A Crew Resource Management Program Tailored to Trauma Resuscitation Improves Team Behavior and Communication

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BACKGROUND: Crew Resource Management (CRM) is a team-building communication process first implemented in the aviation industry to improve safety. It has been used in health care, particularly in surgical and intensive care settings, to improve team dynamics and reduce errors. We adapted a CRM process for implementation in the trauma resuscitation area.

STUDY DESIGN: An interdisciplinary steering committee developed our CRM process to include a didactic classroom program based on a preimplementation survey of our trauma team members. Implementation with new cultural and process expectations followed. The Human Factors Attitude Survey and Communication and Teamwork Skills assessment tool were used to design, evaluate, and validate our CRM program.

RESULTS: The initial trauma communication survey was completed by 160 team members (49% response). Twenty-five trauma resuscitations were observed and scored using Communication and Teamwork Skills. Areas of concern were identified and 324 staff completed our 3-hour CRM course during a 3-month period. After CRM training, 132 communication surveys and 38 Communication and Teamwork Skills observations were completed. In the post-CRM survey, respondents indicated improvement in accuracy of field to medical command information (p = 0.029); accuracy of emergency department medical command information to the resuscitation area (p = 0.002); and team leader identity, communication of plan, and role assignment (p = 0.001). After CRM training, staff were more likely to speak up when patient safety was a concern (p = 0.002).

CONCLUSIONS: Crew Resource Management in the trauma resuscitation area enhances team dynamics, communication, and, ostensibly, patient safety. Philosophy and culture of CRM should be compulsory components of trauma programs and in resuscitation of injured patients. (J Am Coll Surg 2014; 219:545−551. © 2014 by the American College of Surgeons)

Crew Resource Management (CRM) is a communication tool developed in the aviation industry. Review of airline disasters determined safety information was often known to individual crew members but not to all crew members. Inadequate interpersonal communication, poor decision making, and lack of leadership resulted in ineffective information sharing, which inspired CRM, to improve safety through enhanced communication for all team members. This is particularly important for those teams in which there is a perceived power inequality. By flattening the hierarchy, communication is encouraged, leading to improved team interactions.[1]

A growing number of health care disciplines are now using CRM techniques.[1] Such initiatives have been described as transformative and culturally sustainable in improving patient safety.[2,3]

Crew Resource Management in our facility was initially implemented in our operating rooms. Our hospital Board of Directors sought opportunities to improve safety in other patient-care venues. From this established

operating room model, our trauma resuscitation-specific CRM process evolved.

Patients meeting trauma activation criteria are met on arrival in the resuscitation area by the multidisciplinary trauma team. The team goal is to meet the immediate needs of the patient with appropriate resources. Members bring various educational levels and backgrounds, as well as varying degrees of clinical experience.

Trauma team members participate in a number of educational courses to prepare them to resuscitate patients. Advanced Trauma Life Support teaches physicians how to evaluate and resuscitate patients.[4] Similarly, Advanced Trauma Care for Nurses teaches nurses how to assess and care for patients.[5] Although these courses teach their respective audiences how to evaluate and resuscitate patients, little attention is explicitly targeted to teach effective communication. Other team members are rarely exposed to team dynamic education beyond technical skills.

Because of the high volume and acuity of trauma resuscitations, where excellent communication is essential to successful outcomes, we developed a trauma resuscitation-focused CRM program. This article describes the development, implementation, and effectiveness of a modified CRM process in the trauma resuscitation area (TRA). The purpose of this study was to evaluate the effectiveness of a team-building process in resuscitation of trauma patients. Specifically, would the use of a CRM program, modified for use in the TRA, improve teamwork and communication?

METHODS

This investigation highlights efforts to improve patient safety in trauma resuscitations in our 572-bed community teaching hospital with state designation as a Level I regional resource trauma center. The emergency department (ED) sees approximately 77,500 visits per year; 1,600 patients are admitted to the trauma service. Of those, approximately 15% have an Injury Severity Score >15.

A multidisciplinary steering committee with representation from Emergency Medicine, Trauma Services, Nursing, Quality Management, Patient Safety, and Surgical Services was convened. A project charter was completed with timeline development. A process flow map of team communication related to trauma resuscitation was created for purposes of identifying opportunities for CRM effectiveness.

