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Theoretically-Driven Infrastructure for Supporting Health Care Teams Training at a Military Treatment Facility

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ABSTRACT Designated a Department of Defense Team Resource Center (TRC) in 2008, Naval Medical Center Portsmouth (NMCP) currently hosts three tri-service health care teams training courses annually. Each consists of didactic learning coupled with simulation-based training exercises to provide an interactive educational experience for health care professionals. Simulated cases are developed to reinforce specific teamwork skills and behaviors, and to incorporate a variety of technologies including standardized patients, manikins, and virtual reality. The course is also the foundation of a research program designed to explore applications of modeling and simulation for enhanced team training in health care. The TRC has adopted two theoretical frameworks for evaluating training efficacy and outcomes, and has used these frameworks to guide a systematic reconfiguration of the infrastructure supporting health care teams training at NMCP.

INTRODUCTION

In 2008, Naval Medical Center Portsmouth (NMCP) was designated a Department of Defense Team Resource Center (TRC) for the Navy. The mission of the TRC is to promulgate the practice of a crew resource management based patient safety program called TeamSTEPPS, to explore applications of modeling and simulation-based training in support of this program, and to analyze TeamSTEPPS efficacy and impact on patient safety. This "train-the-trainer" program is a major component of a research initiative exploring the use of modeling and simulation to enhance teamwork training in health care. As such, the TRC at NMCP conducts three annual training courses for tri-service medical personnel lasting 2.5 days each. The course consists of didactic learning coupled with simulation exercises to provide an interactive educational experience for health care professionals. Simulated cases are developed to reinforce specific teamwork skills and behaviors, and to incorporate a variety of technologies including standardized patients (SP), manikins, and virtual reality.

The TRC has adopted two theoretical frameworks for structuring training evolutions and evaluating training efficacy. These include Benner's stages of clinical competence model[1] and Kirkpatrick's training outcomes model.[2] The TRC has used these frameworks to guide a systematic reconfiguration of the physical infrastructure of a simulation center that supports health care training and research initiatives at NMCP, as well as realigning TeamSTEPPS training scenarios and the role of the SP.

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Health Care Teams Training

Leadership and communication failures are identified as a root cause of adverse patient outcomes in the majority of reported sentinel events.[3,4] These failures represent a gap in functional teamwork behaviors that have been addressed in a number of other teamwork-intensive domains (e.g., aviation) through the introduction of carefully designed team skills training programs.[5,6] Teamwork has also been empirically linked to clinical patient outcomes in the health care domain,[4] yet evidence suggests that a significant number of health care providers hold misconceptions about the nature and efficacy of teamwork in their own units.[7] Several teamwork (nontechnical) skills training programs have recently been tailored to the health care domain; TeamSTEPPS is such a program.

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.[8] This system aims to instill positive teamwork behaviors in health care professionals by emphasizing key tenets adapted from aviation's Crew Resource Management training system. The five foundational TeamSTEPPS tenets are communication, team structure, leadership, mutual support, and situation monitoring.

Simulation as a Tool for Health Care Teams Training

Simulation and teamwork are two relatively novel aspects of health care training that have only recently begun to receive significant attention. Using a simulated operating room 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 health care professionals to accurately and reliably assess their own nontechnical 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 health care teams training.[6,11,12] The TRC team at NMCP has been able to successfully integrate simulation into our health care teams training program with the goal of enhancing teamwork skill acquisition through hands-on practice.

The TeamSTEPPS program is designed to provide learners with the knowledge and skills necessary for effective teamwork, as well as technique refinement through the use of repeated exposure and feedback from practice scenario simulations. 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 health care teams training efficacy has yielded mixed results.[5,6,13] One possible reason for this is the complexity of linking team performance characteristics to measurable outcomes. Few health care teams training initiatives currently implement a comprehensive evaluation protocol, thus failing to demonstrate the achievement of intermediate training objectives. We have developed a multilevel assessment protocol for health care team training outcomes, which includes behavioral observation and analyses stemming from training scenarios conducted at the NMCP Healthcare Simulation Center.

