ACRM, are not used. To reinforce the principles of DOM training, CTI developed a "challenge and response checklist" which trainees are required to use in the OR.

Data concerning the development and evaluation of DOM are limited. As of January 2003, more than 160 surgical staff members at Methodist University Hospital in Memphis had completed DOM training. Evaluations of DOM have documented improvements in participants' attitudes toward the importance of teamwork issues in the OR, favorable reactions concerning the usefulness of DOM training, and a 50 percent reduction in the number of surgical count errors. However, the small sample size makes assessing the generalizability of the results difficult. Moreover, the lack of control groups prevents determining whether the training *per se* caused these improved outcomes.

Geriatric Interdisciplinary Team Training (GITT)

The primary purpose of GITT is to create a cadre of well-trained professionals who can leverage the effects of interdisciplinary teamwork to improve patient care. A secondary purpose is to improve the responsiveness of academic institutions to the needs of healthcare providers by establishing academic-industry partnerships. To this end, GITT provides interdisciplinary team training for physicians, nurses, nurse practitioners, social workers, pharmacists, therapists, and administrators [142].

GITT, which is also quite similar to MedTeams and to Medical Team Management, includes a full day of team self-evaluation and skills training. The team self-evaluation exercise uses the Strength Development Inventory® [143] to help team members recognize their preferred interpersonal styles. It also uses the Team Signatures Technology® [144] to help each team identify their unique dynamics, through describing the team's level of cohesion, leadership, diversity, and other relevant characteristics. Following the self-evaluation exercises, the team members receive didactic classroom instruction in the principles of effective teamwork, phases of team development, conflict management, leadership, and other factors [142]. A half-day of refresher training is provided approximately one year later. High-fidelity simulators, such as the type used in ACRM, are not used.

Data concerning the development and evaluation of GITT are limited. Of the original eight teams that participated in GITT (all of which were from geriatric treatment facilities in Rhode Island), only three participated in the follow-up. The remaining five teams had ceased to exist in their original configuration because of administrative reassignments. As a result, the evaluation of GITT has been extremely limited. The assessment of training was measured by

comparing the participants' pre- and post-test scores on a variety of dimensions, including their attitudes towards health care teams, anomie, communications, cohesion, and self-reported skills [142]. Although post-training means were higher than pre-training levels on all measured variables, the small sample size, the high level of attrition, and the absence of control groups make generalizations tenuous. To date, we have been unable to identify any other forms of validation evidence, such as post-training changes in the trainees' knowledge or skills, changes in organizational effectiveness, or the extent of behavioral transfer.

Summary

This chapter has summarized the general state of medical-team training. We primarily concentrated our discussion upon Anesthesia Crisis Resource Management (ACRM), MedTeams, and Medical Team Management (MTM) because these are the most thoroughly documented medical-team training programs. These programs have made progress in improving patient safety; nevertheless, despite the encouraging nature of the extant data, the degree to which medical CRM-based training will enhance patient safety remains in question. Thus, to provide a strategy for further investigation, our next chapter integrates our findings into conclusions and recommendations relevant to medical-team training. The final chapter then proposes avenues for future research.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This chapter outlines a number of important conclusions that can be drawn from the foregoing review. We also provide specific recommendations for ensuring that the design and delivery of medical team training improves patient safety.

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

To date, research has not developed a comprehensive model of team performance in medical settings; consequently, medical-team-training programs have not been grounded in a scientific understanding of what comprises effective teamwork in the medical community. Given this gap in knowledge, the first research effort we advocate in the final chapter is to develop a theoretical medical-team performance model that hypothesizes (1) the relations among predictors of performance and (2) the relations between predictors and outcome criteria. Nevertheless, despite the absence of a team-performance model that focuses on medical teams *per se*, previous research has provided considerable relevant knowledge; the availability of this knowledge underlies several of the remaining conclusions and recommendations.

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

As discussed in Chapter 2, a more 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. Our recommendations are: (1) that the medical community continue to inform itself of the progress of this science through a variety of venues (e.g., specialized workshops, books) and (2) that the medical community enlist the help of team-training experts to apply to patient safety the principles, guidelines, and learning afforded by previous research.

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

Previous investigations have also 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. However, as noted in Chapter 2, Cannon-Bowers and colleagues have pronounced the team skills literature confusing, contradictory, and plagued with inconsistent labels and definitions. For example, across studies, different labels are used to refer to the same teamwork skills, and the same labels are used to refer to different skills [21]. Thus, we recommend using a two-step process to develop 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* that are 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 constructs included in the taxonomy must be broadly enough conceptualized to span the medical field, yet specific enough to facilitate valid measurement. Further, although this list of core competencies should reflect all relevant aspects of team performance, it must be concise enough to generate teamwork and team-training research and to facilitate team-training needs analyses in organizations.