A 23-question predidactic education survey about trauma resuscitation teamwork and communication was developed based on the Human Factors Attitude Survey (HFAS).[2] The HFAS has been used to evaluate CRM in medical settings and is based on similar work by the National Aeronautics Space Administration and the aviation industry.[2] The HFAS was modified to include topics on team leadership, team effectiveness, decision making, and communication. The surveys were formulated in a standard 5-point Likert scale ranging from strongly agree to strongly disagree. The providers surveyed were asked to give a 1-word description of communication in the TRA. The descriptors were classified as positive, negative, or neutral.

The Communication and Teamwork Skills (CATS) assessment was used to observe teamwork and communication.[6] The CATS assessment includes categories for coordination of care, situational awareness, cooperation, and communication. An independent observer, trained in the use of CATS, scored trauma resuscitations. Results of observations were recorded by noting observed behavior and did not indicate the appropriateness or effectiveness of the observation.

Based on the results of the HFAS and CATS, problem areas for communication in the process flow map were identified. Root causes were considered and solutions were suggested and incorporated into the didactic curriculum. Any staff member that participated in trauma care was required to attend CRM training. This commitment was financially supported by our institution.

After completion of the didactic CRM training, participants were resurveyed using the identical HFAS. The same independent observer from the pre-CRM training observations used CATS to score post-training resuscitations. Statistical analyses by chi-square and Fisher's exact test were conducted using IBM SPSS Statistics software (version 19, 2012, SPSS, Inc). The project was evaluated and approved by the WellSpan Institutional Review Board.

RESULTS

The initial Trauma Communication Survey was completed by 160 personnel (49.4% response). Twenty-five pre-CRM trauma resuscitations were observed and scored using CATS. Communication issues were identified and the following recommendations to improve team interactions were made: standardize and consistently report patient information during all handoffs, especially prehospital to medical command

and to the TRA; identify team leader; team leader demonstration of positive leadership and communication skills; hold a prearrival briefing to share prehospital patient information; confirm provider roles; describe a plan of care; eliminate and reduce extraneous noise; and dismiss nonessential personnel after checkout with the team leader.

The TRA-specific CRM course was presented in 15 sessions during a 3-month period, with 324 staff completing the 3-hour course. After CRM training, 132 Trauma Communication Surveys (40.7% response) and 38 CATS observations were completed. Substantial improvement was noted in 15 of 23 questions in the post-CRM survey. Improvement was found in the following main areas: exchange of information from prehospital providers to TRA caregivers, role of the team leader, role of the briefing, and comfort of staff with communication (Table 1).

Pre and post-CRM training survey response rates were 49% and 40.7%, respectively. The survey was administered through work email contact to all of the 324 employees required to attend the training sessions. Although a higher response rate would be desirable, they reflect a reasonable cross section of employees through volunteer survey methodology.

Survey respondents noted improvement in accuracy of medical command information ($p = 0.029$), accuracy of information passed from ED medical command to the TRA ($p = 0.002$), and appropriate and accurate information obtained from prehospital providers on arrival ($p = 0.003$). The team leader was viewed as significantly improved at identifying himself or herself to team members, communicating a treatment plan, and assigning roles to providers ($p < 0.001$). The team leader's interaction with prehospital providers was also viewed as improved ($p < 0.001$). There

