

3.4 Theoretically-Driven Infrastructure for Supporting Healthcare Teams Training at a Military Treatment Facility

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T. Robert Turner

Booz Allen Hamilton

Naval Medical Center Portsmouth (VA)

Timothy.Turner3.ctr@med.navy.mil

CDR V. Andrea Parodi, NC, USN

Naval Medical Center Portsmouth (VA)

Andrea.Parodi@med.navy.mil

The Team Resource Center (TRC) at Naval Medical Center Portsmouth (NMCP) currently hosts a tri-service healthcare teams training course three times annually. The course consists of didactic learning coupled with simulation exercises to provide an interactive educational experience for healthcare professionals. The course is also the foundation of a research program designed to explore the use of simulation technologies for enhancing team training and evaluation. The TRC has adopted theoretical frameworks for evaluating training readiness and efficacy, and is using these frameworks to guide a systematic reconfiguration of the infrastructure supporting healthcare teams training and research initiatives at NMCP.

1.0 INTRODUCTION

Designated a Department of Defense Team Resource Center (TRC) in 2008, Naval Medical Center Portsmouth (NMCP) currently hosts a tri-service healthcare teams training course three times annually. The course consists of didactic learning coupled with simulation exercises to provide an interactive educational experience for healthcare professionals.

Simulated cases are developed to reinforce specific teamwork skills and behaviors, and incorporate a variety of technologies including standardized patients, manikins, and virtual reality. The course is also the foundation of a research program exploring the use of modeling and simulation to enhance teamwork training in healthcare.

The TRC has adopted a theoretical framework for evaluating training efficacy based on Kirkpatrick's training outcomes model [1], and has used this framework to guide a systematic reconfiguration of the infrastructure supporting healthcare teams training and research initiatives at NMCP.

1.1 Healthcare Teams Training

Teamwork and communication failures are the leading cause of adverse patient

outcomes [2], [3]. These failures represent a gap in functional teamwork behaviors which has been addressed in a number of other teamwork-intensive industries (e.g., aviation) through the introduction of carefully designed team skills training programs [4], [5].

Teamwork has also been empirically linked to clinical patient outcomes in the healthcare domain [3], yet evidence suggests that a significant number of health care providers hold misconceptions about the nature and efficacy of teamwork in their own units [6]. Several teamwork (non-clinical) skills training programs have recently been tailored to the healthcare domain; one such program (TeamSTEPPS™) is conducted periodically at NMCP.

TeamSTEPPS is a teamwork training system that was developed by the U.S. Department of Defense in partnership with the Agency for Healthcare Research and Quality [7], aiming to instill positive teamwork behaviors in healthcare professionals by emphasizing key tenets adapted from aviation's Crew Resource Management training system. These include

communication, team structure, leadership, mutual support, and situation monitoring.

The NMCP TeamSTEPPS program is designed to provide students with the skills and tools necessary for effective teamwork, as well as hands-on skills training via simulation. The key assumptions are that critical teamwork skills are reinforced during the training program and that patient outcomes will improve as a result of these skills being transferred to the work environment.

However, recent research on healthcare team training efficacy has yielded mixed results [8], [4], [5]. One possible reason for this is the complexity of linking team performance characteristics to measurable outcomes. Few healthcare team training initiatives currently implement a comprehensive evaluation protocol, thus failing to demonstrate the achievement of intermediate training objectives. We have developed a multi-level assessment protocol for healthcare team training outcomes, which includes behavioral observation and analyses stemming from training scenarios conducted at the NMCP Healthcare Simulation Center.

1.2 Simulation as a Tool for Healthcare Teams Training

Simulation and teamwork are two relatively novel aspects of healthcare training that have only recently begun to receive significant attention. Using a simulated operating theater to examine surgical skill acquisition and maintenance over time, Moorthy et al. [9] discovered that communication skills (unlike technical skills) do not develop naturally as a result of increased job experience. Rather, these skills must be consciously trained and reinforced. Further, the ability of healthcare professionals to accurately and reliably assess their own non-technical performance is not sufficient to promote self-regulation and skill acquisition [10].

Effective teamwork is critical for patient safety, yet becoming an expert team member requires practice. Evidence is beginning to emerge in support of simulation as an ideal tool for healthcare teams training [11], [4], [12]. At NMCP, we have been able to successfully integrate simulation into our healthcare teams training program with the goal of enhancing teamwork skill acquisition through hands-on practice.

