Chapter 26
Developing Surgical Teams: Application

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Overview The preceding chapter discussed the theoretical underpinnings of human factors (HF) concepts and their role in promoting high reliability organizations (HROs) as well as highly reliable team function. In addition, it demonstrated that current teamwork in the clinical surgical environment is less than ideal, leading to dysfunction and the development of a silo mentality. This chapter will continue the discussion of developing surgical teams by discussing practical applications of HF concepts to develop highly reliable surgical teams and reviewing the development of simulation-based team training in surgery at LSU Health New Orleans Health Sciences Center.

26.1 Introduction

Today's dynamic, high-risk clinical environment, in which surgeons are required to address an ever-increasing complexity of disease processes and comorbid conditions, requires the smooth collaboration and function of a variety of care teams in order to shepherd safely surgical patients to recovery and health. Unfortunately, as demonstrated in the preceding chapter, current teamwork in the surgical setting is less than ideal, and it often results in a sense of tribalism among the various professions helping to care for the surgical patient [1]. Overcoming this situation, therefore, becomes an important challenge for surgical educators trying to develop surgical teams, especially since working in interprofessional teams is now a recognized core competency in healthcare [2]. In the United States, the Interprofessional Education Collaborative (IPEC) has worked to define major collaborative domains of interprofessional behavior with corresponding general and specific competencies within each one [3]. Such work has also been undertaken in Canada, the United Kingdom, and Australia [4].

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Human factors (HF), the study of the interaction of humans with their environment, have as one of its central axioms the proposition that *human error is inevitable* [5]. Its application, known as HF engineering, is devoted to improving human performance and mitigating the impact of human error in order to promote safety and effectiveness in dynamic, and at times high-risk, work environments. For surgical educators, therefore, HF principles can be brought to bear on developing surgical teams to create highly reliable function. This chapter will focus on this aspect of team development by (1) investigating how HF engineering can be employed in a practical manner to create highly reliable team behavior and (2) illustrating such an application through a discussion of the development of simulation-based training (SBT) of surgical teams at LSU Health Sciences Center New Orleans.

26.2 Applying HF Principles to Develop Highly Reliable Surgical Teams

By adopting an HF engineering perspective to surgical team development, the surgical educator can develop a multipronged approach to the undertaking. In this manner, both systems-focused and people-focused methods can be employed. In fact, evidence in the surgical literature suggests combining the two approaches is more effective in improving team technical and nontechnical performance as well as checklist adherence than either one alone [6].

One systems-based approach worth further discussion is the standardization of perioperative care pathways through the use of the Enhanced Recovery After Surgery (ERAS) [7] patient management strategy. ERAS is an attempt to remove variability in the surgical care of the patient through the adoption of evidence-based practices to replace traditional patterns of care. As a result, patients follow a predictable, consistent pathway of care from the first surgical office visit through the perioperative period to final discharge from the surgeon's care [8]. Such standardization of surgical care decreases complication rates across multiple surgical specialties [9].

Several people-focused approaches have been successfully employed to help develop surgical teams. The introduction of checklists, briefings, and double checks into surgical care has resulted in improvements in communication [10] and teamwork [11] as well as process [12] and outcomes [13] measures. Training and education in team-based competencies also has positive effects [14]. This training can take on a variety of forms: didactic instruction, role play, tabletop exercises, video- or web-based activities, and simulation-based training (SBT) [15]. SBT is a particularly attractive modality for teaching these competencies due to its immersive character which allows for a realistic, safe learning environment in which teams can hone skills treating rare, life-threatening conditions without harm to patients [16]. It is especially attractive to the surgical educator, since this type of experiential learning has been demonstrated to be effective in improving team-based interactions among surgical learners of all stripes, when used alone or in conjunction with other educational modalities (Table 26.1 [12, 17–35]).