Table 1. Pre- and Postintervention Survey Results

Question	Preintervention mean	Postintervention mean	p Value
1. Standardized information about the incoming trauma is obtained by medical command (radio) in the ED.	3.62	3.85	0.044
2. Accurate information about the incoming trauma is obtained by medical command (radio) in the ED.	3.32	3.58	0.029
3. Information from medical command (radio) in the ED is relayed accurately to the trauma room.	3.45	3.78	0.002
4. The team leader elicits appropriate information from prehospital personnel.	3.54	3.84	0.004
5. The team leader is identified to the prehospital personnel.	2.72	3.55	0.000
6. The team leader identifies him/herself to team members.	2.56	3.73	0.000
7. Appropriate information is obtained from prehospital personnel when the patient arrives.	3.81	4.04	0.011
8. Accurate information is obtained from prehospital personnel when the patient arrives.	3.81	4.08	0.003
9. It is important for me to be involved in a briefing before the patient arrives.	4.03	4.11	0.411
10. I know what I am expected to do during a trauma before bedside care begins.	4.20	4.31	0.226
11. The team leader communicates a plan for the patient before the patient arrives.	2.61	3.48	0.000
12. The team leader assigns roles for providers at traumas.	2.79	3.47	0.000
13. A briefing with "game plan" discussion is held before the patient arrives.	2.39	3.37	0.000
14. The quality of communication before care begins at the bedside results in a high level of care.	3.52	3.88	0.001
15. There are predetermined periods in the trauma room when communication occurs unimpeded.	3.02	3.38	0.001
16. The number of staff in the trauma room negatively affects communication.	3.56	3.43	0.265
17. The noise level in the trauma room negatively affects communication.	3.90	3.76	0.253
18. I know the patient's level of acuity, mechanism of injury, and relevant patient information before bedside care begins.	3.37	3.63	0.023
19. If the team leader changes, I know who is in charge.	2.48	3.02	0.000
20. The set-up process for a trauma (gown and glove, set up equipment) negatively affects communication.	2.39	2.47	0.466
21. When there are simultaneous traumas, roles of caregivers are assigned before bedside care begins.	3.14	3.28	0.210
22. Staff will freely speak up if they see something that can negatively affect patient care.	3.24	3.59	0.002
23. Staff are afraid to ask questions when something does not seem right.	3.08	2.85	0.071

ED, emergency department.

was no change in the perception of the briefing's importance (p = 0.411) and understanding of expected roles after the intervention (p = 0.226; Table 1).

Data collected by the observer using CATS supported the survey results of providers (Table 2). Improved communication from the ED about information received from medical command was observed (p = 0.0021). Significant improvement was noted in the use of the briefing (p < 0.0001), verbalizing a plan of care (p < 0.0001), establishing a team leader (p < 0.0001), and assigning roles to team members (p < 0.0001). Cross monitoring (p < 0.0001) and verbally updating team members with relevant information improved significantly (p = 0.0007).

Team briefing contributed to improved understanding of patient needs (p = 0.001) and team communication. Briefings were structured to gain a shared mental model and were held before patient arrival. Respondents noted better knowledge of the patient's acuity, mechanism of injury, and relevant patient information (p = 0.023) before bedside care began. The improved quality of communication was believed to result in a higher level of patient care.

After CRM training, staff stated that they were more likely to speak up if they saw something that might negatively affect the patient (p = 0.002; Table 1). Although not statistically significant, response improved to, "Staff are afraid to ask questions when something does not seem right" (p = 0.071; Table 1).

Respondents were asked to use 1-word summaries to describe their perception of communication. These responses were divided into positive, negative, or neutral. In the post-implementation survey, positive responses increased by 28% (p < 0.0001) and negative responses decreased by 32% (p < 0.001). Neutral responses increased by 4% (p = 0.59); this was not statistically significant.

Both were rated highly before and after CRM training. No significant improvements were found for several items (Table 3).

DISCUSSION

The Institute of Medicine's report in 1999 brought patient safety and medical error issues to the forefront, providing objective evidence for how important these concerns have become in modern medical practice.[7] Patient safety and control over medical errors are a primary focus of the Joint Commission for Accreditation for Healthcare Organizations, which emphasizes such issues as effective communication.[8]

The CRM Model, which has been endorsed by the Joint Commission for Accreditation for Healthcare Organizations, and methods of improving communication, leadership, team effectiveness, and safety, have been used in high-risk hospital environments, such as operating rooms and intensive care settings.[9-12] However, conclusive evidence about CRM effectiveness has yet to emerge, as implementation has not been adequately studied.[10,13]

Alternate methods of team building have been described and implemented, such as Team Stepps, endorsed by the Agency for Healthcare Research and Quality. We chose to use CRM in the TRA because our organization had previously implemented CRM with success in the Department of Surgery to improve patient safety. The Joint Commission for Accreditation for Healthcare Organizations published descriptions of CRM-based team training in obstetrics, which provided additional justification for choosing the CRM paradigm.[9] It has been our organizational intention to standardize such initiatives where possible.