The second step, determining relevant core competencies, encompasses two activities. One is to establish which of the many competencies manifested in previous research are relevant to virtually all medical teams; a second, and perhaps more demanding, task is to identify core medical-team competencies that have not emerged from team research in other domains. For guidance in this area, researchers might rely, to some extent, upon medical experts like those engaged in the panel that AIR convened in January 2003 (refer to the Appendix for a list of panel participants). However, we believe that, along with developing a theory of medical team performance, using job analytic techniques (e.g., survey questionnaires, structured interviews, and non-obtrusive observations) will yield the most valid information. We also emphasize the importance of large-scale, stratified data collections because the goal is to identify generic competency requirements with which the medical community at-large concurs.

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

As also illustrated in Chapter 2, the science of team performance and training has developed and validated numerous training strategies that can provide requisite competencies to teams who perform in complex environments. Through a variety of formats and objectives, these strategies extend beyond CRM training. We recommend (1) that the medical community use these strategies wherever possible, given that some are relatively easy to design and deliver, and (2) that the community explore strategies other than CRM to improve patient safety.

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

We are convinced that no single model of team training can be applied across all medical practices and contexts. For purposes of this discussion, we define a "practice" as a medical specialty or sub-specialty, such as emergency medicine, general or family medicine, intensive care, surgical medicine, obstetrics, etc. 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. As an example, emergency medicine providers function in hospital emergency departments, in

emergency-response mobile units, and on battlefields. Similarly, to mention several obvious distinctions, urban and rural general providers operate in independent or multi-practitioner offices, as well as in community walk-in clinics. Neither the competencies that impel successful teamwork nor an optimal team-training strategy can be expected to generalize across all these contexts. And, of course, not all members within the same team will necessarily need the same knowledge, skills, and attitudes.

Therefore, in addition to the core-competency taxonomy proposed in Conclusion 3, we also recommend developing practice-specific taxonomies of medical-team competencies. These putative taxonomies would not be redundant with the generic, core-competency taxonomy. Rather, a practice-specific taxonomy of core competencies would denote 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 drive the identification of relevant team competencies.

For instance, a successful emergency team in which the membership changes frequently might need to know the various roles that must be filled in each patient encounter, but not the strengths and weaknesses of particular team members. In addition, some team members may need incisive decision-making skills, whereas others may need to set up and operate equipment swiftly; none may need the skill to assess long-term treatment options for a chronic condition. Further, all emergency team members may need to express "empathy" as an emotional detachment that allows them to function in the fact of appalling injuries.

Conversely, a family-medicine practice in which the team comprises 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 patient welfare. Additionally, the physician may need the skill to communicate his or her treatment protocol to the patient, to the nurse, and/or to a consulting physician, whereas the receptionist may need office-organization skills. As a final example, the specific competencies needed, along with their relative importance, may differ for hospital emergency departments, as compared to mobile response units and for a rural versus an urban family-medicine office.

Virtually no previous research has addressed the manner in which differences within and between medical practices should be reflected in practice-specific taxonomies. Yet we find this issue sufficiently compelling to warrant further investigation. Because these taxonomies are derived from the medical characteristics of specific practices (and contexts within them), subject-matter experts who represent each practice might be invaluable in identifying practice-specific team competencies that are not redundant with the generic core-competency taxonomy. Nevertheless, we would also suggest that researchers avail themselves of survey questionnaires, structured interviews, and non-obtrusive observations.

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

Our review of team training programs clearly shows that the medical 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. Furthermore, as noted previously, the medical community should explore other strategies that can be effectively applied to medical-team training. Specifically, we first recommend that medical-team training be *developed* to reflect the established instructional principles that underlie team-training research. Second, we recommend that the quality of these programs be *evaluated* on the basis of confirmed 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 the data from other domains are encouraging and although 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, as mentioned in Chapter 3, collecting data to demonstrate the efficacy of CRM (or of any other team-training strategy) is difficult because of the low base rate at which serious mistakes occur. Nevertheless, supportive evidence is essential if the field is to advance. The future research advocated 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 embed team training in professional development. By "embedding" we mean implementing and regulating team training throughout a healthcare provider's career. As noted in Chapter 4, the Accreditation Council for Graduate Medical Education (ACGME) has identified several teamwork-related competencies that surgical-training residents must 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. Although not originally targeted towards team performance, the results revealed the importance of a number of teamwork-related competencies [104].