Table 26.1 Selected examples of the use of simulation-based training of surgical teams with their impacts

Operating room (OR) teams			
Group	Intervention	Participant characteristics	Results
Paige et al. [17]	*Ex cura* high-fidelity OR team training	Senior medical students, senior undergraduate nursing students, nurse anesthesia students	Improved attitudes toward team-based competencies, improvement in individual and team-based behaviors
Nguyen et al. [18]	*Ex cura* laparoscopic cholecystectomy OR team training	Surgical residents, real OR team	Improved completion preoperative checklist, intraoperative ACGME[a] competencies
Cumin et al. [19]	*Ex cura* high-fidelity OR scenarios	Surgical residents, faculty and OR staff	Better recall of important information if given during formal communication (i.e., brief, time-out)
Pena et al. [20]	*Ex cura* high-fidelity OR team training in conjunction with workshop	Surgical residents and fellows	Improvement in NTS[b] between two sessions for junior and senior residents
Stevens et al. [21]	*Ex cura* high-fidelity cardiac surgery OR team training in conjunction with workshop	Cardiac surgeon, cardiac anesthesiologists, surgical physician assistants, cardiac OR nurse, cardiac anesthesia nurse, perfusionist	Improved concept of working as a team after intervention
Arriaga et al. [12]	*Ex cura* high-fidelity OR crisis scenarios	Surgical and anesthesia residents and faculty; operating room nurses, surgical technologists, certified nurse anesthetists	Increased adherence to lifesaving processes of care with the use of checklists with training
Arriaga et al. [22]	In situ and *ex cura* high-fidelity OR team training in crisis scenarios across a four hospital system	Surgical residents, faculty, and physician assistants; anesthesia faculty and certified nurse anesthetists; surgical technologists, operating room nurses, and biomedical engineers	Feasibility demonstrated; reduction in malpractice insurance awarded for participation
Dedy et al. [23]	*Ex cura* high-fidelity simulation as part of 5-day NTS[b] curriculum	PGY[c] 1 surgical residents	Improvement in knowledge, attitudes, and performance related to NTS[b]
Trauma teams			
Doumouras et al. [24]	*Ex cura* high-fidelity trauma team training	Surgical residents and trauma nurses	Improvement in attitudes; no decay in NTS[b] over 6 months

(continued)

Table 26.1 (continued)

Operating room (OR) teams			
Group	Intervention	Participant characteristics	Results
Steinemann et al. [25]	In situ high-fidelity trauma team training	Residents, emergency medicine and trauma faculty, nurses, respiratory therapists, and emergency department technicians	Improvement in team performance; 76% increase in frequency of near-perfect task completion; 16% reduction in mean overall resuscitation time
Capella et al. [26]	TeamSTEPPS™[d] for trauma teams augmented by simulation	Surgery residents, faculty, nurses	Improvement in leadership, situational awareness, mutual support, communication, and overall teamwork; decrease in times to computed tomography scanner, OR, and endotracheal tube intubation
Zeismann et al. [27]	*Ex cura* high-fidelity trauma team training	Surgical residents, nurses, respiratory therapists	Improvement in attitudes toward teamwork principles
Perioperative/postoperative teams			
Nicksa et al. [28]	In situ and *ex cura* high-fidelity team training using high-risk crisis scenarios in various settings (ED, PACU, ICU, OR)	Surgical, anesthesia, medicine, critical care fellows and residents; nursing, respiratory therapy, pharmacy students, and faculty	PGY[c] 2 improvement in NTS[b]; no change PGY[c] 1
Pucher et al. [29]	*Ex cura* high-fidelity training on mock surgical ward (rounds)	Surgical residents	Feasibility demonstrated
Arora et al. [30]	*Ex cura* high-fidelity training on mock surgical ward	Surgical residents	Improvement in communication, leadership, decision-making; improved ability to clinically recognize falling saturation, check circulatory status, reassess patient, call for help
Stephens et al. [31]	*Ex cura* high-fidelity training in conjunction with day long course	Practicing surgeons, anesthesiologists, nurses, other staff in perioperative care	Improved confidence related to team behaviors, recognizing different team perspectives, employing checklists
Doumouras et al. [32]	*Ex cura* high-fidelity crisis simulation training	Surgical residents	Improvement in NTS[b] of PGY[c] 2/3 residents with no decay in skills over year

(continued)

Table 26.1 (continued)

Operating room (OR) teams			
Group	Intervention	Participant characteristics	Results
Literature reviews			
Doumouras et al. [33]	Structured literature review of simulation-based crew resource management training	Postgraduate trainees	Improvement in team-based skills; no decay at 2 months
Tan et al. [34]	Systematic search of literature involving simulation-based OR team training	Not stated	Positive learner response, some reported change to behavior in team environment
Gjeraa et al. [35]	Systematic review of simulation-based trauma team training	Pre-licensure, postgraduate, and practicing participants	Significant effect on learning; improvement in clinical performance