A Significant but not Insurmountable Challenge

During the normal course of events, military medical centers are characterized by consistent fluctuations in clinical staffing because of the normal course of vacations and sick days (like our civilian counterparts), out-of-unit training evolutions, in addition to the numerous deployment opportunities and duty station rotations or possibly prolonged absence because of extensive training or education programs such as Duty Under Instruction. Before the current war, a nurse manager, for example, could estimate that one-third of their staff would be either preparing to detach to another location, transfer, or be a new acquisition to the unit or to the Command.

In short, the military is "comfortable" with continuous training and orientation. However, the need is significantly amplified in today's environment by the frequency of deployments and the required out-of-Command predeployment training, which create staffing and training challenges in general. Mitigating the impact of a continuous state of staff flux, the TeamSTEPPS program was designed to instill in its learners the requisite knowledge and skills for developing teamwork training and sustainment programs for their own units.

Unit-specific training programs are meant to promote and reinforce critical team behaviors, irrespective of individual team members' history with the official TRC program. Though regularly supported by the TRC, these unit-specific programs are primarily driven by local TeamSTEPPS leaders. Additionally, an abbreviated TeamSTEPPS orientation program is offered on a monthly basis to provide the individual clinician an opportunity to understand the rationale behind this valuable patient/clinician safety program and to facilitate the insertion of a new member into an already established and functional team.

Performance Assessment: Kirkpatrick Training Outcomes 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.[5,6] TeamSTEPPS learners at NMCP are evaluated throughout the course along four levels of measurable outcomes: reaction, learning, behavior, and results. These levels are based on Kirkpatrick's[2] model of training outcomes assessment (Fig. 1).

Level 1: Reaction

Reaction-level feedback reflects the degree to which the training course and its content are valued by the learners. The learners complete two short, five-point Likert-type surveys at the end of the course. The surveys were designed to solicit the attitudes and perceptions of the learners in reference to their experience with either the didactic- or simulation-based learning components. This level of program assessment focuses on the learners' perceived value of the training experience and content. Additionally, these reaction-level data help course administrators identify program strengths and opportunities for improvement.

Level 2: Learning

Learning-level feedback represents the degree to which relevant learner attitudes and knowledge are positively impacted by participation in the course. Before training,

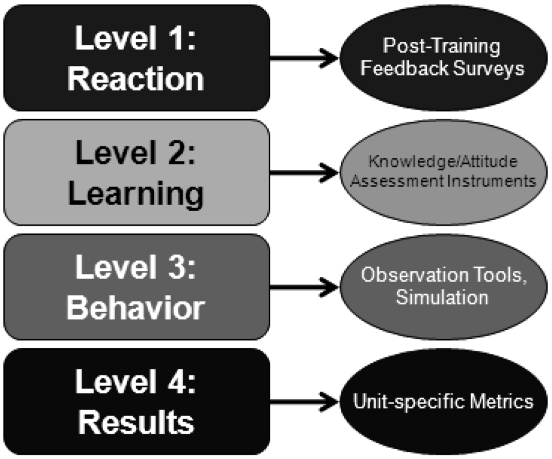

FIGURE 1. Kirkpatrick training outcomes evaluation model[2] adapted to illustrate corresponding TeamSTEPPS assessment at each level.

a test battery including the TeamSTEPPS Teamwork Attitudes Questionnaire (TAQ)[14] and a modified version of the TeamSTEPPS Knowledge Assessment Instrument (KAI)[8] is administered to our learners to establish baselines. The TAQ is a 30-item assessment instrument designed to explore learner beliefs and attitudes corresponding to each of the five core TeamSTEPPS tenets. The TAQ has been determined to be a valid and reliable instrument for documenting relevant TeamSTEPPS attitudes.[14]

Our modified KAI is comprised of two 10-item multiple-choice instruments that can be alternately administered as pre- and post-tests. Individual KAI items represent brief descriptions of team-based scenarios in which learners must draw on their TeamSTEPPS knowledge to choose a best-course option from among several alternatives. Content validation and parallel forms reliability for the modified TeamSTEPPS KAI tool was established internally before its implementation at NMCP.

