Evaluation of Communication and Safety Behaviors During Hospital-wide Code Response Simulation

Dennis M. Ren, MD[1], Anna Abrams, MD[2], Maureen Banigan, MD[3], Rachael Batabyal, MD[1,4], James M. Chamberlain, MD[1,4], Amanda Garrow, RN, PhD[4,5], Rima Izem, PhD[4,6], Laura Nicholson, MSN, RN, CHSE, CPN[5], Mary Ottolini, MD, MPH, MEd[7], Mary Patterson, MD, MEd[8,9], Rachel Sarnacki, BA[10], Heather A. Walsh, MSN, RN, PCNS-BC, CHSE, CPN[5], Pavan Zaveri, MD, MEd[1,4,5]

[1]Division of Emergency Medicine, Children's National Hospital, Washington, DC

[2]Division of Emergency Medicine, Children's Hospital Colorado, Aurora, CO

[3]Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia, Philadelphia, PA

[4]Department of Pediatrics, George Washington University School of Medicine and Health Sciences, Washington, DC

[5]Simulation Program, Children's National Hospital, Washington, DC

[6]Division of Biostatistics and Study Methodology, Children's Research Institute, Children's National Hospital, Washington, DC

[7]Department of Pediatrics, Maine Medical Center, Portland, ME

[8]Department of Emergency Medicine, University of Florida College of Medicine, Gainesville, FL

[9]University of Florida Center for Experiential Learning and Simulation, University of Florida College of Medicine, Gainesville, FL

[10]Global Health Initiative Children's National Hospital, Washington, DC

Corresponding author: Dennis Ren, MD, Division of Emergency Medicine, Children's National Hospital, 111 Michigan Ave. NW, Washington, DC 20010.

Phone: 202-476-4177; Fax: 202-476-3573; Email: Dmren2@childrensnational.org.

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Abstract

Introduction: To understand the baseline quality of team communication behaviors at our organization, we implemented institution-wide simulation training and measured the performance of safety behaviors of ad hoc teams in emergent situations.

Methods: Clinicians participated in two interprofessional video-recorded simulation scenarios, each followed by debriefing. Using a standardized evaluation instrument, two reviewers independently evaluated the presence or absence of desired team safety behaviors, including escalating care, sharing a mental model, establishing leadership, thinking out loud, and identifying roles and responsibilities. We also scored the quality of sharing the mental model, closed-loop communication, and overall team performance on a 7-point scale. Discordant reviews were resolved with scoring by an additional reviewer.

Results: A total of 1404 clinicians participated in 398 simulation scenarios, resulting in 257 usable videos. Overall, teams exhibited desired behaviors at the following frequencies: escalating care, 85%; sharing mental models, 66%; verbally establishing leadership, 6%; thinking out loud, 87%; and identifying roles and responsibilities, 27%. Across all reviews, the quality of the graded behaviors (out of 7 points) was 2.8 for shared mental models, 3.3 for closed-loop communication, and 3.2 for overall team performance.

Conclusions: In a simulation setting with ad hoc teams, there was variable performance on completing safety behaviors and only a fair quality of graded communication behaviors. These results establish a baseline assessment of communication and teamwork behaviors and will guide future quality improvement interventions.

Introduction

Healthcare institutions regularly establish interprofessional ad hoc teams for patient care emergencies. These ad hoc teams are expected to function in high-stress, high-pressure, and time-sensitive environments. The ability of team members with different backgrounds, training, and experience to coordinate care and communicate effectively is paramount to ensuring quality of care and patient safety.

Despite recognition of the importance of effective teamwork skills in healthcare delivery, patients continue to suffer harm related to lapses in communication. A systematic review and meta-analysis of studies from 2000 to 2019 estimated that about 1 in 20 patients are exposed to preventable harm across medical settings.[1] The Joint Commission reported in 2015 that 79% of sentinel events were attributed to poor communication.[2] The Accreditation Council for Graduate Medical Education (ACGME) identified patient safety as one of six major focus areas in the clinical learning environment review program.[3] Yet widespread training across entire institutions on frameworks and models for developing and assessing effective communication among interprofessional teams is lacking.