1.3 Early Training Infrastructure and Resource Availability at NMCP

1.3.1 Audio/Video Data Support

The NMCP Healthcare Simulation Center is equipped with a network of ceiling-mounted video cameras and microphones which feed into a central control area for programming camera angles, recoding and storing audio/video data, and rendering hard-copy discs. This network covers the entire center, with several cameras and microphones dedicated to each training room throughout the center. For training purposes, it is often desirable to play back the video feed so that participants have a chance to review performance and debrief individually or with instructors.

1.3.2 Patient Simulators

The Simulation Center houses a number of manikin simulators, including the Laerdal SimMan 3G, Laerdal SimBaby NEWBIE, and METI iStan. Training scenarios for the manikins can be created and delivered using either PC or Mac systems, depending on user needs. A larger number of part-task skills and box trainers are also available, covering a range of tasks such as IV line insertion, orthroscopy, central line placement, airway management, suturing, lumbar puncture, and more.

1.3.3 Virtual Reality

To support the acquisition and maintenance of psychomotor skills for minimally invasive surgery (MIS), the Simulation Center offers a variety of virtual reality (VR) trainers. These VR trainers can be used practice

upper and lower GI respiratory scope insertion, colonoscopy, hernia repair, laparoscopic cholecystectomy, and more. Each of the VR systems provides students with a set of physical instruments that must be manipulated in order to affect some physiological change on a virtual patient. These changes are fed back to the student through display of realistic sights and sounds (delivered through digital monitors) and touch feedback (delivered through the instruments themselves).

1.3.4 Standardized Patients

The Team Resource Center at NMCP currently partners with the Theresa A. Thomas Professional Skills Teaching and Assessment Center at the Eastern Virginia Medical School to provide standardized patients in support of our training courses. Standardized patients are highly-trained actors who present symptoms of illness and then assess healthcare professionals' diagnostic and interpersonal skills during face-to-face interactions. The standardized patients are carefully integrated into training scenarios to produce a realistic social context for students to practice within.

1.4 Performance Assessment: Kirkpatrick Training Model

The NMCP Healthcare Simulation Center offers a range of simulation technologies to support team training. However, technology alone is not the key to training success. Simulation must be part of a larger training process, including a well-designed curriculum and evaluation protocol. The latter is perhaps more often neglected than the former [4], [5]. TeamSTEPPS students at NMCP are evaluated throughout the course along four levels of measurable outcome: reaction, learning, behavior, and results. These levels are based on Kirkpatrick's [1] model of training outcomes assessment.

1.4.1 Level 1: Reaction

Reaction-level feedback reflects the degree to which the training course and its content are valued by the students. This generally

consists of asking students to complete a short pencil-and-paper feedback survey at the end of the course. Reaction-level data also help course administrators identify program strengths and opportunities for improvement.

1.4.2 Level 2: Learning

Learning-level feedback represents the degree to which relevant student attitudes and knowledge are positively impacted by participation in the course. Instruments such as the Team Attitudes Questionnaire [13] and modified TeamSTEPPS knowledge assessment instruments [7] are administered before training to establish baseline metrics. Upon completion of the course, students are asked to complete these assessments a second time to establish a comparison metric. The instruments may be continually administered over time to determine whether teamwork attitudes and knowledge have been sustained.

1.4.3 Level 3: Behavior

Behavioral outcomes reflect the degree to which core TeamSTEPPS tools and strategies have been successfully implemented in hospital units. To generate this form of data, trained observers spend time in the units monitoring and recording team activity using behavioral checklists. Behavior-level feedback is also generated during the training course, when students are asked to apply TeamSTEPPS concepts to resolve simulated case scenarios. These simulation sessions are audio/video recorded, and performance is critiqued during a post-scenario debrief.

1.4.4 Level 4: Results

Unit-specific metrics are maintained on a unit-by-unit basis and are analyzed periodically by the TRC. These metrics may reflect patient outcome data, procedural checklists, brief/debrief content analysis, and a number of other teamwork-related evaluations. Results-level outcomes reflect the organizational impact of the TeamSTEPPS training program over time.

1.5 TRC Performance and Assessment Needs

The first two outcome levels are assessed with pencil-and-paper survey instruments designed to record students' perceptions, knowledge and attitudes toward team training. Behavioral outcomes (Level 3) involve demonstration of acquired skill through hands-on TeamSTEPPS implementation. This is unlikely to occur in the work setting unless students are provided sufficient practice and feedback during training.