Crew Resource Management evolved from the National Aeronautics and Space Administration's efforts revealing that communication errors, inefficient leadership, and faulty decision making in crisis were more to blame than individual performance for accidents and mishaps.[1,14,15] In the CRM model, highly functioning teams are described with the following attributes: situational awareness by team members; effective leadership; empowerment of nonleader members of the team; closed loop communication; critical language and standardized procedures; assertive communication; adaptive and supportive behavior by team members; and follow-up with a

Table 2. Communication and Teamwork Skills Metrics: Improved Post Implementation

Observation metric	Pre-CRM (n = 25), %*	Post-CRM (n = 38), %*	p Value
Briefing	40	89	<0.0001
Verbalize plan of care	44	89	<0.0001
Establish team leader	12	82	<0.0001
Assign roles	4	89	<0.0001
ED gives patient summary to trauma personnel	48	84	0.0021
Request external resources if needed	12	87	<0.0001
Ask for help from team as needed	28	68	0.0016
Cross monitoring	16	87	<0.0001
Closed loop	8	76	<0.0001
Verbal updates-think aloud	8	71	0.0007
Use names	8	84	<0.0001

*Percentage of observations.
CRM, Crew Resource Management; ED, emergency department.

Table 3. Communication and Teamwork Skills Metrics: No Change after Intervention

Observation metric	Pre-CRM (n = 25), %*	Post-CRM (n = 38), %*	p Value
Verbalize expected time frames	0	6	0.5135
Visually scan environment	96	100	0.3968
Verbalize adjustments in plan as changes occur	4	13	0.3885
Verbally request team input	8	5	0.5220
Verbal assertion	0	5	0.5135
Escalation of asserted concern	0	5	0.5135
Receptive to assertion and ideas	0	8	0.2703
Appropriate volume and tone of voice	100	92	0.2703
Critical language	0	3	1
Trauma staff pay attention to EMS report	92	100	0.1536

*Percentage of observations.
CRM, Crew Resource Management; EMS, emergency medical services.

reflective debriefing process,[1,16-21] all of which are applicable to the resuscitation of trauma patients.

York Hospital trauma resuscitation area Crew Resource Management education

All participants in trauma resuscitations were required to attend a 3-hour CRM educational program. A video presentation of a health care scenario comparing and contrasting effective and ineffective team dynamics and CRM principles was included.

Trauma team Crew Resource Management process

Patients are first triaged to the TRA by ED physicians according to established triage criteria and as outlined in the Resources for Optimal Care of the Injured Patient.[22] The team leader assimilates relevant information and briefs the entire team by initiating a "time out" where everyone is attentive. Team members' presence and identity are confirmed, as are resources appropriate for the clinical condition of the patient. Team members are then invited to ask questions or raise concerns. Each team member is given equal voice and, according to our culture of CRM, is empowered to be assertive and adaptive, thereby "flattening the hierarchy" of the trauma team. A "stop the line" perspective is encouraged with any perceived imminent threat to patient safety. The team leader otherwise conducts the evaluation and treatment of the patient and, through closed-loop communication, stays engaged with team members as he or she makes priorities and treatment plans known. The concept of situational awareness is used to assure that there is a shared mental model from which the team is working. Through the tools of team-member empowerment by adaptive behavior and assertive communication, as well as the mechanisms highlighted here, care can be tailored to meet the immediate and changing needs of the patient.

The CRM initiative in our trauma resuscitation setting is unique in terms of venue for CRM application and its evaluation of effectiveness before and after implementation. Reductions in medical errors and patient safety parameters were not specifically measured, however, such impact can be inferred from improvements in communication and team dynamics, which were specifically considered. Outcomes measures were not included as part of this team building educational initiative. Impact on such measures as preventable mortality would require a very large study group, and metrics such as length of stay and transfusion requirement are affected by too many variables to be compared with a "no-CRM" control group. As indexed by 1-word descriptors, we showed a 28% improvement in team dynamics and a 32% decrease in negative responses after CRM implementation.

