ORIGINAL ARTICLE

Single-group analysis of simulation training improves the ability of anesthesiologist assistant students to use TeamSTEPPS during crisis management scenarios

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Abstract

Background: Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) was developed to increase patient safety through improved health care teamwork skills. The purpose of this investigation was to determine whether the teamwork skills of anesthesiologist assistant (AA) students improve after training with simulated crisis management scenarios. **Methods:** This is a single-group pre-intervention and post-intervention study that included 12 students and four evaluators during crisis management simulations. Student self-assessment surveys and preceptor evaluation forms were administered before and after the intervention. The self-assessment survey evaluated their knowledge of and clinical utility of TeamSTEPPS strategies, and how well they applied specific TeamSTEPPS skills. The preceptors evaluated how the students performed the TeamSTEPPS skills along with their knowledge of principles and team structure. The survey and evaluation questions used a 5-point Likert scale. The intervention consisted of teaching the students the TeamSTEPPS Essentials course and giving feedback between the two crisis management scenarios. **Results:** Student self-evaluation scores on TeamSTEPPS knowledge (1.25–4.08, $P < 0.001$), utility (3.75–4.75, $P = 0.03$), leadership (2.08–3.17, $P = 0.02$), and mutual support (2.42–3.25, $P = 0.03$) showed improvement. Differences in student self-evaluation scores on communication (3.25–3.50, $P = 0.55$) were non-significant. Preceptor evaluation for TeamSTEPPS knowledge (1.52–3.85, $P < 0.001$), team structure (1.96–4.08, $P < 0.001$), leadership (2.33–3.52, $P = 0.006$), communication (2.54–3.61, $P = 0.023$), mutual support (2.08–3.27, $P = 0.005$), and situational awareness (2.40–3.69, $P = 0.002$) all showed significant improvement. **Conclusion:** This innovative curriculum helps AA students to learn the principles of TeamSTEPPS and improves their performance during simulated crisis management scenarios.

Keywords: *simulation training; anesthesia assistants; graduate medical education; competency-based education; patient safety; health care crew resource management*

Introduction

Within health care, effective teamwork is essential to provide the highest level of safety and quality for patient care.[1] Joint Commission-accredited hospitals must meet standards of safety culture and evaluate them regularly. A survey tool from the Agency for Healthcare Research and Quality (AHRQ) supporting this standard has 12 measures of safety, two of which are teamwork within and across patient care units.[2] Teamwork communication has been cited by the Joint Commission as a root cause in the majority of reported sentinel events. A recent integrative review of the literature concluded that a marked improvement in communication, a decrease in clinical error rates, and

improvement in patient satisfaction were achieved by adopting Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) fundamentals.[3]

Like many services in medicine, anesthesiology has adapted to an increasingly complex health care environment by adopting a team approach to anesthetic delivery. Effective collaboration and communication among members of the anesthesia care team, including anesthesiologists, residents, anesthetists, and students, are essential for the success of the anesthesia care team. Although several campuses, medical schools, and residency programs have developed curricula that promote team-based competencies, most do not provide formal training. In the first year of their Masters of

Science program, anesthesiologist assistant (AA) students at the University of Colorado participate in an interprofessional education and development curriculum with other professional students on the Anschutz Medical Campus. This curriculum is broad and may be applied to improve clinical teamwork. However, it does not provide the opportunity to practice these skills before AA students enter their senior clinical year. In an effort to help with the transition between didactic and clinical education and clinical practice, we added the TeamSTEPPS curriculum and crisis intervention to the AA students' existing simulation laboratory course.

TeamSTEPPS was developed by the US Department of Defense and the AHRQ to improve leadership, communication, and teamwork skills among health care professionals.[1] Previous pre-intervention and post-intervention single-group studies demonstrated improved self-evaluation scores, team skills, and teamwork knowledge during simulated immersive patient encounters using TeamSTEPPS for medical and nursing students.[4,5] The purpose of this investigation was to determine whether AA student teamwork skills improve after training with simulated crisis management scenarios and with teaching the TeamSTEPPS Essentials course between crisis management scenario training. We hypothesized that the TeamSTEPPS Essentials curriculum and crisis management scenario training would provide an effective framework from which to build teamwork skills and that students' self-assessment scores, in addition to preceptor evaluation scores, would improve with this training. To our knowledge, this is the first study to determine if TeamSTEPPS principles and strategies can effectively improve AA teamwork skills through simulated crisis management scenarios and the TeamSTEPPS Essentials course.

