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A Saturated Approach to the Four-Phase, Brain-Based Simulation Framework for TeamSTEPPS® in a Pediatric Medicine Unit

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ABSTRACT

Introduction : Although many organizations have reported successful outcomes as a result of Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS), implementation can be challenging, with its share of administrative obstacles and lack of research that shows observable change in practice. **Methods:** This quantitative, pretest/posttest design pilot research used a combination of classroom simulation-based instruction and in situ simulation in a Pediatrics department in an urban academic center. All personnel with direct patient care responsibilities (n = 547) were trained in TeamSTEPPS in an 8-week period. TeamSTEPPS course knowledge scores were compared pretraining to posttraining using the Wilcoxon rank-sum test. The performance of two-day and overnight shift teams, pre- and postintervention was assessed using the TeamSTEPPS Team Performance Observation Tool. **Results:** TeamSTEPPS course knowledge improved from the beginning of the course to completion with median scores of 16 and 19, respectively ($P < 0.001$). Both day and evening postintervention groups demonstrated greater team performance scores than their control counterparts. Specifically, postintervention day shift team showed the greatest improvement and demonstrated more TeamSTEPPS behaviors. **Conclusion:** This pilot study involving 1 department in an urban hospital showed that TeamSTEPPS knowledge and performance could be improved to increase patient safety and reduce medical errors. However, teams need to be trained within a shorter period so they can apply a shared-model of teamwork and communication. Leaders and educators throughout the department must also reinforce the behaviors and include them in every education intervention. *(Pediatr Qual Saf 2018;3:e086; doi: 10.1097/pq9.0000000000000086; Published online June 22, 2018.)*

It is very well documented that teamwork and communication issues can adversely affect patient safety and quality.[1,2] Researchers have observed that teamwork and communication issues can impact patient care, patient handoffs, and team performance.[3] Poor teamwork and communication can impact the climate and culture of an organization,[3] whereas physician well-being, nurse and physician burnout, and employee turnaround are all influenced by both climate and culture.[4] Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS®) provides clinical teams with the tools to improve teamwork and communication by focusing on 4 behaviors or competencies: Leadership, Situational Monitoring, Mutual Support, and Communication. TeamSTEPPS® provides the clinician with the means to speak up to share timely, thorough information that can mean the difference between good and unfavorable patient outcomes.[5]

Although many organizations have reported successful outcomes as a result of TeamSTEPPS®,[6–9] implementation has its own set of challenges. Some of these obstacles may be associated with or caused by lack of administrative support and ineffective instructional practices.[10] A plan for implementation that does not include a plan for sustainment and reinforcement training can also hinder implementation team efforts.[11] Organizations attempting to implement TeamSTEPPS® over longer periods might find that the revolving door affiliated with many

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organizations also prevents them from fully implementing TeamSTEPPS®. The saturation-in-training theory[10,12] posits that training the greatest number of people in the shortest period can generate the greatest effect. Our goal was to train at least 90% of the department in less than 3 months so that everyone had the same TeamSTEPPS® knowledge and skills. The purpose of this pretest/posttest design pilot research was to assess the impact of the saturation-in-training model of TeamSTEPPS® implementation in an urban hospital department of pediatric academic setting.

INTERVENTION

The 4-phase, brain-based simulation framework for TeamSTEPPS®[13] was designed to prepare learners to function as high-performing teams. This training is a modification of the original lecture-based course and has been implemented by one of the researchers in hospital systems worldwide. The course employed the latest, evidence-based practices and proven instructional design principles based on the 4-phase brain-based lesson plan for simulation.[13,14] The inquire phase of the course assists learners with creating situational interest in the topic. The gather phase includes instruction in all 4 TeamSTEPPS® competencies, including leadership, situational monitoring, mutual support, and communication. Interprofessional teams train together in this course and apply the competencies progressing from written cases, video cases, and finally to simulation-based clinical cases in the process phase. Lastly, the apply phase assists learners with transferring the content to their clinical situations through the use of debriefing.

THEORETICAL FRAMEWORK FOR THIS INTERVENTION

The frameworks that support this intervention include Bandura's Social Learning Theory[15] and the 4-phase, brain-based simulation framework.[13,14] Learners construct their knowledge and revise their existing frames of knowledge individually and with the assistance of others in 4 phases that are conducive to learning.