Simply stated, for medical-team training to deliver the impact that it can potentially exert on patient safety, it must be instantiated at every stage of a provider's working life. For example, certain medical school assignments might require students to prepare team projects. In a related vein, interns and residents might observe, participate in, and evaluate practicing teams in

hospitals. The larger challenge, however, occurs after providers have completed their formal training.

At present, the delivery of recurrent team training across the healthcare community is generally haphazard. Few structural or procedural mechanisms exist to ensure that it continues at regular intervals. Similarly, few system-wide procedures exist for reporting errors, and few organizational policies allow and encourage providers to report near misses, without incurring sanctions. As a result, lip service to the contrary notwithstanding, the organization often fails to regard medical teamwork as an important facet of medical performance. One way to correct this systemic indifference is to institute a formal, mandatory error-reporting system. Another strategy would be to require that providers participate at specified intervals in newly developed team-training enterprises or in refresher training. This programmatic initiative would be analogous to education's ongoing licensing requirement, which obliges teachers to earn a certain number of continuing education credits within a specified time period.

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

CHAPTER 6: WHERE DO WE GO FROM HERE? RESEARCH NEEDS

At the outset of this final chapter, let us once again state our belief that the medical community will benefit from heeding the foregoing review and our suggested conclusions and recommendations. In short, we believe that this document advances the information provided Pizzi and colleagues in AHRQ's Evidence Report 34, which, among other things, assessed whether a sufficient weight of evidence supported the inference that CRM team training, applied to the medical domain, would enhance patient safety by reducing error [5]. Specifically, we have included in our review the CRM findings from military programs and provided a more comprehensive summary of the state of CRM in aviation. In addition, and perhaps most significantly, by evaluating the six existing programs, this report presents the current state of medical team-training *per se*.

This chapter delineates research needs that we have identified through the course of our investigation. The theme that unites these suggestions is the need for a more thorough understanding of the medical-team and medical-team training performance domains than the research currently provides.

Research Need 1: Develop a model of medical-team performance.

As noted in the previous chapter's first conclusion, research has not formulated a comprehensive model of team performance in medical settings. Thus, the first research effort we propose is to develop a theoretical model of medical-team performance.

The advantages of such a model are fourfold. First, based on the generic and practice-specific competency taxonomies that we have recommended, the model would provide researchers with a common language for labeling and defining the key *personal* variables that affect medical-team performance. Second, previous research has already yielded considerable information regarding the organizational facilitators or constraints that shape team performance in medical settings (e.g., organizational climate factors, like the sanctions that result from reporting errors or near misses; the degree to which teamwork is supported at the corporate level; the extent to which the organization mandates team training and *re*-training; etc.); this information provides a foundation for defining the *environmental* variables that influence effective medical teamwork. Third, additional research would yield an agreed-upon set of process and end-result variables to serve as performance outcome (i.e., criterion) measures. (This aspect of the model is addressed more fully in the next section.) And fourth, once such a model has been conceptualized, it would provide researchers with a common framework for specifying and testing hypotheses concerning (1) the relations among predictors of performance and (2) the relations between predictors and outcome criteria. This programmatic research effort

would ultimately generate a body of applied scientific knowledge that is tailored to the medical community's concerns.

Research Need 2: Focus more attention on measuring teamwork processes and outcomes as they relate to medicine.

One consequence of not grounding medical teamwork and team-training research in a theory of medical-team performance is that previous research has often lacked criteria that are pertinent to error reduction and patient safety. Thus, in addition to developing valid prediction measures, future research needs to define and build valid measures of relevant outcomes. As discussed in Chapter 3 in relation to CRM training, the low base rate of serious errors precludes this "ultimate criterion" from serving as a viable outcome construct in CRM training research [62]. Given the vast number of medical procedures conducted each day, applying this "ultimate criterion" to the medical-team performance domain is equally impractical, despite the prevalence of errors noted in our introduction.

In an effort to resolve the criterion problem, we suggest that research in medical teams and medical-team training should define and develop criterion measures from a more theoretically focused perspective. For example, a theory of medical-team performance, once defined, would suggest process criteria that (1) theoretically relate to the ultimate criterion and (2) reflect actual performance behavior. Examples might include the time taken to execute the initial decision in an emergency-medicine 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. Besides their relatively easy development and implementation, the advantage of such measures is that they objectively assess performance during a process that is theoretically linked to patient safety outcomes. Furthermore, behaviorally based, process-oriented criteria constitute relevant measures for comparing performance among teams or among team-training programs.