Team member assertiveness was an area we hoped to impact through CRM implementation. As illustrated by our observational metrics, there is no statistically significant improvement; however, the pre-CRM assertiveness, as indicated by "verbal," "escalation," and "repetition," are nonexistent, with positive responses in each category in post-CRM observations. This indicates a definite trend toward increased assertiveness of team members. When considered in the context of the CATS tool, these "nonobservations" of behavior did not address their necessity and, therefore, do not reflect a failure of the system. For example, "verbal assertion" might not have been needed at all or the briefing/mental model eliminated the potential concern. This can be illustrated by the low number of pretraining observations for the same metrics, where events requiring "escalation" can be infrequent. Infrequent occurrence, however, should be considered as a rationale to emphasize assertiveness in CRM training, and thereby improve the training paradigm.

Communication was improved by implementation of our CRM process. Enhanced situational awareness was

fostered, as was a shared mental model. Resuscitation team organizational improvement was demonstrated by better team leader identification, assignment of roles, and defining resources. These improvements could be even more important in the event of multiple simultaneous trauma patients or mass-casualty situations, which can stress traditionally structured trauma team organization. Therefore, CRM training can prove beneficial in a large, high-volume trauma center. Smaller programs would benefit equally from such training, as it standardizes communication and team behavior that might be called upon only frequently.

Follow-up through a debriefing process is crucial to assuring constructive team dynamics and learning. As patients in this clinical setting are merging into divergent areas of the hospital for definitive diagnostics and care, a debriefing is not always immediately feasible. Cases are reviewed specifically with regard to issues through established trauma program quality and performance-improvement processes, and as raised by individual trauma team members. Trauma room resuscitations are videorecorded and audiorecorded for purposes of review and care assessment. In the rare instance where substantial or systems-based issues arise, the team convenes for case review through our established trauma program performance-improvement mechanisms. Five random activations are audited monthly for the sole purpose of observing CRM compliance. The original CATS is used to record expected behaviors (Table 1). Results of these audits are shared through our hospital-wide Patient Safety Committee.

Maintaining ongoing awareness and compliance with the CRM culture of safety is imperative for success. Crew Resource Management is not a single-task skillset, but rather an ongoing cultural orientation that requires continual development, coaching, and feedback. New trauma team member orientation occurs semi-annually. All employees who participate in the resuscitation phase of trauma activations are required to attend one CRM session within the first year of employment. Visual cues are displayed in the TRA and include topics such as briefing components and performance-improvement venue options.

Reinforcement of CRM concepts is provided through a self-learning, internet-based teaching module in our CRM program. This module was granted continuing medical education credit and is made available annually to all staff members who previously completed the full CRM presentation course. Crew Resource Management continues to be rolled out into all procedural areas of our hospital. Concepts of team member equality and communication have become our culture of safety.

Advanced Trauma Life Support and Advanced Trauma Care for Nurses fulfill important characteristics of highly functioning teams by standardizing procedures and providing a mechanism for leadership. However, these programs do not explicitly address some of the other improvements that the CRM model provides for managing critical situations.[2,7] What has also been lacking is objective evidence that CRM is effective in improving patient safety.[2,23,24] Although specific improvements in clinical outcomes were not measured in this study, it is inferred by improvements in team dynamics and communication, which were explicitly considered.

CONCLUSIONS

In describing a new health system for the 21st century, the Institute of Medicine describes 10 rules for redesign. The 5 that follow are addressed explicitly in our application of CRM in the TRA: care is customized according to patient needs and values; knowledge is shared and information flows freely; safety is a system property; needs are anticipated; and cooperation among clinicians (we would say all team members) is a priority.[23] Crew Resource Management enhances team dynamics and communication and ostensibly impacts patient safety. Philosophy and culture of CRM should be compulsory components in organization of trauma programs and in resuscitation of injured patients.

Author Contributions

Study conception and design: Hughes, Benenson, Krichten, Ryan, Hammond
Acquisition of data: Benenson, Krichten
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Drafting of manuscript: Hughes
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