METHODS

This pretest/posttest design pilot research used a combination of classroom simulation-based instruction and in situ simulation in a Pediatrics department in an urban academic center. The term in situ in this research refers to the natural clinical setting. Institutional research board approval was granted for this education-based intervention. All collected data was deidentified. All department members with direct patient contact responsibilities (n = 547) completed the intervention: 4-phase simulation TeamSTEPPS® training facilitated by Master Trainers using the saturation-in-training principle (Fig. 1).

KNOWLEDGE TEST

We used the TeamSTEPPS® course pre- and posttest to evaluate changes in knowledge. This test was developed by 1 of the researchers and used at multiple sites worldwide. The course examination consisted of 20 multiple-choice questions assessing understanding of the 4 TeamSTEPPS® competencies. Scores were calculated based on the number of correct responses (0–20). The test was administered immediately before and after the TeamSTEPPS® course. Kirkpatrick[16] observed 4 levels of educational outcomes: reaction to the experience, change in knowledge, observable change in practice, and change in organizational-level outcomes. The pre/posttest was used to assess whether there was a change in knowledge based on the intervention.

In Situ Team Performance

In situ team performance was evaluated to assess an educational outcome of an observable change in behavior. Two in situ simulations, pre- and postintervention, with 2-day and overnight shift teams, were conducted in the Pediatric inpatient unit using the validated TeamSTEPPS® Team Performance Observation Tool.[17,18] This observation tool, available from the AHRQ TeamSTEPPS® program, was used to assess the clinical teams before and after the intervention. The validated TeamSTEPPS® Team Performance Observation Tool[17,18] measures five areas: team structure, leadership, situational monitoring, mutual support, and communication. Each of the 25 evaluated criteria are scaled from 0 (done poorly) to 5 points (excellent).

The following research hypotheses and questions were created to learn about the impact of our organization's TeamSTEPPS® intervention.

Research Hypotheses and Questions.

H1: Those who complete TeamSTEPPS® training will perform a team debrief after clinical events at a higher rate than those who have not completed this training.

H2: Teamwork and communication scores, as measured by the TeamSTEPPS® Team Performance Observation Tool, will be higher for those who have completed TeamSTEPPS® training compared with those who have not completed this training.

RQ1: Do clinical teams debrief following a TeamSTEPPS® intervention?

RQ2: Do clinical teams completing the TeamSTEPPS® training score higher on the TeamSTEPPS® Team Performance Observation Tool?

RQ2: Do team members use situational monitoring and mutual support following a TeamSTEPPS® intervention?

RQ3: Is there a clear leader and are team members assigned to roles and responsibilities following a TeamSTEPPS® intervention?

RQ4: Is there a change in teamwork and communication knowledge after the TeamSTEPPS® training?