Upon completion of the course, learners are asked to complete each assessment a second time to generate post-training comparison data. Learners' post-training knowledge and attitudes should demonstrate significant gains over pretraining baseline scores to demonstrate positive training impact. The instruments may be continually administered to determine the degree to which teamwork attitudes and knowledge have been sustained over time.

Level 3: Behavior

Behavioral outcomes reflect the degree to which core TeamSTEPPS tools and techniques have been successfully integrated into patient care and/or health care operations. To generate this type of data, trained observers using behavioral checklists spend time in the units monitoring and recording recognized and observable teamwork activity. Appropriate checklist content will vary by unit and procedure, but generalized instruments such as the Teamwork Performance Observation Tool[8] may serve as a foundation for behavioral data. Behavior-level feedback is also generated during the training course, when learners are asked to apply TeamSTEPPS concepts to resolve simulated case scenarios. The simulation sessions are audio/video recorded, and performance is critiqued and recorded by trained facilitators during a postscenario debrief. The inter-rater reliability of our facilitators is established before their participation in the sessions to ensure consistency in behavioral feedback and scoring. Learners are then provided an opportunity to incorporate debrief feedback by participating in the scenario a second time.

Level 4: Results

Unit-specific metrics are maintained on a unit-by-unit basis and are analyzed periodically by the TRC for the purpose of team process improvement. Two such initiatives (Intensive Care Unit and Labor/Delivery) are currently underway at NMCP. Unit metrics may include patient outcome data, procedural checklists, brief/debrief content analyses, and a number of other teamwork-related evaluations. For example, unit-specific drills designed to assess teamwork in a code blue scenario may generate response time data for key events, number of repeated requests/orders, and frequency of verbal order/action confirmation. These data are indicative of positive gains in teamwork, communication, and coordination skills when improved over time as a result of team training; they can also relate directly to improved quality of care, resource utilization, and error mitigation. Results-level outcomes reflect the organizational impact of the TeamSTEPPS training program over time.

TRC Performance and Assessment Needs

The first two outcome levels are assessed with pencil-and-paper survey instruments designed to record learners' 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 learners are provided sufficient practice and feedback during training.

Carefully designed simulation scenarios allow learners 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 because of training infrastructure limitations.

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 traditionally configured, ceiling-mounted video cameras and audio devices were installed to provide top-down, patient-centered perspectives for evaluating clinical skills 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 many hours to process, making immediate training debriefs impossible.

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 limitations for supporting TeamSTEPPS instruction and debriefing, it was also determined that conventional teamwork simulation scenarios were not producing the desired learning effects.

The 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 health care team. The goal was to provide for clinical fidelity at the highest possible level, thus allowing learners 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 nonclinical task training scenarios.

The TeamSTEPPS unit-based training evolutions (i.e., noninstructor training program) take place with existing clinical teams either in the simulation center or in the clinical setting based on the specific training goals for the event of the day. However, the majority of learners selected to attend the Tri-Service trainer courses originate from outside the local NMCP Command. They are generally hand-selected to attend based on their affiliation with a unit or Command change team, rather than on their individual clinical specialties or job roles. For example, an intensive care unit change team attending TeamSTEPPS may consist of that unit's medical director, three physicians, one nurse, and two administrative personnel. This characteristic often posed a challenge if, for example, a learner's provided registration information was incomplete or ambiguous with regard to their specific background (i.e., present job role, clinical specialty, training needs, etc.). As a result, simulation scenarios necessitating specific job roles and/or skill requirements proved to be too inflexible and were difficult to manage from an administrative perspective, and could not appropriately target the specific training needs of our learners.