[a]*ACGME* Accreditation Council for Graduate Medical Education
[b]*NTS* nontechnical skills
[c]*PGY* postgraduate year
[d]*TeamSTEPPS*™ Team Strategies and Tools to Enhance Performance and Patient Safety™

Another advantage of SBT is that it is very amenable to interprofessional education (IPE), a practice growing in popularity in health professions education. The World Health Organization (WHO) has defined IPE as follows: "…students from two or more professions [who] learn *about*, *from*, and *with* each other to enable effective collaboration and improve health outcomes (italics added)" [36]. IPE is now recognized as the way forward in helping to overcome the tribalism found in healthcare [1]. In addition it is seen as a means of improving communication [1] and promoting both cultural change and patient safety [37]. In addition, IPE has been demonstrated to improve collaborative team behavior within the OR micro-system [38]. Combining SBT with IPE, therefore, has the potential of accelerating the development of surgical teams by allowing learners to "deliberately work together" to promote safety and patient-centeredness [3]. Due to its large potential in transforming healthcare professional education, efforts have been undertaken around the world to help develop frameworks and competencies related to IPE [3]. By targeting such competencies, which often involve teamwork and communication, surgical educators can start building teams from the beginning of an individual's education in the health professions.

Clearly, SBT and IPE are two powerful modalities for promoting highly reliable team function, and, consequently, high reliability in healthcare. Pitfalls do exist, however, in implementation of curricula related to each. For SBT, such pitfalls can arise if the surgical educator interprets the use of simulation as the end rather than the means. Put another way, simulation is a *tool*, not a curriculum. Thus, any educational intervention employing simulation-based activities should be founded on sound principles related to curriculum development. The use of needs assessments, the creation of goals and learning objectives, the appropriate selection of teaching modalities and their delivery, the use of reliable assessment tools with evidence of

validity, and the evaluation of the effectiveness of the educational program are but a few key items. In addition, scenario development for high-fidelity simulation-based sessions should follow effective, established methods of development. One accepted methodology is the event-based approach to training (EBAT) [39] that has been successfully used in scenario development for trauma team training [40]. Finally, training and expertise in debriefing is essential for surgical educators engaged in such work in order to optimize the self-reflection, gap analysis, and behavioral change that occurs during high-fidelity SBT sessions. An emphasis on "what is right" over "who is right" must be followed in this setting of immediate feedback because it opens participants to becoming more aware of patient care hazards and gives them the opportunity to help find solutions [39, 41].

IPE challenges exist as well. They often center on incongruences related to disparate professional schedules, curricula, and cultural views [42]. In addition, institutional issues, such as lack of support from leadership, entrenched cultural views hostile to IPE and/or change interventions, and faculty inadequately trained in IPE techniques, can be important impediments [42]. Often IPE and SBT challenges are similar in scope and nature. Thus, overcoming them is essential for success. Solutions can be undertaken in a variety of ways; taking a systematic approach is helpful. For example, Paige et al. [43] proposed the "5P" approach to implementing successfully surgical high-fidelity SBT. In it, potential challenges are grouped into five major categories in which strategic and tactical solutions are then developed to meet them. These categories include the following: (1) finding a *patron*, (2) developing a *plan*, (3) locating a *place*, (4) assembling the appropriate *people*, and (5) choosing effective *products*. This example illustrates that, by taking a systematic approach to the challenges faced, the necessary support, personnel, and resources can be mustered to succeed.

26.3 Leveraging SBT and IPE to Promote the Development of Surgical Teams: The LSU Health New Orleans Experience

At LSU Health New Orleans, SBT and IPE have both been employed across the entire continuum of professional development to promote highly reliable teams in the perioperative micro-system (Fig. 26.1). From an HF perspective, such efforts in training and education are people-focused approaches. They began over a decade ago with the development of the Virtual OR (VOR) for *ex cura* (i.e., in a center *away from the clinical environment*) training of OR surgical teams comprised of prelicensure, postgraduate, and practicing learners [44]. Shortly following this start, training expanded with the development of the Mobile Mock OR (MMOR) and its application to in situ training of OR teams at satellite facilities within the Louisiana state hospital system [45–47]. The focus of team training then shifted to the prelicensure level in an effort to "get them (i.e., students) while they are young." In this

