

# Practice and Quality Improvement: Successful Implementation of TeamSTEPPS Tools Into an Academic Interventional Ultrasound Practice

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**OBJECTIVE.** The goal of this study was to implement an evidence-based teamwork system to improve communication and teamwork skills among health care professionals (TeamSTEPPS) into an academic interventional ultrasound program and to assess safety and teamwork climate across team members both before and after implementation.

**MATERIALS AND METHODS.** Members of a change team (including master trainers) selected specific tools available within TeamSTEPPS to implement into an academic interventional ultrasound service. Tools selected were based on preimplementation survey data obtained from team members ( $n = 64$ : 11 attending faculty physicians, 12 clinical abdominal imaging fellows or residents, 17 sonographers, 19 nurses, and five technologist aides or administrative personnel). The survey included teamwork climate and safety climate domains from the Safety Attitudes Questionnaire. Four months after implementation, respondents were resurveyed and postimplementation data were collected.

**RESULTS.** Teamwork climate scores improved from a mean of 67.9 (SD, 12.8) before implementation to a mean of 87.8 (SD, 14.1) after implementation ( $t = -7.6$ ;  $p < 0.001$ ). Safety climate scores improved from a mean of 76.5 (SD, 12.8) before implementation to a mean of 88.3 (SD, 13.4) after implementation ( $t = -4.6$ ;  $p < 0.001$ ). In particular, teamwork items about “input being well received” and “speaking up” were the most responsive to the intervention.

**CONCLUSION.** The implementation of TeamSTEPPS tools was associated with statistically significant improvements in safety and teamwork metrics in an academic interventional ultrasound practice. The most notable improvements were seen in communication among team members and role clarification. We think that this model, which has been successfully implemented in many nonradiologic areas in medical care, is also applicable in imaging practice.

**Keywords:** evidence-based teamwork system, interventional ultrasound, noninterpretive skills (NIS), practice and quality improvement, TeamSTEPPS

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**M**edical care delivered in any hospital or outpatient setting, including diagnostic or interventional radiology practices, requires attention to diagnostic quality but also must foster a culture of patient safety. In diagnostic imaging, even relatively simple procedures require a cooperative effort among health care professionals. This cooperation is exemplified with interventional procedures involving technologists, nurses, physicians, and other health care professionals, often with different levels of expertise, especially in academic settings. These imaging-guided interventions are analogous to surgical procedures, in which team members work together to prepare the patient, perform the procedure, and then help the patient recover before returning to their inpatient unit or being discharged to home. Every team member relies on other team members to

have the necessary materials and information in the right place, at the right time, in the right amount, in order for them to perform their contributed portion of the care delivery safely and effectively. This reliance on other team members is frequently covert—that is, health care team members may not consciously consider team functions or team behaviors as critical to their success. Often, because of this unacknowledged factor of teamwork, teams are far less successful than their potential. This failure of optimal teamwork leads to inefficiencies and, worse, errors that can literally be deadly [1].

With support and evolving forces to enhance the culture of safety in U.S. health care [2], hospitals and health systems are adopting strategies and methods from other high reliability industries. Specifically, teamwork methods such as Crew Resource Management and TeamSTEPPS (Team Strategies