Additionally, we observed that as clinical fidelity for a given scenario increased, so too did learners' criticism of minor inconsistencies or differences between the scenario/environment and their own unique workplace environments. This pattern of learner reaction to high-level clinical fidelity in training scenarios resembles the "uncanny valley" phenomenon,[15] in which greater fidelity is sometimes associated with increased criticism of any observable discrepancies. Interestingly, the criticisms were rarely about the TeamSTEPPS task at hand, but rather on environmental or procedural concerns. For example, a particular group of dental providers found it difficult to proceed with a scenario until a particular type of handheld mirror was made available.

One potential solution to learners' negative reactions toward increased clinical fidelity was to restructure the scenario design. The scenario development process was modified in such a way as to de-emphasize clinical fidelity in favor of supporting a stronger personal interactive and nontechnical skill emphasis; this was achieved by expanding the roles of our SP and deconstructing the scenarios toward improved communication and situational awareness. Learner debriefs following the revised scenarios began to include discussion of interpersonal skills rather than on perceived inadequacies of the scenario's clinical fidelity. These changes generated a clear shift toward focusing the learner's behavior on TeamSTEPPS skill acquisition.

Infrastructure Evolution

In order to maximize TeamSTEPPS training efficacy, a number of modifications and upgrades to the NMCP Sim Center's audio/video system were required. First, the existing audio/video system was upgraded to better support the interpersonal nature of team training rather than the traditional top-down camera angle. 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 with eye-level panning capability were installed to capture team performance. The wall-mounted cameras provided screen coverage of team performance unattainable by ceiling-mount cameras. The visualization control center was upgraded to include new monitors and selector switches for improving coordination between the cameras and microphones. A shoulder camera was purchased and incorporated into the data collection network for unit observation potential and Sim Center filming. Additionally, a new computer was installed and dedicated for rendering hard-copy playback discs in minutes rather than hours, hence enabling immediate postscenario debriefs.

The TRC research team expanded the utilization of the SP by devising a new simulation training scenario format. Rather than focusing on increased clinical fidelity for patient-centered, learner-driven scenarios, we pilot tested a series of scenarios, which de-emphasize clinical details and focused instead on providing a high-fidelity social context in which learners could gain greater practice opportunities of the nonclinical, highly interactive TeamSTEPPS skills. The new scenarios constituted a carefully scripted sequence of events that were mapped to a TeamSTEPPS key tenant. These scenarios then would unfold in a generic health care setting (for example, at the nurses station, in a private office, or directly outside a patient's room), but did not involve clinical activities. This ensured that any learner, regardless of background or job role, could freely participate in any of the scenarios.

Roll Camera! The Learning Now Begins…

The scenario has been scripted and camera angles blocked, sound checks are complete. Enter the team of trained actors who are our SP. While the learners observe nearby, the team of actors engages in a sequence of scripted social interactions with each other while the scenario unfolds. Some of the interactions intentionally reflect suboptimal teamwork decisions and behaviors. At various points, individual learners are asked to step into the scenario as a participant and attempt to resolve an escalating situation by drawing on their TeamSTEPPS knowledge and training.

Each learner 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 learner 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 learners to observe and practice teamwork skills throughout and stimulates lively support discussion and sometimes debate within the training group. Debriefing is in the form of self-reflection, SP, and master trainer guided analysis at the completion of the exercise and during video playback.

IMPACT OF SYSTEMS EVOLUTION

Audio/Video Capabilities

As a result of the Simulation Center audio/video system upgrades, we were able to record complete scenario sessions from multiple viewpoints and perspectives. We "capture" the entire learner group in a single frame and identify types of communication (including nonverbal) as events unfold. Complete audio/video integration and hard-copy disc transfer is possible within a matter of minutes, which permits almost immediate video debriefs for learners. This not only improves the quality of the training experience for learners, but also provides course directors/researchers with a record (data) of how well the scenario functioned as a learning exercise. Additionally, recorded scenarios serve as training material for volunteer unit observers to learn how to use the TeamSTEPPS behavioral observation tools and for establishing inter-rater reliability between proposed unit observers.