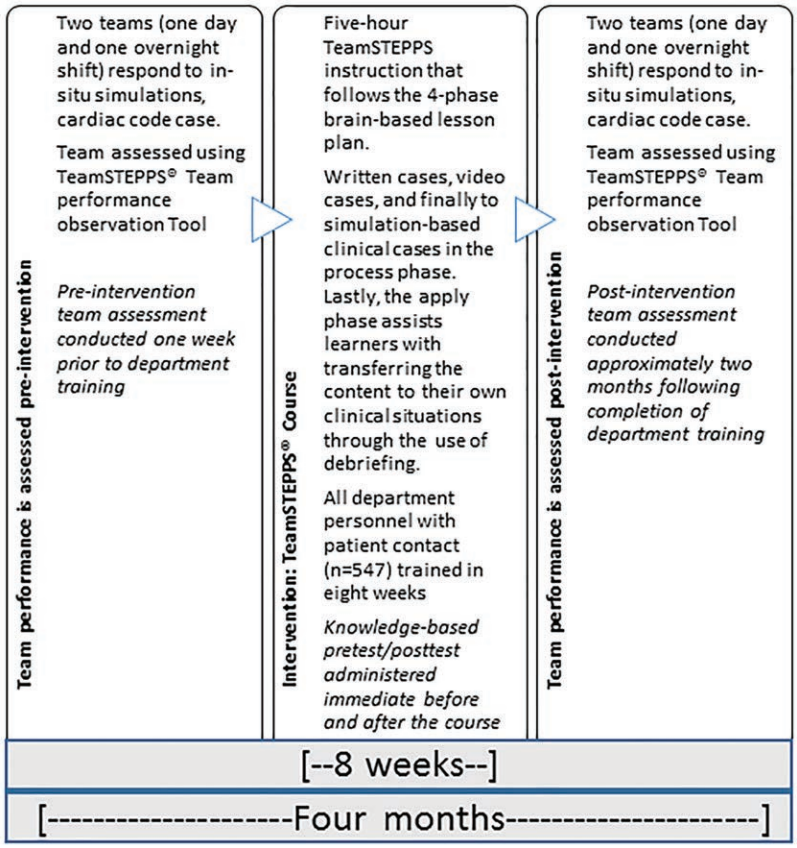

Fig. 1. Intervention and research protocol.

Sample

Classroom Portion of the Research. The sample for this research protocol included all personnel with direct patient care responsibilities (n = 547), including nurses, physicians, pharmacists, respiratory therapists, unit clerks, and environmental workers in the department of pediatric medicine. These numbers do not reflect the 17 TeamSTEPPS® Master Trainers who received training and assisted with the instruction for the 547 members of the department.

In Situ Team Performance Research

For the team performance assessment, we activated a mock code on the clinical floor, and the responding teams were briefed and consented to the research. A total of 4 teams, 2 teams before and after the intervention, were briefed that they would participate in in situ simulations that included a mock code. They were told that team performance would be assessed using the TeamSTEPPS® Team Performance Observation Tool and that the information would be deidentified. The participants were told that they could opt out of the research at any time. Teams included a total of 20 participants: resident physicians (n = 8), nurses (n = 11), and one respiratory therapist (n = 1). Due to shift scheduling, patient coverage concerns, and high patient census, teams often did not include the same members.

Procedure

Using the saturation-in-training model,[10,12] the entire department received training by Master Trainers in 27 courses facilitated over a period of eight weeks. Before implementing the 27 courses, we conducted 2 in situ simulations with two teams from the day and overnight shifts in the Pediatric inpatient unit. Two additional in situ sessions were conducted two months following the last TeamSTEPPS® session. We measured the performance of teams from both the day and overnight shifts because researchers[19–21] have noted differences in performance in some clinical behaviors between the two shifts. This observation caused us to include a team from each shift, pre and postintervention so we could also assess if team performance would differ. Because the intervention was approximately 8 weeks long, there was nearly four months between the pre- and postintervention team simulations. The same pediatric simulator and cases were used (asystolic cardiac arrest) to ensure consistent conditions for this research. The same two master trainers assessed team performance using the TeamSTEPPS® Team Performance Observation Tool. There were no differences in the scoring results between the two raters. Scores for all areas were positioned on the same end of the 5-point scale. The assessors addressed minor differences through discussion.

Statistical Analyses

Course Knowledge Scores were compared from pretraining to posttraining by Wilcoxon rank-sum tests. We described the team performance scores for the control and postintervention groups (day/night). Analyses were 2-sided with statistical significance evaluated at the 0.05 alpha level. Statisticians performed the analyses in R version 3.4.1 (Vienna, Austria).[22]

RESULTS

The first hypothesis is rejected (*Those who complete TeamSTEPPS® training will perform a team debrief after clinical events at a higher rate than those who have not completed this training*). Under the leadership competency, the second area of the TeamSTEPPS® Team Performance Observation Tool, the leader was assessed on conducting team events such as briefs, huddles, and debriefings. During the course, the facilitators emphasized the need for a debriefing immediately following the case.[23] Therefore, the assessors specifically observed to see if a leader debriefed following the case. The assessors noted that while the 2 teams that did not receive the TeamSTEPPS® training did not debrief their teams following the simulation cases, only 1 team conducted a debriefing postintervention.