Methods

Participants and study design
All first-year AA students at the University of Colorado School of Medicine were eligible to participate in this 2-day study. The entire class of 12 students participated. We received Colorado Multiple Institutional Review Board (COMIRB) category 1 exemption for protocol 17-0596. This allowed "research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. [Additionally], students should be able to refuse participation without penalty." The COMIRB exemption did not require written consent from the

students because the surveys were anonymous and the students were de-identified. Four clinical preceptor evaluators participated in the evaluation survey portion of the study. Three of the preceptor evaluators were Certified Anesthesiologist Assistants (CAAs), one was an anesthesiologist, and the other a second-year AA student. The CAAs and anesthesiologist were involved in teaching the simulation laboratory curriculum at the University of Colorado for the first year of AA training. The second-year AA student had never worked with or evaluated the study participants and was an independent observer. All evaluators studied TeamSTEPPS and reviewed the elements of each evaluation category. Evaluators completed a 5-point Likert scale survey after each student completed a scenario based on the student's performance.

Before participating in the first of two crisis management scenarios, all student participants were asked if they were willing to participate in the study and gave verbal consent. They filled out a five-question self-assessment to evaluate knowledge of TeamSTEPPS strategies, clinical utility of TeamSTEPPS application, leadership skills, communication skills, and mutual support skills. Students individually participated in a pre-intervention crisis management scenario. Preceptors evaluated how the students performed the TeamSTEPPS skills (leadership, communication, mutual support, and situation awareness) along with their knowledge of principles and team structure. Details of the student self-assessment and the preceptor assessment are included in the appendix. The student being evaluated was the leader. The preceptors also played standardized roles as team members, such as nurses, technicians, or surgeons, in the scenarios. Preceptors did not consult each other when scoring students or see each other's results. All preceptors involved in this this study had equal levels of teaching responsibility with the students. The survey and evaluation questions used a 5-point Likert scale.

The intervention consisted of teaching the students the TeamSTEPPS Essentials course[6] and providing feedback on their performance as a group between the two crisis management scenarios. Students individually participated in a post-intervention crisis management scenario and were again evaluated on their performance by preceptors. The students then took the same five-question self-assessment survey after completing the second crisis management scenario.

Simulation setup and equipment
The simulation laboratory course was held at the University of Colorado Hospital Critical Care Annex with one room dedicated to the simulation laboratory. A fully stocked anesthesia cart with the same equipment for basic airway

management, arterial and intravenous access, anesthesia medication, a fully operational Datex-Ohmeda Aestiva 5/7900 ventilator, and additional airway devices were available to the students. Equipment was also available to provide rapid administration of intravenous fluids and blood products, including large-bore central venous catheters, specialized blood product tubing, a Level 1 H-1200 (Smith's Medical) fluid warmer, and a rapid infuser. This course used the University of Colorado Department of Anesthesiology's Laerdal SimMan 3G portable patient simulator. Wireless technology allowed for physiologic and clinical changes pertinent to the crisis management scenarios.

The scenario on day 1 (pre-intervention) was a patient with a history of a difficult airway scheduled for an urgent laparoscopic cholecystectomy. After induction of general anesthesia, the students discovered that they could not ventilate or intubate the patient. The scenario proceeded with inadequate oxygenation and ventilation and the students were expected to use methods to restore oxygenation and ventilation with a secure airway. The scenario ended when the students performed a surgical airway. The scenario on day 2 (post-intervention) was patient with a motor vehicle accident trauma in the operating room under general anesthesia and hemodynamically unstable. The students were expected to recognize hemorrhagic shock and place invasive monitors while rapidly resuscitating the patient with fluids and blood products. Arterial blood gas analysis was available to the students so that they could interpret the progression of resuscitation and direct further intervention.

Statistical analysis

Data were analyzed using Microsoft Excel. Statistical analysis was a two-tailed, paired t test, two samples for means with statistical significance set at $P < 0.05$.

Results

The student pre-intervention and post-intervention self-evaluation scores and assessment categories are shown in Fig. 1. Scores for TeamSTEPPS knowledge (1.25–4.08, $P < 0.001$), utility (3.75–4.75, $P = 0.03$), leadership (2.08–3.17, $P = 0.02$), and mutual support (2.42–3.25, $P = 0.03$) showed increases (Table 1). Student self-evaluation scores on communication (3.25–3.50, $P = 0.55$) were not significantly different (Table 1).