Fig. 26.1 Simulation-based training (SBT) for developing teams at LSU Health New Orleans. Simulation-based training activities occur across the entire continuum of professional development (i.e., pre-licensure and postgraduate education as well as continuing professional development), focusing on skills, tasks, procedures, and interprofessional team training in the clinical lab and the clinical environment

manner, students of the health professions would be afforded an opportunity to be exposed to concepts related to team-based competencies and effective teamwork that would hopefully overcome the negative modeling seen in the clinical environment. This student-based team training using high-fidelity simulation began approximately a decade ago with the Student Operating Room Team Training (SORTT) project involving senior medical students in the Senior Anatomy Elective, undergraduate nursing students in a Perioperative Nursing Elective, and nurse anesthesia students [17]. Since then, the training has expanded to the Team Training of Inter-Professional Students (TTIPS) projects [48, 49]. TTIPS currently includes both trauma team training of 3rd year medical students on their surgery clerkship with senior undergraduate nursing students taking their intensive care course and ED- and ICU-based team training of senior medical students during their Critical Concepts Course with nurse anesthesia students and various Allied Health students. In this manner, students have an opportunity to undergo distributed training in team-based competencies as they progress through these programs, reinforcing positive teamwork attitudes and behaviors.

At the postgraduate and continuing professional development level, team training using high-fidelity simulation has included *ex cura* as well as in situ examples. Multi-crew training has been undertaken *ex cura* with OR crisis scenario sessions involving general surgical and anesthesiology residents meeting about eight times

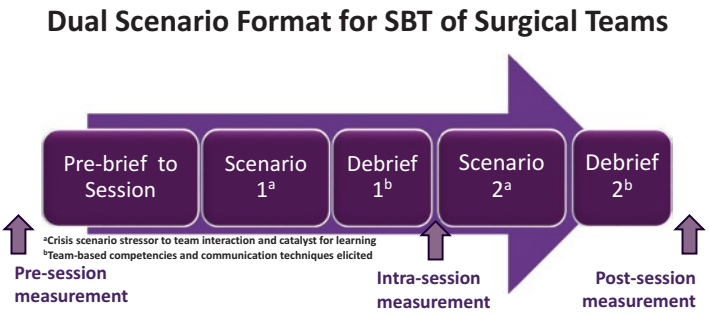

Fig. 26.2 Dual scenario format for simulation-based training (SBT) surgical teams. Simulation-based training sessions of surgical teams begin with a pre-brief orienting learners and outlining objectives. This pre-brief is followed by a crisis scenario with after-action debrief focusing on team-based competencies and communication techniques. Learners then participate in a second crisis scenario with debriefing and summary

per year. In addition, SBT with IPE involving the *ex cura* Trauma Team Emergency Room Transfer Training (TTERTT) pilot has been successfully undertaken. In this program teams of general surgical residents, emergency medicine residents, and senior undergraduate nursing students must physically transfer computer-based mannequin "patients" needing exploratory laparotomy from a virtual trauma bay located on the second floor of the LSU Health New Orleans School of Nursing to the VOR on the fifth floor of LSU Health New Orleans School of Medicine's Simulation Center which is in a separate building connected to the School of Nursing via a sky bridge. Such team-based progressive SBT provides opportunities to discuss systems-based issues related to transfer of care. Finally, in situ OR team training has also been accomplished involving general surgical residents and practicing OR staff at the university-affiliated hospital.

Each learning session for this SBT using IPE is organized similarly for every project (Fig. 26.2) [17, 46–49, 50] and draws on Kolb's theory for experiential learning [51]. The training session begins with a pre-brief in which the facilitators introduce themselves, state the goals and objectives for the session, orient the learners to the technology, review the format of the session, and establish the ground rules for participation. This last aspect is essential to help establish the feeling of psychological safety in the learners needed for the suspension of disbelief that leads to optimal learning. Three major ground rules are emphasized: (1) treat it real (i.e., consider the mannequin as an actual patient in the clinical setting and act according to how one would act in real life); (2) treat us [the facilitators] like ghosts (i.e., act like the facilitators and mannequin operators do not exist by not addressing or acknowledging them in any manner); and (3) treat it like Vegas (i.e., what happens during the session related to the scenario type and comments made regarding others' performances and events stays in the session; team-based skills, however, are encouraged to be pursued in the clinical environment).