Our second hypothesis is accepted (*Teamwork and communication scores, as measured by the TeamSTEPPS® Team Performance Observation Tool will be higher for those who have completed TeamSTEPPS® training compared with those who have not completed this training*). As shown in Table 1, there were improvements in team performance, which we described in the discussion section. However, since team composition was not consistent, and the researchers did not conduct enough simulations, statistical significance could not legitimately be implied.

In the first domain of the Team Performance Observation Tool, *Team Structure*, the researchers found improvement

Table 1. Scores on the TeamSTEPPS Team Performance Observation Tool: Pre and Post-team Intervention for both Day and Night Shifts

Possible Pts: 1 (Very Poor) to 5 (Excellent)	Control (Day) N = 3	Intervention (Day) N = 8	Control (Evening) N = 5	Intervention (Evening) N = 4
Team structure				
Assembles a team	3	3	3	2
Establishes a leader	1	3	3	1
Identifies team goals and vision	2	4	2	4
Assigns roles and responsibilities	2	4	3	2
Holds team members accountable	3	4	3	4
Actively shares information among team members	4	5	3	3
Total—team structure	2.5	3.8	2.8	2.7
Leadership				
Utilizes resources efficiently to maximize team performance	2	3	3	3
Balances workload within the team	2	4	3	5
Delegates tasks or assignments, as appropriate	2	4	3	5
Conducts briefs, huddles, and debriefs	1	5	2	2
Empowers team members to speak freely and ask questions	1	5	2	3
Total—leadership	1.6	4.2	2.6	3.6
Situational monitoring				
Includes patient/family in communication	NA	NA	NA	NA
Cross monitors fellow team members	3	4	3	4
Applies the STEP process when monitoring the situation	1	4	2	1
Fosters communication to ensure team members have a shared mental model	3	4	1	2
Total—situational monitoring	2.3	4	2	2.33
Mutual support				
Provides task-related support	2	4	3	5
Provides timely and constructive feedback to team members	1	5	2	2
Effectively advocates for the patient	2	4	2	NA
Uses the 2-challenge rule, CUS, and DESC script to resolve conflict	NA	4	NA	NA
Collaborates with team members	2	4	2	5
Total—mutual support	1.8	4.2	2.3	4.0
Communication				
Coaching feedback routinely provided to team members, when appropriately	1	5	2	1
Provides brief, clear, specific, and timely information to team members	2	5	3	4
Seeks information from all available sources	2	5	3	2
Verifies information that is communicated	2	5	3	5
Uses SBAR, call-outs, AND check-backs to communicate effectively with team members	2	5	3	3
Total—communication	1.8	5	2.8	3
Team performance score/average	10 (2 average)	21.2 (4.24 average)	12.5 (2.5 average)	15.6 (3.12 average)

The simulation cases did not create opportunities for the participants to be able to apply some TeamSTEPPS tools such as 2-Challenge and CUS (I am *Concerned*, I am *Uncomfortable*, I am stopping the line because of a *Safety* issue). These areas are marked, not applicable or NA. **DESC: D** = Describe the specific situation or behavior; provide concrete data. **E** = Express how the situation makes you feel/what your concerns are. **S** = Suggest other alternatives and seek agreement. **C** = Consequences should be stated in terms of impact on established team goals; strive for consensus. **SBAR:** Situation, Background, Assessment, Recommendation/Request

in the day shift scores (2.5–3.8 points), but the overnight scores decreased from 2.8 to 2.7 points.

There was improvement in the second domain, *Leadership*, in both the day and overnight shifts (1.6–4.2 points; 2.6–3.6 points).

There were increases in the third area, Situational *Monitoring* in both the day and overnight shifts (2.3–4 points; 2.0–2.33 points).

Mutual support was one of the largest gains in improvement for both the day and overnight shifts (1.8–4.2 points; 2.3–4.0 points).

Communication scores were also improved. This last domain of the Team Performance Observation Tool resulted in increases in scores in both the day and overnight shifts (1.8–5.0; 2.8–3.0 points).

Overall points on the Team Performance Observation Tool improved more on the day shift (10–21.2 points) than on the overnight shift (12.5–15.6 points).