Preceptor pre-intervention and post-intervention survey scores and categories are shown in Fig. 2. As shown in Table 2, preceptor evaluation for TeamSTEPPS knowledge (1.52–3.85, $P < 0.001$), team structure (1.96–4.08, $P < 0.001$), leadership (2.33–3.52, $P = 0.006$), communication (2.54–3.61, $P = 0.023$), mutual support (2.08–3.27, $P =$
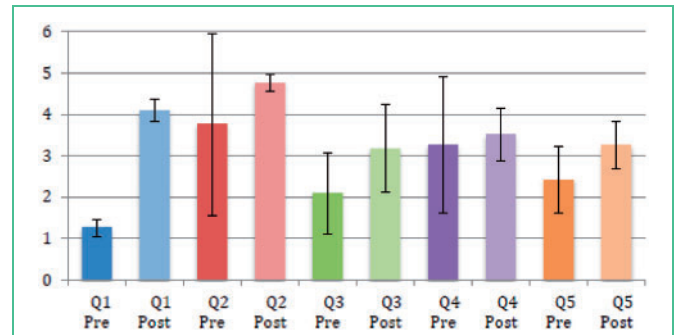

Figure 1. Student pre- and post-self-evaluation survey results represented in a bar graph with standard deviations. Survey categories: Q1, TeamSTEPPS strategies; Q2, TeamSTEPPS utility; Q3, leadership; Q4, communication; Q5, mutual support.

Table 1. Student survey results with average pre- and post-self-evaluation scores and corresponding *P* values

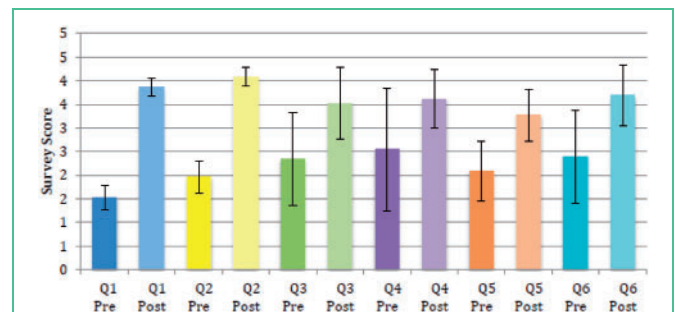|	Average Pre	Average Post	P value
Q1	1.25	4.08	<0.001
Q2	3.75	4.75	0.032
Q3	2.08	3.17	0.020
Q4	3.25	3.50	0.555
Q5	2.42	3.25	0.034

Figure 2. Preceptor pre- and post-evaluation survey results represented in a bar graph with standard deviations. Survey categories: Q1, TeamSTEPPS strategies; Q2, team structure; Q3, leadership; Q4, communication; Q5, mutual support; Q6, situational awareness.

0.005), and situational awareness (2.40–3.69, $P = 0.002$) all showed significant increases.

Discussion

Like many services in medicine, anesthesiology has adapted to an increasingly complex health care environment by adopting a team approach to anesthetic delivery. The anesthesia care team prevalent in many anesthesiology

Table 2. Preceptor survey results with average pre- and post-evaluation scores and corresponding *P* values (paired t test)

	Average Pre	Average Post	*P* value
Q1	1.52	3.85	< 0.001
Q2	1.96	4.08	< 0.001
Q3	2.33	3.52	0.006
Q4	2.54	3.61	0.023
Q5	2.08	3.27	0.005
Q6	2.40	3.69	0.002

practices and led by anesthesiologists, includes a spectrum of anesthesia providers, such as anesthesiology fellows, anesthesiology residents, AAs, nurse anesthetists, AA students, and student nurse anesthetists.[7] The entire team in the operating room consists of surgeons, nurses, technicians, and the anesthesia providers. Underdeveloped team skills have the potential to cause risk, errors, and poor patient outcomes in the operating room.[8] Up to 30% of team exchange errors have been demonstrated to originate from communication alone and up to one third of those jeopardized patient safety.[8] AA students receive teamwork training at the University of Colorado School of Medicine with other health professionals in the Interprofessional Education (IPE) course. This course was designed to provide teamwork and collaboration training to improve patient safety, quality, population health, and to promote cost-reduction.[9] Adding TeamSTEPPS training to the simulation laboratory curriculum reinforced the existing teamwork training already provided by the IPE course.