**TABLE 1: Survey Scales and Items on Teamwork and Safety Climate, Before and After Implementation of TeamSTEPPS**

Variable	Before Implementation	After Implementation	<i>p</i>
Teamwork climate scale score	67.9 (12.8)	87.8 (14.1)	<0.001
Sonographer input is well received in this clinical area.	4.5 (1.1)	4.9 (0.6)	0.022
Nurse input is well received in this clinical area. <sup>a</sup>	3.0 (1.6)	4.4 (1.2)	<0.001
In this clinical area, it is difficult to speak up if I perceive a problem with patient care. <sup>a</sup>	4.3 (1.2)	2.4 (1.7)	<0.001
Disagreements in this clinical area are resolved appropriately (i.e., not who is right, but what is best for the patient). <sup>a</sup>	4.4 (1.1)	4.5 (1.0)	0.619
I have the support I need from other personnel to care for patients. <sup>a</sup>	4.4 (1.1)	4.9 (0.5)	0.002
It is easy for personnel here to ask questions when there is something that they do not understand. <sup>a</sup>	4.4 (1.1)	4.8 (0.6)	0.007
The physicians and sonographers here work together as a well-coordinated team.	4.4 (1.2)	4.9 (0.5)	0.003
The physicians and nurses here work together as a well-coordinated team. <sup>a</sup>	4.4 (1.1)	4.8 (0.7)	0.039
The physicians, sonographers, and nurses here work together as a well-coordinated team.	4.5 (0.9)	4.8 (0.7)	0.1
Safety climate scale score	76.5 (12.8)	88.3 (13.4)	<0.001
I would feel safe being treated here as a patient. <sup>a</sup>	4.5 (0.9)	4.8 (0.6)	0.033
Medical errors are handled appropriately in this clinical area. <sup>a</sup>	4.6 (0.9)	4.8 (0.6)	0.243
I know the proper channels to direct questions regarding patient safety in this clinical area. <sup>a</sup>	4.2 (1.2)	5.0 (0.3)	<0.001
I receive appropriate feedback about my performance. <sup>a</sup>	3.6 (1.6)	4.4 (1.1)	0.003
In this clinical area, it is difficult to discuss errors. <sup>a</sup>	2.9 (1.5)	2.4 (1.6)	0.114
I am encouraged by my colleagues to report any patient safety concerns I may have. <sup>a</sup>	4.6 (1.0)	4.7 (0.8)	0.456
The culture in this clinical area makes it easy to learn from the errors of others. <sup>a</sup>	3.9 (1.1)	4.5 (1.1)	0.004

Note—Except for *p* values, data are mean (SD) scores. *p* < 0.05 is statistically significant.

<sup>a</sup>Denotes a scaled item.

and Tools to Enhance Performance and Patient Safety) are being adopted in a variety of settings and, in some cases, as hospital-wide standards for communication and collaboration [3]. As a result of required culture of safety analyses, health care organizations are turning to new methods to improve the effectiveness of their teams and to improve outcomes for their patients.

TeamSTEPPS is a curriculum that was developed through collaboration between the Department of Defense and the Agency for Healthcare Research and Quality and is backed by over 25 years of research associated with teams and team performance in high-risk industries [4]. Particularly, the National Aeronautics and Space Administration and the Department of Defense paved the path to teamwork as a solution to error when they performed detailed analyses of aviation-related crashes in the 1980s [5–7]. Through this in-depth analysis, they concluded that many aviation tragedies occurred because of communication failures, inadequate resource or workload management, and hierarchic boundaries [1]. By changing the dynamic in the cockpit and using prescribed communication and coordination methods, aviation disasters were

markedly curbed. TeamSTEPPS is unique in that it not only describes how to improve health care quality and patient safety through teamwork, but it also provides guidance for the implementation process and instructional resources [4]. Besides improvement in safety and teamwork culture, there are some additional tangible benefits of TeamSTEPPS that have been shown, such as a 16% reduction in nursing turnover rate [1] and 19% increase in operating room employee satisfaction [8].

Duke University Health System has been a national training site for the Agency for Healthcare Research and Quality TeamSTEPPS model of teamwork training since 2005, and training has occurred in anesthesiology, the operating suite, and the neonatal ICU, to name a few. However, to date, the model had not been implemented in the Department of Radiology. Moreover, to our knowledge, there has been no systematic study of the impact of this model focused on radiology practice. Therefore, the purpose of this investigation was to assess the need for and impact after introduction and implementation of the TeamSTEPPS model into an interventional radiology ultrasound practice in an academic radiology department.