For the research question, *do team members use situational monitoring and mutual support following a TeamSTEPPS® intervention*, the answer is yes. Specific examples and the higher scores from those sections of the observation tool are described in the discussion section.

For the research question, *is there a clear leader and are team members assigned to roles and responsibilities following a TeamSTEPPS® intervention,* the researchers did not record any differences in team performance in these two leadership areas.

Our last research question asked if there would be a *change in teamwork and communication knowledge* following the training. As shown in Table 2 and Figure 2, mean and median postcourse Knowledge Scores were higher than the precourse scores. The minimum test score was higher postcourse than precourse (10 versus 0), and the median score was significantly higher postcourse compared with precourse (19 versus 16; $P < 0.001$)

DISCUSSION AND FINDINGS

The purpose of this research was to assess the impact of the saturation-in-training model to the 4-phase, brain-based simulation framework of TeamSTEPPS® in an urban department of pediatric medicine. More specifically, we were interested in changes in knowledge, teamwork, and communication as a result of this intervention. We noted improvements in in-situ team performance with statistically significant improvement in TeamSTEPPS® knowledge. Concerning the first research question, *do clinical teams debrief following a TeamSTEPPS® intervention*, the answer is no. This finding was discouraging because while the teams did it well following the simulation cases that were included in the TeamSTEPPS® course, only the postintervention day shift team debriefed following the in-situ simulation. That is, we hypothesized that teams would debrief at a higher rate and they did, but not consistently, or significantly. This finding may suggest that during the approximate 2 months following the intervention, these behaviors were not reinforced. The TeamSTEPPS® program includes a plan for initial training and reinforcement/sustainment training.[11] The saturation-in-training model equipped the teams with the TeamSTEPPS® knowledge and team behaviors. However, if not reinforced by leaders, educators, and administrators, the gains can dwindle over time.[10,11] Implementation is an iterative process, and direct-observation sessions and remedial or concurrent training plans are important for maintaining or strengthening TeamSTEPPS® behaviors following initial training.[11]

Table 2. Pre and Post Course Knowledge Test Scores

Test data	N	Mean	SD	Median	Minimum	Maximum	*P*
Precourse	498	15.51	3.20	16.00	0.00	20.00	
Postcourse	547	18.96	1.39	19.00	10.00	20.00	< 0.001

P from Wilcoxon rank-sum test.

The researchers hypothesized that *teamwork and communication scores, as measured by the TeamSTEPPS® Team Performance Observation Tool will be higher for those who have completed TeamSTEPPS® training compared with those who have not completed this training.* The researchers did see improvement in most areas of the observation tool and vast improvements in overall performance. However, scores did not reach statistical significance because of a few factors. First, team composition was inconsistent on the 4 teams. When we studied each of the 4 teams, the unit census was high, and it was difficult to take away clinicians to perform in the in-situ simulation. Resident physicians also have to rotate as part of their clinical/academic development, and the researchers did not have a method for controlling team member schedules. Also, we only assessed 2 teams before and after the intervention. Additional teams would need to be assessed to be able to imply that the changes were not due to chance.

For the research question, *do team members use situational monitoring and mutual support following a TeamSTEPPS® intervention*, the answer is yes. As indicated by the higher scores on the teamwork observation checklist, teams in the postintervention group actively scanned their environment and mutually supported their team members more consistently. Some examples noted by the evaluators included recognizing the need for a step stool to aid in chest compressions or regularly taking over compressions from tiring team members.

The researchers also wanted to know *if there would be a clear leader and are team members assigned to roles and responsibilities following a TeamSTEPPS® intervention.* The researchers did not see any differences in team performance in these 2 areas. All teams could benefit from reinforcement training tailored toward leaders *announcing their leadership role* in the team and *directly* assigning team members. Although there was a clear leader in all cases, their role was not announced to the team. Also, team members often self-assigned roles rather than the leader assigning roles.