Carefully designed simulation scenarios allow students to practice using TeamSTEPPS skills and strategies in a safe learning environment and to receive feedback from colleagues and instructors so that these skills can be reinforced. However, conducting team training scenarios and video debrief sessions for TeamSTEPPS was not originally possible due to training infrastructure incompatibility.

Early in the training program it was determined that the Simulation Center's audio/video network was not designed to support teamwork debriefing. Rather, the ceiling-mounted video cameras and audio devices were installed to provide top-down, patient-centered perspectives for evaluating clinical proficiency. The cameras and microphones themselves produced low-grade surveillance quality sound and imaging. Further, the computer system dedicated to rendering hard-copy discs of the audio/video data for the purposes of analysis and debriefing required several hours to process, making immediate training debriefs impractical.

In addition to training debriefs, high-quality audio/video data were necessary to train unit and ward observers, to analyze effectiveness of training scenarios, and to demonstrate TeamSTEPPS skill improvement over a number of trials. Aside from the training center's infrastructure incompatibility for TeamSTEPPS, it was also determined that our conventional

teamwork simulation scenarios were not producing the desired learning effects.

Our initial approach to scenario development was to embed specific TeamSTEPPS learning objectives into a series of patient-centered clinical scenarios, with roles and learning opportunities available for all members of the healthcare team. The goal was to provide for clinical fidelity at the highest possible level, thus allowing students to focus on improving teamwork rather than becoming distracted by an unfamiliar technical context (e.g., lack of functioning anesthesia machine, absence of an attending physician, or varying the point at which an official timeout is conducted before surgery). However, it quickly became evident that our strong emphasis on clinical detail was counterintuitive to our goals of delivering quality non-clinical training scenarios.

The majority of TeamSTEPPS students were from outside NMCP and were registered to attend by TRICARE Management Activity (TMA). Frequently we did not know the students' background information (i.e., job role, specialty, training needs, etc.) in advance. As a result, simulation scenarios targeting students with specific job roles and skill requirements proved to be too inflexible and were difficult to manage from an administrative perspective.

We have also observed that as clinical fidelity of a given scenario increases, so too does student criticism of minor inconsistencies between the scenario and their own unique work environments. This pattern of student reaction to clinical fidelity in training scenarios resembles the "uncanny valley" phenomenon [14], in which greater fidelity can be associated with increased criticism of observable discrepancies under certain conditions.

One potential solution to our scenario development process was to de-emphasize the clinical nature of scenarios in favor of a

stronger non-clinical focus by expanding the training roles of our standardized patients.

2.0 INFRASTRUCTURE EVOLUTION

In order to maximize TeamSTEPPS training efficacy, a number of modifications and upgrades to the system's infrastructure were required. First, the existing audio/video system was upgraded to support team training. Second, the traditional model for healthcare simulation training scenarios was modified to de-emphasize clinical detail and focus on the non-clinical context of team training content.

2.1 Audio/Video System Upgrades

To enhance data collection and training debriefs, all ceiling cameras and microphones in the Simulation Center were upgraded to high-quality resolution systems. Additionally, a number of wall-mounted cameras were installed for the purpose of capturing team performance using eye-level panning. The wall-mounted cameras provide screen coverage of team performance otherwise unattainable by ceiling-mount cameras. The visualization control center was upgraded to include new monitors and selector switches for improving coordination among the cameras and microphones. A shoulder camera was purchased and incorporated into the data collection network, and a new dedicated computer system was installed for rendering hard-copy discs in minutes rather than hours (allowing for immediate debriefs).

2.2 Training Scenario Modifications

We expanded the utilization of our standardized patients by devising a new form of simulation training scenario. Rather than focusing on increased clinical fidelity for patient-centered, student-driven scenarios, we decided to pilot a series of scenarios which de-emphasize clinical details and focus instead on providing a high-fidelity social context in which students can practice non-clinical TeamSTEPPS skills. Our new scenarios each constitute a carefully scripted sequence of events which

unfold in a generic healthcare setting, but do not involve clinical activities and are not patient-centric. This ensures that any student, regardless of background or job role, may freely participate in any of our scenarios.

The scripted scenario is carried out by a team of trained actors while students observe nearby. The team of actors engages in a sequence of social interactions with each other while the scenario unfolds, and some of the interactions are scripted to reflect sub-optimal teamwork decisions and behaviors. At various points, individual students are asked to step into the scenario as a participant and attempt to successfully resolve an escalating situation by drawing on their TeamSTEPPS training.