## Materials and Methods

This study is HIPAA compliant and was deemed as exempt from review from our local institutional review board. The interventional ultrasound suite at our institution is the site where we perform procedures using sonographic guidance, with representative cases including tissue biopsies (e.g., thyroid, liver, and abdominal and pelvic soft-tissue masses), ultrasound-guided thrombin injections for arterial pseudoaneurysms, and fluid aspirations (e.g., paracenteses and abscess drainages). This suite was opened in 1995 when a shift in our practice was made from CT to ultrasound as the primary form of imaging guidance for procedures [9, 10]. Part of the reason for this switch was the ability to have real-time guidance and visualization of the needle, lack of ionizing radiation, and cost effectiveness [11]. The suite is staffed daily by an attending faculty physician from the division of abdominal imaging, a clinical fellow or resident, a dedicated sonographer, a registered nurse, and a technologist aide.

In October 2010, the planning phase of the TeamSTEPPS project began and members of the team (referred to as the “change team”) included those from the department of radiology (vice chair for safety and quality, radiology safety officer, abdominal imaging radiologist, nurse manager, chief

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**TABLE 2: Key Components of TeamSTEPPS, Barriers Addressed by Each Skill or Technique, Tools Available for Implementation, and Anticipated Outcomes**

Teachable Learnable Skill	Barriers	Tools	Outcomes
Leadership	Hierarchic culture	Briefs	Shared mental model
	Lack of resources or information	Huddlers	Adaptability
	Ineffective communication	Debriefs	Team orientation
	Conflict	Conflict resolution	Mutual trust
Situation monitoring	Time	STEP <sup>a</sup>	Situation awareness
	Distractions	Cross monitoring	
	Workload		
	Fatigue		
	Misinterpretation of data		
	Failure to share information		
Mutual support	Defensiveness		Feedback
	Conventional thinking	Advocacy and assertion	
	Workload	Two-challenge rule	
	Misinterpretation of cues	CUS <sup>b</sup>	
	Lack of role clarity	DESC script <sup>c</sup>	
Communication	Varying communication styles	Collaboration	Patient safety
	Conflict	SBAR <sup>d</sup>	
	Lack of coordination and follow-up with coworkers	Call-out	
	Distractions	Check-back	
	Fatigue	Handoff	

Note—Table has been modified from the TeamSTEPPS core curriculum [3].

<sup>a</sup>The STEP process involves ongoing monitoring of the status of the patient, team members, environment, and progress toward the goal.

<sup>b</sup>“CUS” refers to a technique that provides another framework for conflict resolution, advocacy, and mutual support. “CUS” stands for I am concerned, I am uncomfortable, and there is a safety issue.

<sup>c</sup>“DESC” is a mnemonic for describe the specific situation, express your concerns about the action, suggest other alternatives, and consequences should be stated.

<sup>d</sup>“SBAR” provides a standardized framework for members of the health care team to communicate about a patient’s condition. This mnemonic stands for situation, background, assessment, and recommendation.

ultrasound technologist, ultrasound supervisor, and senior chief technologist) and from the Duke University Health System (strategic services associate and patient safety officer). The change team met throughout the course of the project to determine which questions would be asked of team members who work within the interventional ultrasound suite before and after implementation of TeamSTEPPS, which team members should be surveyed, which elements of TeamSTEPPS should be focused on and the optimal means by which to educate team members, and the course of action once postimplementation survey results were available.

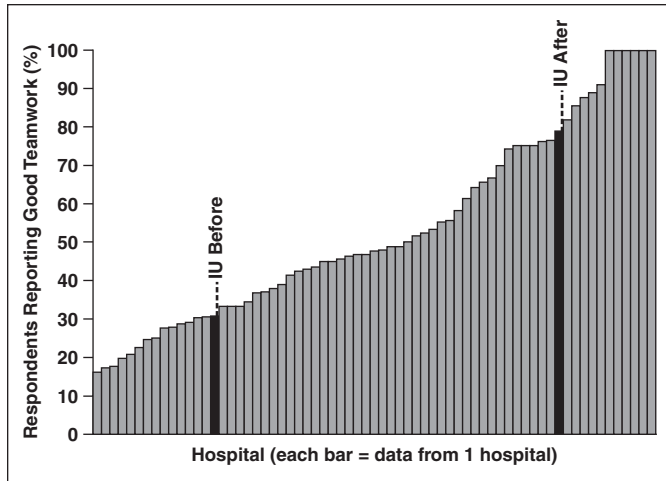
Of the several safety culture survey instruments in the literature, the Safety Attitudes Questionnaire is widely used, has good psychometric properties [12], and is associated with clinical outcomes [13–17]. The Safety Attitudes Questionnaire scales used for this study were the complete teamwork climate and safety climate domains, including a few additional items to accommodate