Actor-driven Scenarios

In July 2010, two nonclinical, actor-driven simulation scenarios were piloted at NCMP. Overall, the new format for TeamSTEPPS simulation training was considered a success. Learner reactions to the actor-driven scenarios were positive. Because the emphasis was placed on psychosocial rather than clinical events, each scenario provided learners multiple opportunities to engage without requiring a specific degree of clinical training or job role. This added flexibility gives the TRC team the ability to include learners from a variety of backgrounds, including nonclinical hospital administrative staff.

The new format also resulted in a greater amount of TeamSTEPPS-related dialogue during postscenario debriefs, whereas clinical scenarios tended to be dominated by discussion of clinical activity, treatment options, and hospital-specific policies and protocols. Actor-driven event scripts guaranteed that the scenario would unfold in a manner consistent with our established learning objectives, whereas previous learner-driven scenarios required constant interjection and management from staff scenario "directors."

FUTURE DIRECTION/GOALS

Drawing on Benner's stages of clinical competence[1] (Fig. 2), our team began to reassess the learners' 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 learners were considered to be clinically proficient (to expert) within their respective disciplines, yet were advanced beginners at best in the areas of communication and teamwork. Our primary goal was to facilitate learner transformation from an advanced beginner in TeamSTEPPS to functional competence by the end of the 2.5-day training course.

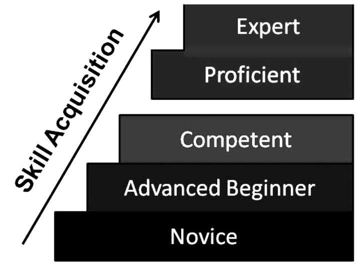

FIGURE 2. Benner Stages of Clinical Competence,[1] adapted from the Dreyfus "Novice to Expert" Skill Acquisition Model.[16]

Specifically, the identified learning objectives for course completion were to (a) demonstrate competence in the use of TeamSTEPPS strategies and techniques, (b) be able to initiate TeamSTEPPS activities upon returning to the learners' parent Command, and (c) recognize that developing the skills required to become a proficient TeamSTEPPS practitioner would require over time 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 interpersonal and professional interactions rather than clinical practice. The goal at each outcome level is to demonstrate marked improvement as a function of focused teamwork training and active sustainment of skills. Thus, the importance of establishing baseline and subsequent comparison data through repeated measurement over time cannot be understated. Regardless of the metrics or instruments used, it will be impossible to highlight significant improvement over time without first documenting the starting point.

The TRC's new model of actor-driven training scenarios reflects efforts to help learners achieve TeamSTEPPS competence and to capitalize on Kirkpatrick's level 3 (behavior) training outcomes.[2] The goal was to provide learners with ample opportunities to apply TeamSTEPPS skills and strategies in a safe educational environment where immediate feedback could facilitate learning. SP are capable of providing learners 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 learners 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.

The use of SP actors has been shown to be a reliable and valid means of assessing health care professionals' non-technical skills.[17,18] The TRC is currently developing a standardized protocol for assessing learners' TeamSTEPPS performance during simulated scenarios; the results of these assessments will serve as discussion points 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 learner 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 SP 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 SP. Inter-rater reliability can then be established and potential biases explored through the analysis of ratings provided by the various SP.

As the TRC at NMCP moves forward, the continued objective is to provide meaningful learning experiences so that the learners complete the TeamSTEPPS course with a sense of commitment and are fully competent so they can implement TeamSTEPPS strategies upon return to their parent Commands. We hope the competence we see at the course completion develops over time into an expertise and a passion for assuring patient safety through their individual contributions to the sustainment of highly functional health care teams. Additionally, the TRC research team continues to measure not just the efficacy of this important patient safety program, but also the best approaches and uses of modeling and simulation in health care and TeamSTEPPS education. Ultimately, the research team seeks to identify the extent of direct and indirect benefit to the patient and to the military health care system gleaned from error and injury avoidance or positive patient outcomes. An important and final point is that the acquisition of expert teamwork and leadership skills requires both the knowledge of valuable principles as well as the consistent practice of these principles to enable the growth of a true culture of patient safety that is part of the fabric of our work, and our commitment to all our beneficiaries.

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