A final issue that bears noting in this context is the potential for examining "near misses" as a proxy criterion for error. Near misses are examined in aviation research, albeit not generally in relation to teams. Near-miss research was not mentioned in any of the medical-team literature that we reviewed; nonetheless, assuming the information could be collected, near misses comprise a potentially feasible outcome criterion that is likely to exhibit a higher prevalence than does error. In addition, using near-miss criteria opens two worthwhile avenues of investigation: (1) determining which predictive factors or process outcomes contributed to the near miss and (2) determining which factors or processes ultimately *prevented* the error. The answers to either question would foster insight regarding the links between teamwork and patient safety.

Research Need 3: Evaluate medical-team training more effectively.

Also related to the need for a conceptual, testable model of medical-team performance is the need to evaluate team training more effectively. In short, this need reflects our firm opinion

that gathering "reaction" criteria (in which training participants report their *liking* for a training program and their *opinion* that it will help them do their jobs better) does not provide an adequate basis for determining a training program's effectiveness. The foregoing discussion of establishing relevant *performance-based* criteria addresses this issue. However, in addition to developing agreed-upon performance criteria that reflect optimal processes and results, organizational research must conduct these evaluations consistently—as an integral aspect of each team-training initiative. Institutionalizing evaluations that assess standard performance-based criteria would allow organizations to compare the effectiveness of diverse programs and training strategies; without standardized evaluations, such comparisons are not possible.

Research Need 4: Focus on diagnosing team performance.

This research need also flows from establishing a theoretical medical-team performance model. That is, once research has identified the personal and environmental variables that are relevant to effective medical teamwork—and has linked them to performance-based criteria—any particular team's functioning would be open to examination. These examinations, primarily qualitative in nature, would provide a diagnosis that not only identifies performance areas in which the team has met or failed to meet particular criteria, but also reveals the potential reasons for these outcomes.

More specifically, as implied in our discussions of the previous needs, conducting in-depth *quantitative* diagnoses *across* teams would yield data concerning the degree to which certain outcomes could be attributed to certain predictor variables. This general data could then be applied to a *single* team's scores on the same variables, to assess whether the team's effective or ineffective performance appeared to be a function of personal competencies, organizational characteristics, performance on intermediate process criteria, or a combinations of these factors.

Thus, given a team's performance, the evaluator would conduct a qualitative "case study," which might involve using personnel records or other sources to determine the team's "scores" on relevant predictors. Of course, quantitative statistical analyses of a single team would not be possible unless the same team had participated in numerous team-training trials (and, even then, repeated exposure to the same stimuli creates its own evaluation confound). However, such scores could be compared to norms gathered through previous across-group research. In addition, case studies could include content analyses of verbal and other team behavior. Taken together, the norm and the content-analysis information would offer a rich explanation of a given team's performance and a clear indication of what corrective interventions might be necessary.

Research Need 5: Determine the role of simulation-based training.

The final research need we address in this report is that of determining more fully the manner in which simulation-based training can most effectively be applied to training medical teams. Previous research documented throughout this review has established that simulators

provide training participants an incomparable opportunity to practice both technical and team-process skills and to receive feedback on the degree to which they exhibit these skills proficiently; moreover, simulators offer this opportunity in a virtually risk-free environment. Despite their value, however, simulator training can be extremely expensive (see Chapter 4's discussion of ACRM training).

Therefore, the overall question that future research must address is, "What constitutes the optimal trade-off between training effectiveness and cost effectiveness?" The answer to this question encompasses numerous subsidiary issues, such as the number of specialty clinics sponsoring the training, the number of trainees involved, and the financial and personnel resources available. However, of key importance to all these subsidiary issues—and a more focused central research question—is, "To what degree must an effective simulation reflect physical versus psychological fidelity?" Based on previous simulation-training research [34,88] we assume that the more realistic the training *scenario,* the more effective the training; nonetheless, we also believe that it is often unnecessary for a simulation to replicate the same *physical* environment in which the actual teamwork will take place.

Still, some degree of physical fidelity is required in medical-*team* training, whereas it might not be required for all medical training. For example, paper scenarios, which might play a valuable role in training medical diagnostic skills, are not appropriate for training team members to perform teamwork skills. In short, teams must *function* as teams during training. The extent to which physical fidelity can be and must be sacrificed to cost and other constraints thus remains the ultimate simulator-related question for future research to answer.

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