the role of sonographers. All items are detailed in Table 1. Each item is rated on a 5-point Likert scale ranging from disagree strongly to agree strongly. Items included such statements as, “The physicians and nurses here work together as a well-coordinated team,” or “In this clinical area, it is difficult to discuss errors.” Using the standard and published technique, the teamwork and safety climate scale scores were calculated as the percentage of respondents within a clinical area that had a mean equivalent across the scaled items of “agree slightly or strongly,” which is also known as the “percentage positive” [18, 19].

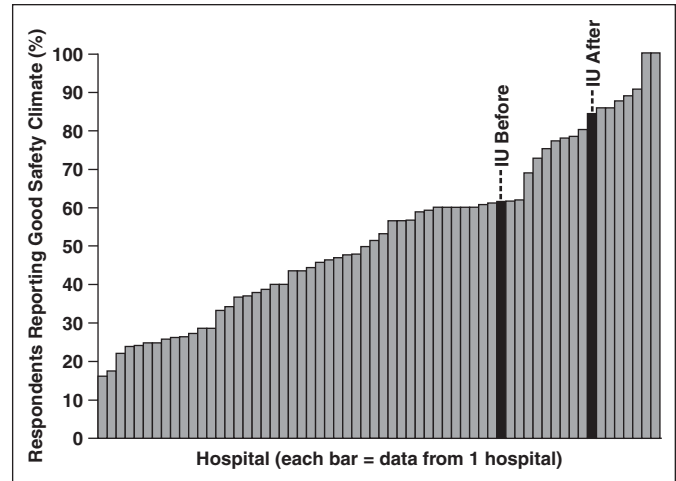
Pre- and postintervention scale scores were benchmarked against published operating room norms for teamwork climate [20] and safety climate [21]. Team members surveyed included 11 attending faculty physicians from the division of abdominal imaging, 12 clinical abdominal imaging fellows or residents, 17 sonographers, 19 nurses, and five technologist aides or administrative

personnel, for a total of 64 respondents. This preimplementation survey was performed in December 2010. After the results of the preimplementation survey were collected, the change team met to discuss the results and to determine the appropriate tools available within TeamSTEPPS to be used to address the issues identified by the survey data.

On the basis of the preimplementation survey results, we determined that improving communication among all team members and role clarification were of paramount importance. As such, the tools available within the context of TeamSTEPPS (Table 2) modified for implementation in interventional ultrasound were as follows: first, before the procedure, all interventional days were to begin with preprocedure briefings with all members of the care team, initiated by the physicians; second, during the procedure, the statement, “I need clarity” was used to “stop the line” (i.e., stop all activity within the room by all individuals because of a patient safety concern from any team mem-



**Fig. 1**—Scaled scores before and after intervention for interventional ultrasound (IU) benchmarked against published operating room norms for percentage positive teamwork climate. Adapted with permission from Wolters Kluwer Health (Sexton JB, Makary MA, Tersigni AR, et al. Teamwork in the operating room: frontline perspectives among hospitals and operating room personnel. *Anesthesiology* 2006; 105:877–884).



**Fig. 2**—Scaled scores before and after intervention for interventional ultrasound (IU) benchmarked against published operating room norms for percentage positive safety climate. Adapted with permission from Wolters Kluwer Health (Makary MA, Pronovost PJ, Sexton JB, Millman EA, Freischlag JA. Patient safety in surgery. *Ann Surg* 2006; 243:628–635).

ber); and third, after the procedure, there was an optional postprocedure debriefing that could be called for by any member of the team as part of the observation or debriefing process.