Each student is given multiple opportunities to engage the actors throughout the scenario. As they do so, they will receive realistic, immediate feedback from the actors in the form of improvised reactions. For example, a student who attempts to address an actor-physician's unprofessional behavior may receive a passive, hostile, or defensive response from the actor. This "interactive theater" simulation provides multiple opportunities for students to practice teamwork skills throughout and also supports continual student discussion/debriefing as part of the learning exercise.

3.0 IMPACT OF SYSTEMS EVOLUTION

3.1 Audio/Video Capabilities

As a result of the Simulation Center audio/video system upgrades, we are now able to record complete scenario sessions from multiple viewpoints and perspectives. We are also able to capture the entire student group in a single frame and identify sources of communication (including non-verbal) as events unfold. Complete audio/video integration and hard-copy disc transfer is possible within a matter of

minutes, which permits relatively immediate video debriefs for students. This not only improves the quality of the training experience for learners, but also provides administrators with a record of how well the scenario functioned as a learning exercise. Additionally, recorded scenarios serve as training material for volunteer unit observers learning how to use TeamSTEPPS behavioral observation tools in the hospital.

3.2 Actor-driven Scenarios

Two non-clinical, actor-driven simulation scenarios were piloted in July 2010 at NCMP. Overall, the new format for TeamSTEPPS simulation training was considered a success. Student reactions to the actor-driven scenarios were positive. Because the emphasis was placed on social rather than clinical events, each scenario provided students multiple opportunities to engage without requiring a specific degree of clinical training or job role. This added flexibility gives us the ability to include students from a variety of backgrounds, including hospital administrative staff without any clinical training.

The new format also resulted in a greater amount of TeamSTEPPS-related dialogue during post-scenario debriefs, whereas clinical scenarios tend to be dominated by discussion of clinical activity and performance. Actor-driven event scripts guaranteed that the scenario would unfold in a manner consistent with our established learning objectives, whereas previous student-driven scenarios required constant interjection and management from staff scenario “directors.”

4.0 FUTURE DIRECTION/GOALS

The NMCP Team Resource Center has adopted a theoretical framework for evaluating healthcare teams training efficacy based on Kirkpatrick’s model of training outcomes assessment [1], and is using this framework to guide a systematic reconfiguration of the infrastructure supporting training and research initiatives at NMCP.

Early reaction-level feedback suggested that as efforts were made to increase the clinical fidelity of training scenarios, students were becoming more critical of minor inconsistencies within the clinical context. It was not our intention to emphasize technical proficiency with these scenarios, yet providing a practice environment with high clinical fidelity resulted in a preoccupation with clinical performance by our students. Therefore, the administrative team found it necessary to step back and reconsider the methodologies being used to develop TeamSTEPPS training scenarios.

Drawing on Benner’s stages of clinical competence [15], our team began to reassess the students’ readiness and progression with regard to TeamSTEPPS skill development. Benner’s theory is based on the Dreyfus model of skill acquisition [16], which delineates five stages of increasing skill: novice, advanced beginner, competent, proficient, and expert. Our students were considered to be clinically proficient (to expert) within their own respective disciplines, yet were advanced beginners at best within the areas of communication and teamwork. Our primary goal was to facilitate student transformation from an advanced beginner in TeamSTEPPS to functional competence by the end of the 2.5-day training course.

Specifically, the identified learning objectives for course completion were a.) to demonstrate competence in the use of TeamSTEPPS strategies and techniques, b.) to be able to initiate TeamSTEPPS activities upon returning to the students’ parent command, and c.) to recognize that developing the skills required to become a proficient TeamSTEPPS practitioner would require continued use of the strategies and techniques learned during the course. The distinction between the advanced beginner and competent skill levels was the guiding force behind our shift to a training scenario model emphasizing the social rather than clinical context.

The TRC's new model of actor-driven training scenarios reflects efforts to help students achieve TeamSTEPPS competence and to capitalize on Kirkpatrick's Level 3 (Behavior) training outcome [1]. The goal was to provide students with ample opportunities to apply TeamSTEPPS skills and strategies in a safe educational environment where immediate feedback could facilitate learning. Standardized patients are capable of providing students with two forms of feedback during these training scenarios: real-time improvisational feedback and post-scenario debrief feedback. The former constitutes a variety of realistic actor responses directed toward the students as they practice resolving teamwork issues throughout each scenario. The latter is an overall performance critique presented by the actor after the scenario has ended.

Standardized patient actors have been shown to be a reliable and valid means of assessing healthcare professionals' non-technical skills [17], [18]. The TRC is currently developing a standardized protocol for assessing students' TeamSTEPPS performance during simulated scenarios; the results of these assessments will serve as discussion during post-scenario debrief sessions. However, as with any formal assessment protocol, it will be critical to ensure that our assessments are not influenced by evaluator bias.