The healthcare industry has examined qualities exhibited by high reliability organizations (HROs) such as aviation, nuclear energy, and aircraft carriers to improve safety and reduce errors. HROs function in complex and high-risk settings and are able to prevent or mitigate catastrophic accidents. There are five main principles of HROs: (1) preoccupation with failure, (2) reluctance to simplify, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise.[4-6] Effective teamwork and engagement across all levels are key components of HROs in creating a culture of safety to achieve the ultimate goal of zero harm.[5,7-10]

Most medical studies evaluating teamwork and nontechnical skills through simulation have been performed within specific departments or environments involving specific tasks and a limited number of participants. As a recipient of an ACGME “Pursuing Excellence Through Innovation” grant targeting improvement in the clinical learning environment, we implemented hospital-wide simulation training at a large stand-alone pediatric institution. Through this project, we evaluated the baseline quality of communication behaviors across our institution and identified areas to target future quality improvement efforts.

Methods

The project was submitted to the Children's National Hospital Institutional Review Board and deemed to be quality improvement and not human subjects research, thus exempt from oversight of the Institutional Review Board. Simulation participants included physicians (faculty and fellows), nurses, advanced practice providers (nurse practitioners and physician assistants), patient care technicians, and respiratory therapists from across our institution. Hospital leadership required attendance and engaged medical and nursing directors to ensure compliance. The Chief Quality and Safety Officer and Chief Nursing Officer directed all staff to sign up for the training, providing two continuing education credits and pay to all nurses. The simulation team managed enrollment and reported compliance to hospital and unit leadership through the four-month period, October 2016 to January 2017, of this training.

Curriculum

We developed three required online modules relating the principles of HROs with a focus on patient safety fundamentals. After completing the modules, groups of clinicians participated in two interprofessional simulations. The objectives for the simulation training were to

demonstrate essential behaviors for team formation and care escalation and to practice communication techniques. Each session was composed of two simulation scenarios designed for interprofessional learning with a maximum of four physicians, eight nurses, and up to two other staff. Given the actual number of participants in a session varied, the team was limited to six participants per simulation scenario with the remaining learners observing the team performance. In the second scenario, the observers would then become the active participants and vice versa. Scenario 1, an airway event, involved a toddler in the cafeteria with an obstructed tracheostomy tube. Scenario 2, a sepsis event, involved a child on the inpatient unit in septic shock. Simulation sessions were conducted in the hospital-based simulation center using the 1- to 3-year-old HAL manikin with a tracheostomy tube and the 5-year-old HAL manikin (Gaumard, Inc., Miami, FL). At the beginning of each session, a trained facilitator provided an orientation of the manikin and simulation space. After completion of each scenario, a physician and nurse co-facilitated a debriefing focused on discussion around the formation of ad hoc teams using basic safety communication behaviors.

Evaluation Development

Based on review of existing assessment tools for nontechnical and communication skills,[11-26] our team developed an evaluation instrument (Figure 1) to assess the presence or absence of specific desired behaviors needed to self-organize an ad hoc team and to evaluate these behaviors. While there are measurement tools to evaluate an individual's performance within a team, most tools have limitations in assessing the teamwork and communication behaviors exhibited by an interprofessional team as a whole. Several tools included elements for one specific setting such as the emergency department or operating room.[13,15,16,18,20,22-24] Other tools focused only on the physician,[12-14,16,19,20,26] while others evaluated only students.[11,19,21]

Several tools had a large numbers of items that would have made the assessment prohibitively lengthy.[12,14,15,17,18,20,25]

To create our evaluation instrument, we started by identifying key safety and communication behaviors that we believed to be crucial in high-functioning teams and reflective of key principles in HROs. The initial draft of our evaluation instrument had approximately 20 elements. In order to apply our instrument in different settings and quickly identify areas of improvement across the entirety of our institution, we decided to remove scenario-specific behaviors (e.g., administering a normal saline bolus in the septic shock simulation). Our final instrument to evaluate the teamwork and performance of interprofessional ad hoc teams included assessment of the following behaviors: escalating care, sharing a mental model, verbally establishing leadership, thinking out loud, identifying roles and responsibilities, and using closed-loop communication. These behaviors relate directly to the key principles of HROs as demonstrated in Table 1.