The implementation of these tools was accomplished by a structured debriefing of the survey results to all groups surveyed, followed by a demonstration of the targeted TeamSTEPPS tools and the rationale for why these tools were being implemented. Members of the change team were present during all of these debriefings; more important, members of the change team were present at meetings attended by people of different ranks or groups (i.e., when presenting to faculty, the nurse manager, chief ultrasound technologist, and ultrasound supervisor were present along with the abdominal imaging radiologist on the change team). This process occurred between January and February 2011.

From February through June 2011, the interventional ultrasound suite was run using the new rules and tools set forth as part of the TeamSTEPPS concept. A postimplementation survey was then performed in June 2011. Data and feedback were analyzed in aggregate to minimize the ability for an individual's response to be identifiable. Two-tailed *t* tests were performed on the teamwork climate and safety climate scale scores, as well as their individual items using statistical software (SPSS for Windows, version 21.0, IBM).

## Results

A total of 46 individuals (71.9%) completed surveys before implementation and 63 individuals (98.4%) filled out surveys after implementation. Teamwork climate scores improved

from a mean of 67.9 (SD, 12.8) before implementation to a mean of 87.8 (SD, 14.1) after implementation ( $t = -7.6$ ;  $p < 0.001$ ). This mean difference translates to a percentage positive of 30.6% reporting good teamwork climate in the preimplementation survey and 78.9% reporting good teamwork climate in the postimplementation survey (Fig. 1). Safety climate scores improved from a mean of 76.5 (SD, 12.8) before implementation to a mean of 88.3 (SD, 13.4) after implementation ( $t = -4.6$ ;  $p < 0.001$ ). Here, the mean difference translates to a percentage positive of 61.2% reporting good safety climate in the preimplementation survey and 84.2% reporting good safety climate in the postimplementation survey (Fig. 2). Of the 16 individual teamwork and safety-related items (nine regarding teamwork and seven regarding safety), 11 questions (68.8%) improved statistically significantly from before to after implementation (Table 1).

Notable teamwork climate improvements included, “Physicians and sonographers here work together as a well-coordinated team” (from 75.0% agreement to 94.7% agreement;  $p = 0.003$ ), “Nursing input is well-received in this clinical area” (from 34.7% agreement to 81.1% agreement;  $p < 0.001$ ), and “In this clinical area, it is difficult to speak up if I perceive a problem with patient care” (from 69.4% agreement to only 25.5% agreement;  $p < 0.001$ ).

Notable safety climate item improvement included, “The culture in this clinical area makes it easy to learn from the errors of others” (from 47.9% agreement to 80.7% agree-

ment;  $p = 0.004$ ), “I receive appropriate feedback about my performance” (from 51.0% agreement to 73.7% agreement;  $p = 0.003$ ), and “I would feel safe being treated here as a patient” (from 77.1% agreement to 91.2% agreement;  $p = 0.033$ ).

## Discussion

To address the culture of safety and teamwork against the backdrop of growing complexity and increasing volume of patient procedures, we undertook the process of implementing specific TeamSTEPPS tools in our interventional ultrasound suite daily workflow. We found significant improvements not only in teamwork climate but also in the safety climate norms and behaviors reported by our respondents. More specifically, the teamwork climate components of “input being well received” and “speaking up” improved the most, indicating that there is more psychologic safety for finding your voice in interventional ultrasound after implementation. This culture of safety and related teamwork is of critical importance, especially in the current environment of health care delivery, in which outcomes-based metrics are being used with greater frequency and for which there are attendant needs for health care professionals, health care teams, group practices, and hospitals to document performance, including programmatic improvements for safe and effective treatment of patients.

One of the critical elements for the successful implementation of these tools was

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a change team that included members from the department of radiology, including physician leadership, and from the health system to foster collaboration. The need for strong physician leadership has been described in prior work as being an absolute requirement for successful clinical change. Without it, it can be perceived that nurses and others are left to push change up the hierarchy, which is, predictably, less successful [1]. In addition, there were representatives from all key areas (i.e., physicians, sonographers, nurses, and patient safety advocates) who were empowered to speak freely on behalf of their respective groups. It also became clear that open communication and mutual respect in change team meetings was essential to effecting change and that all change team members had to feel that the group was striving toward a common goal. The fact that the change team felt this way made for an easier implementation to the team members in this area who could feel that these changes were going to make their days simpler and safer for all involved [1]. Finally, with regard to teaching and implementation of the TeamSTEPPS tools, members from all groups needed to be available to deploy implementation strategies to other groups (i.e., physicians to sonographers, nurses to physicians, and so forth).