As we develop a standardized protocol for TeamSTEPPS skills assessment, we will examine the degree to which evaluator bias impacts ratings of student performance [18], [19]. Inconsistencies in actors' role portrayal, improvised feedback, or scoring could be the result of unique biases (e.g., gender, age) attributable to the actor-evaluators. One methodology that has been developed to assess standardized patient bias and establish inter-rater reliability is the use of "standardized examinees" [19]. Standardized examinees are individuals trained to a specific level of proficiency, after which they are subjected to

assessment by a number of standardized patients. Inter-rater reliability can then be established and potential biases explored through the analysis of ratings provided by the various standardized patients.

The most important goals of the TRC moving forward are to continue stripping away the veneer of expertise that comes from students' confidence in their respective technical abilities and to reinforce the notion that a significant amount of learning still lies ahead for those who would develop teamwork expertise as well. It is our objective to provide meaningful learning experiences for students so that they complete the TeamSTEPPS course with the competence to implement TeamSTEPPS strategies and the motivation required to transform their competence into expertise.

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T. Robert Turner, MA, ABD
Booz Allen Hamilton
Naval Medical Center Portsmouth

CDR Andrea Parodi, NC, USN
Head, Nursing Research
Director, Team Resource Center
Naval Medical Center Portsmouth



Naval Medical Center Portsmouth (VA)



First and Finest

- Construction began 1827
- Completed in 1830
- Oldest hospital in Navy medical system



Norfolk Naval Hospital (c.1900)



Naval Medical Center Portsmouth (VA)



- Residency programs in 13 specialties
- 300+ clinical and 140 specialty exam rooms, 17 operating rooms
- Designated DoD Team Resource Center (TRC) in 2008
 - DoD/AHRQ TeamSTEPPS™ program
 - 3 tri-service TtT courses annually
 - Command Orientation classes monthly



Naval Medical Center Portsmouth, VA

3



Healthcare Teams Training



- Teamwork/communication breakdowns
 - Root cause in most sentinel events [1, 2]
 - Effective teamwork critical for patient safety
 - Behaviors do not develop naturally [3, 4]
 - Consciously trained
 - Reinforced
 - Mastered over time
 - Successfully addressed in other high-risk domains
 - Crew Resource Management (aviation)
 - TeamSTEPPS™ (healthcare)
 - Department of Defense
 - Agency for Healthcare Research & Quality
 - Jury still out on healthcare teams training [5-7]

4



TeamSTEPPS from CRM

- TeamSTEPPS core competencies
 - Team Structure
 - Leadership
 - Situation Monitoring
 - Mutual Support
 - Communication
- TRC program
 - Prepare to lead by example
 - Support change teams
 - Study modeling & simulation technologies

5



Healthcare Simulation Center

- Training/Research Assets
 - Didactic training facilities
 - Audio/Video capture system
 - Manikin
 - Virtual Reality
 - Standardized Patients



6



Simulation Center Infrastructure Evolution

Level 4

Level 3

Level 2

Level 1

Initial State	Current State
Ceiling mount only	Ceiling, wall mounts
Surveillance quality video	High resolution video
Delayed debriefs	Immediate debriefs

Kirkpatrick [8] Training Outcomes Model

7



Simulation Training Scenario Evolution

- Original model: Student-driven scenario
 - Identify TeamSTEPPS training objectives
 - Outline clinical context & key events
 - Set the stage
 - Direct the scenario
 - Debrief

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Simulation Training Scenario Evolution

- Challenges

- Specific role requirements (anesthesia)
- Specialty areas (ED, Dental)
- Content validity (conflict resolution)
- Information availability → flexibility of scenarios
- Clinical fidelity



9



Simulation Training Scenario Evolution

- Current Model: Actor-driven scenario

- Identify TeamSTEPPS training objectives
- Script key events, clinical or non-clinical
- Set the stage
- Students engage actors intermittently
- Debrief



10



Simulation Training Scenario Evolution

● Outcomes

- Flexible scenarios
 - Students practice skills regardless of background and experience
 - No specific team structure required
- Improved scenario control
- Increased opportunities for feedback
 - Actor & Peer feedback:
 - Immediate
 - General
- Greater content validity
- Social over clinical fidelity
 - Clinical experts vs. social novices [9, 10]



11



The Actor-driven Scenario

The Dreyfus Model



12



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