Behavior modification in crisis management training for anesthesia providers has been proven to improve patient safety, improve performance in crisis management scenarios and even make anesthesia providers eligible for malpractice premium reductions.[10]

Student and preceptor evaluation questionnaires were designed to assess similar categories with the preceptor evaluation specifically addressing two additional strategies. We believed that team structure and situational awareness were easier to observe and measure from an observational perspective by preceptors than by students immersed in the scenario.

In future TeamSTEPPS training with AA students in the simulation laboratory, we plan to have them self-evaluate their situational awareness, which we did not study this time. This would promote self-reflection in this skill area of TeamSTEPPS. In addition, we will add more in-depth

training on communication tools, including how to engage team members when in a leadership position, feedback loop completion, and check-back and read-back techniques. This may improve self-evaluation scores on communication in future studies. Overall, this study has shown that simulation education and the TeamSTEPPS Essentials course is an effective framework to build AA student teamwork skills as demonstrated by both self-evaluation and preceptor evaluation. We plan to include this training as part of the simulation laboratory curriculum in the future.

Conclusion

This study sought to investigate whether TeamSTEPPS concepts effectively improve AA student teamwork in crisis management scenarios. Our results demonstrate that teaching TeamSTEPPS to AA students improves self-evaluation scores on TeamSTEPPS knowledge, utility, leadership, and mutual support. Students reported no improvement in communication skills as a result of the TeamSTEPPS curriculum, which may be a result of their self-evaluation bias. Preceptor crisis management evaluations show that the TeamSTEPPS curriculum improved scores in teamwork in all categories (Table 2). These differing results highlight the weakness of self-assessment evaluation, which does not always reflect performance improvement. We believe adding preceptor evaluations validates the results through more objective measurements. Preceptor bias was minimized by having each of them review the elements of TeamSTEPPS being evaluated through the TeamSTEPPS Essentials course and by choosing preceptors who spent similar time clinically teaching the students. To further reduce bias in future studies, observers could be chosen who did not know the students but do understand the elements of TeamSTEPPS performance being rated. In addition, in the future it would be beneficial to have more preceptors whose role would be limited to either participation in the scenario or observation and evaluation. These results are similar to those produced by Meier and Boehler.[4]

Conflict of interest

None declared.

Acknowledgements

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Appendix

Student self-assessment survey

1.	How well do you feel you know TeamSTEPPS strategies?				
	1	2	3	4	5
	not at all	very little	a little	somewhat	very well
2.	Do you think that TeamSTEPPS is helpful for your clinical education and practice?				
	1	2	3	4	5
	not at all	very little	a little	somewhat	very helpful
3.	How would you rate your ability to organize, facilitate, and be the team leader in a clinical emergency?				
	1	2	3	4	5
	poor	fair	OK	good	excellent
4.	How would you rate your ability to communicate with OR staff, to speak up, and ask questions in clinical situations?				
	1	2	3	4	5
	poor	fair	OK	good	excellent
5.	How would you rate your ability to anticipate the needs of your team members (OR staff)?				
	1	2	3	4	5
	poor	fair	OK	good	excellent

Preceptor assessment survey

1.	How knowledgeable is this student on TeamSTEPPS principles?				
	1	2	3	4	5
	not at all	very little	a little	somewhat	very
2.	Is this student knowledgeable in the components of Team Structure in a multi-team system?				
	1	2	3	4	5
	not at all	very little	a little	somewhat	very well
3.	Rate the student's ability to organize, facilitate, and be the team leader in a clinical emergency				
	1	2	3	4	5
	poor	fair	OK	good	excellent
4.	Rate the student's ability to communicate with OR staff, to speak up, and ask questions in clinical situations				
	1	2	3	4	5
	poor	fair	OK	good	excellent
5.	Rate the student's ability to provide mutual support to their team members (OR staff)				
	1	2	3	4	5
	poor	fair	OK	good	excellent
6.	How would you rate the student's ability to maintain situational awareness and a global assessment for their team members during crisis management?				
	1	2	3	4	5
	poor	fair	OK	good	excellent