To assess performance, we first analyzed each video for presence or absence of each of the safety behaviors listed above using a dichotomous yes/no scale. Quality of behavioral elements—specifically quality of the shared mental model, quality of closed-loop communication, and overall team performance—was assessed using a 7-point, behaviorally anchored, rating scale. Using existing tools,[11,15,23-25,27] we developed anchor descriptors for the 7-point scales. Additionally, we measured the time taken to share a mental model. Our team agreed that a reasonable time goal for sharing a mental model was less than 3 minutes.

In total, we scored six dichotomous (yes/no) items and three scaled (1–7) items (Figure 1). Discordant reviews—defined as disagreement on dichotomous items or a difference of more than two points between reviewers—were resolved with a third reviewer.

Video Review

Simulations were video recorded for review using a proprietary program (SimCapture, B-line Medical, Washington, DC). Recordings with poor audiovisual quality, inadequate number of participants, or facilitator participation were excluded.

To standardize the data collection and quality, all data were collected and managed using Research Electronic Data Capture (REDCap).[28] To select and train the raters, given the large number of events that were to be reviewed, simulation facilitators were invited to review the video recordings on a volunteer basis. Prior to data collection, the team reviewed a sample of five study videos as a group to test the instrument and calibrate the reviewers. Initially, two of the nine reviewers (D.R., A.A., M.B., R.B., A.G., L.N., H.W., M.W., P.Z.) were assigned to evaluate each recorded simulation scenario. Additional reviewers from this group were assigned as needed to resolve discordant reviews. The research team met monthly to recalibrate the reviewers to the operational definitions of communication behaviors in an effort to optimize consistency and reproducibility among reviewers. When a reviewer was added to the group, one member (D.R.) of the research team trained the reviewer by watching two videos together and completing the instrument. All video reviewers viewed a set of three example videos (rated 1, 4, 7) in an effort to standardize ratings.

Statistical Analysis

We report overall scores for dichotomous items and means and standard deviations for graded items across all scenarios and ratings. We decided to accept a tolerance of ±2 as a team because we were assessing a subjective measure of quality of various behaviors. Statistical

analyses of the raters were performed using R software (version 3.5.2) with the *irr* library (Version 0.84.1) for interrater reliability measures.[29,30] To evaluate consistency of scoring across reviewers, we initially measured the percentage of agreement between the first two reviewers across items then performed a more robust analysis of agreement using Krippendorff's alpha[31] across all reviewers and items. We used Krippendorff's alpha instead of other measures, such as Cohen's Kappa, because some videos had multiple raters (more than two), and the set of raters differed for each video. Krippendorff's alpha can measure inter-rater reliability for multiple raters, when not all raters review all videos. Krippendorff's alpha varies from 0 (perfect disagreement) to 1 (perfect agreement).

Results

Seventy-eight percent of inpatient hospital clinicians (1404/1800) participated in 398 simulation events over a 4-month period (199 airway events and 199 sepsis events). Of the 398 events, 105 were excluded because of poor video/audio quality, 6 were excluded because of insufficient number of participants, and 30 were excluded because of facilitator participation. Each simulation scenario required a minimum of one physician and two nurses with a maximum of six participants. Ultimately, 134 airway events and 123 sepsis events were analyzed (Figure 2). There were 9 reviewers; most reviewed between 50 and 100 videos. The review process generated 699 total reviews with 367 of the airway event and 332 of the sepsis event.

Team Performance

Table 2 depicts the overall and per scenario performance of desired behaviors assessed as dichotomous items. Overall, teams demonstrated escalation in 85% of scenarios and thinking out loud in 87% of scenarios. Teams rarely verbally established leadership (6% overall) and were

inconsistent in identifying roles and responsibilities (27% overall). Teams established a mental model within 3 minutes approximately half the time. Table 3 demonstrates overall and per scenario performance of graded items. Scenario 2 scores were higher than Scenario 1 scores for all items, except for escalating care. Overall, teams scored approximately 3 on the 7-point scale for the quality of the shared mental model, closed-loop communication, and overall team performance.