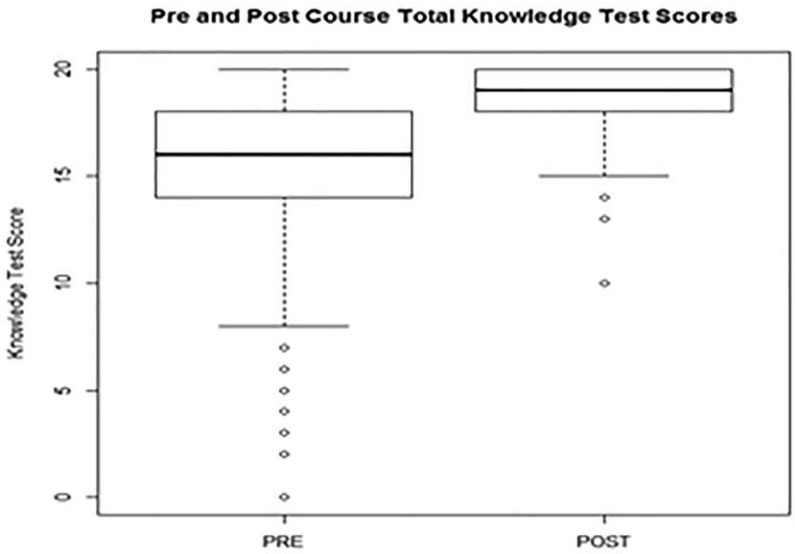

Fig. 2. Pre and postcourse knowledge test scores.

Addressing our last research question, *is there a change in teamwork and communication knowledge,* the answer is yes. There were significant improvements in TeamSTEPPS® knowledge following the TeamSTEPPS® training. Course participants scored significantly higher on the 20-question multiple-choice examination.

Our research results differ from implementation efforts at other institutions. Sheppard et al.[24] reported on TeamSTEPPS® implementation at 2 institutions. They reported positive outcomes in 8 of the 10 facilities, including surveys of patient perspective of the teamwork and communication of the caregivers.

At the time of their article, the former North Shore–LIJ Health System in New York comprised 13 hospitals. Their TeamSTEPPS® implementation initiative spread out over a longer period and included outcomes such as the more frequent use of briefings and huddles. Paul et al.[25] reported a 5-year voluntary TeamSTEPPS® initiative to integrate teamwork into a large network of reproductive health care organizations in the United States. They found that attendees felt the Master Trainer courses were useful in terms of gains in knowledge, but time restraints and competing initiatives were perceived as barriers to full implementation. The obstacles identified in the background section of this article are profound and very common across health care organizations. Even with evidence for the need for TeamSTEPPS® and what it can accomplish, there remain obstacles that organizations face when implementing the program.[10] We attribute the success of our intervention in part to leadership buy-in. Coupled with a curriculum that allowed the participants to practice the 4 competencies using simulation, our implementation team used the saturation-in-training model to train our department in less than 8 weeks, virtually eliminating competing interests and the notion of time constraints.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Our research has a few limitations. Our research was based on implementation in 1 department. While our research included a large sample size for the knowledge tests, the simulations included actual responders to a code resuscitation and only 4 teams thus impairing or limiting our ability to assess whether there was a change in practice as a result of our intervention. With only 1 team preintervention and 1 team postintervention for both the day and night shifts, we could not perform a formal statistical analyses for comparisons. Since the saturation-in-training model was applied, improvements are likely to be the result of the training. However, we cannot prove causality or make any statistical inferences. Also, the code team responders in the pre/postsimulation groups were not the same in both pre/post, day and overnight shift simulations. A follow-up mixed method observational research protocol is needed to learn where behaviors were strengthened or dissipated over time and the reasons why those changes occurred.

CONCLUSIONS

Although TeamSTEPPS® can be an effective means of improving teamwork and communication, implementation can be challenging.[10] This pilot study involving 1 department in an urban academic center showed that teamwork knowledge and performance could be improved following the intervention of TeamSTEPPS® that used the 4-phase simulation framework and saturation-in-training models. Studies such as this one are encouraging and may provide a useful implementation model for organizations planning a teamwork intervention. High-performing teams can improve patient safety and reduce medical errors, but teams need to be trained to a high standard.

Even with an excellent implementation plan, it is equally important to have a good reinforcement-sustainment strategy. Although our department saw improvements in teamwork and communication in the clinical setting, more might be realized if leaders and educators throughout the department insist on seeing certain behaviors and include them in every education intervention.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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