Following the pre-brief, a dual scenario format for training is employed in which the interprofessional team participates in a high-fidelity simulation using a computer-based mannequin patient involving a crisis event designed to place stress on team interactions. Upon completion, it is followed immediately by an after-action debriefing emphasizing reflective practice in which team-based competencies for highly reliable performance are introduced and discussed. A second, different SBT crisis scenario is then undertaken to practice targeted competencies followed by a final debrief at the end of which learners commit to adopting one teamwork behavior in clinical practice. Measurements of targeted knowledge, skills, and abilities (KSAs) using reliable instruments with evidence of validity are taken pre-, intra-, and post-session to demonstrate learning. The effectiveness of the training is evaluated using Kirkpatrick's model: participant reaction, participant learning, participant behavior change, and organizational outcomes [52]. To date, SBT using IPE to develop surgical teams at LSU Health New Orleans has yielded positive results related to promoting characteristics of highly reliable teams (Tables 26.2 [17, 46–49]).

Such SBT using IPE for teaching team-based competencies is supplemented by focused SBT in key surgical skills [53], tasks, and procedures [54] in order to ensure that team members have the requisite KSAs to provide quality care to patients. In this manner, SBT is undertaken in which all three skill sets needed for successful care in the perioperative setting are targeted: (1) technical skills, (2) cognitive skills, and (3) interpersonal skills. Surgical teams are thus developed using a comprehensive approach in an effort to promote highly reliable team function, quality of care, and patient safety.

Table 26.2 Impact of Simulation-based Training of Surgical Teams using Inter-Professional Education at LSU Health New Orleans

Project	STEPS[a]	SORTT[a]	TTIPS[a]	TTERTT[a]
Learner teams	Surgical residents, faculty, operating room personnel	Senior medical students, senior undergraduate nursing students, nurse anesthesia students	Junior and senior medical students, allied health profession students, nurse anesthesia students, senior undergraduate nursing students	Surgical residents, emergency medicine residents, and senior undergraduate nursing students
Training location	In situ	*Ex cura*	*Ex cura*	*Ex cura*
Impact of training				
Improved attitudes toward team-based competencies	√[46]	√[17]	√[48,49]	√[b]
Improvement in individual and team-based behaviors	√[c]	√[17]	√[48,49]	√[b]

(continued)

Table 26.2 (continued)

Project	STEPS[a]	SORTT[a]	TTIPS[a]	TTERTT[a]
Retention of skills up to 6 months	n/a	n/a	√[48,49]	n/a
Improvement in team-based attitudes over year	n/a	n/a	√[50]	n/a
Reinforcement of attitudinal improvements with distributed training	√[47]	n/a	n/a	n/a

[a]*STEPS* System for Teamwork Effectiveness and Patient Safety, *SORTT* Student Operating Room Team Training, *TTIPS* Team Training of Inter-Professional Students, *TTERTT* Trauma Team Emergency Room Transfer Training
[b]Published abstract: Paige JT, Qingzhao Y, V Rusnak, Garbee DD, Kiselov V, Detiege P. Moving on up: team training for emergency room trauma transfers (TTERTT). Proceedings of the Australasian Simulation Congress 2017 (http://proceedings.simulationautralasia.com/index.html).
[c]Published abstract: Paige et al. J Am Coll Surg 207:S87–S88 (2008)

26.4 Conclusion

In today's evermore complex healthcare environment, developing highly reliable surgical teams is an imperative. For the surgical educator, applying HF engineering to such team development has many advantages. First, it recognizes the ubiquity of human fallibility and the need to promote a culture of safety in healthcare. Second, it provides a framework for both systems- and people-focused interventions to foster better team interaction through force functioning, automation, standardization, the implementation of checklists and policies, and training. Among the latter of these methods, the use of simulation-based techniques and IPE are powerful modalities for promoting highly reliable teamwork due to the experiential nature of simulation and the ability of members of different professions to learn with, from, and about each other. Both methodologies have been successfully integrated into surgical team training programs at LSU Health New Orleans, which can serve as an example of how to implement SBT using IPE in order to provide ultimately high-quality and safe care to the surgical patient.

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