Psychologic safety improvements revolved around the ability of an individual to feel comfortable asking questions during procedures and knowing what to do if an individual on the team felt uncomfortable with the course of action being taken. The use of role clarification, whereby each individual was provided with written expectations for their performance and job duties, likely led to some of the statistically significant improvements in the perception of safety and teamwork between the pre- and postimplementation responses. In addition, by “breaking down barriers” and attempting to remove any perceived hierarchy, team members stated they felt that the interventional ultrasound suite was a place that they would feel comfortable being treated as patients.

Many of the health care teamwork implementations have been focused on emergency departments, ICUs, and operating rooms [1, 4, 8, 20]; however, the strategies and tools available in TeamSTEPPS were designed to be applied to any clinical setting. At Duke University Medical Center, the use of TeamSTEPPS practices is expanding, and the implementation of tools available as part of the TeamSTEPPS program has helped to statistically

significantly improve health care worker assessments of safety and teamwork across a wide range of team members in a busy academic interventional ultrasound practice.

Our study does have certain limitations. First, the preimplementation survey response rate was lower than that after implementation. Nevertheless, both administrations achieved the minimum requirement of 60% for interpretation over time [22]. Surveys of this kind are an attempt to capture the consensus views of health care workers at that point in time. Even with some changes in respondents, which is typical in most clinical areas, the use of minimum thresholds for representative and interpretable data are used to ensure an accurate reflection of the consensus view of the respondents; in our study, the consensus view appears to have improved significantly. Although we acknowledge that this is not ideal for comparison of data, we also think that the increased participation in the postimplementation survey indicates a level of engagement that corresponds with the improvement found. In other words, we think that this indicates that team members “bought in” to the concept of TeamSTEPPS after seeing how it impacted their clinical practice, and we think that this is key reason for the success of this program. A testament to this is that the tools implemented remain a part of our daily routine in this work area as of the writing of this manuscript.

Second, data were analyzed in aggregate to minimize the ability to link survey responses to individuals and to preserve statistical power based on the total possible number of respondents in interventional ultrasound; a potential area for future research could be to assess how metrics changed within and across these groups of individuals. Third, our results reflect the implementation of TeamSTEPPS tools in only one interventional area within our department. Theoretically, other areas in which interventional procedures are done could have different results; of note, some of these tools are being implemented in these other areas on the basis of the success of the program in the interventional ultrasound suite.

Next, outcomes of interest here were health care worker assessments of teamwork and safety before and after implementation of TeamSTEPPS tools. An avenue for future research could be how these attitude changes for team members affect specific behaviors as they relate to patient care, workflow, reducing medical errors, and so forth. Finally, in looking at our preimplementation

safety climate results, one could suggest that there was no need for intervention to get a score of greater than 60% even higher. That said, it was the teamwork climate results that prompted the implementation of TeamSTEPPS tools, and as shown by the benchmarking data from Figure 1, the teamwork scores left a great deal to be desired from preimplementation.

In addition to showing how TeamSTEPPS tools can be successfully implemented into a radiology practice, another reason that we think this study is potentially valuable is that it can provide a blueprint for how the American Board of Radiology’s Practice and Quality Improvement (PQI) program can lead to meaningful change within one’s practice. PQI is part four of maintenance of certification now required for all time-limited certificate holders, and three such PQI projects need to be completed in each 10-year cycle. The key elements of a successful PQI project are defining a question, obtaining preimplementation data, creating a plan to implement changes according to the data, obtaining postimplementation data, performing data analysis, and, finally, assessing whether and how meaningful practice and quality improvement was achieved.

In summary, a targeted implementation of TeamSTEPPS tools was associated with a statistically significant improvement in safety and teamwork metrics in an academic interventional ultrasound radiology practice.

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