Inter-rater Reliability

The first two reviewers agreed upon dichotomous items 86.2% of the time. The first two reviewers agreed upon graded items, with a tolerance of ±2, 86.8% of the time. Krippendorff's alphas for all dichotomous items and graded items were 0.736 and 0.495, respectively.

Discussion

In this large project using video review and standardized assessment of two pediatric emergency scenarios across all hospital-based clinicians, we found inconsistent performance of desired safety behaviors. This was the first hospital-wide simulation-based training and the first simulation experience for many faculty and staff. Escalating care and thinking out loud occurred in most simulation events. Establishing leadership and assigning roles occurred infrequently demonstrating a lack of commitment to resilience and deference to expertise. A mental model was shared in a timely manner in only half of the events. The quality of sharing a mental model, closed-loop communication, and overall team performance was rated as poor to fair. In our healthcare institution's transition towards becoming an HRO, we have identified the gaps that still exist. While doing well in behaviors reflecting reluctance to simplify and sensitivity to operations, the commitment to resilience and deference to expertise are areas for potential

improvement. Finally, behaviors associated with preoccupation with failure had mixed results, identifying additional areas of growth for the institution.

Reviewer Agreement

To assess agreement among reviewers, we performed an initial evaluation for agreement between the first two reviewers followed by assessment of agreement across reviewers with Krippendorff's alpha. Typically, Krippendorff's alpha value ≥0.8 reflects good reliability, ≥0.667 allows for tentative conclusions, and <0.667 reflects low reliability.[31] While the alpha value for dichotomous items (0.736) is within the threshold for drawing tentative conclusions, the alpha value for graded items (0.495) is low, likely related to two shortcomings. First, in creating the anchoring descriptors for the graded items, we drew from multiple existing tools. In the process, multiple constructs were present in these anchoring descriptors including presence/absence of behavior, quality (poor to excellent), and effectiveness. The presence of multiple constructs in these descriptors may have contributed to lower inter-rater reliability for graded items. Additionally, although the study team determined a difference of ±2 between reviewers on graded items would be acceptable, no tool we found for interrater reliability including Krippendorff's alpha would take account for this tolerance. Thus, the alpha value for graded items may be higher if the tolerance was considered.

Lessons

In the course of conducting, debriefing, and reviewing these simulation scenarios, a few lessons and observations helped explain the results. First, knowledge and expertise often exist in silos. While teams who routinely work together in the same department or setting may function well because they are already aware of each team member's expertise, ad hoc teams do not have this advantage. We noticed many ad hoc teams defaulting to a hierarchy in which the physician

participant was the presumed leader, even when a nurse had the subject matter expertise. This resulted in scenarios where the knowledge and experience of team members was not used effectively and deference to expertise was not practiced. Second, lack of verbalized leadership severely hindered patient care. In scenarios with multiple physician participants, this issue became magnified. We witnessed confusion in teams where orders seemed to be coming from multiple people. It became difficult for the team to anticipate next steps and prioritize interventions, demonstrating gaps in resilience and deference to expertise. Third, a lack of assigning roles and responsibilities resulted in pauses in care or overlooked interventions as team members appeared confused as to who should be performing the task. Finally, our most effective teams demonstrated behaviors where all team members felt empowered to share a mental model. However, tasks were performed without a verbalized mental model in a significant portion of scenarios. We saw teams perform the Heimlich or abdominal thrusts without a shared mental model in the airway scenario. Additionally, we saw teams immediately intervene to change the tracheostomy tube in the airway scenario without sharing their thinking. While this latter action may have been correct for the simulation scenario, both examples led to confusion as teams could not anticipate next steps or goals without knowing what problem was being treated, reflecting weaknesses in preoccupation with failure.

Although simulation is a useful method to improve nontechnical and teamwork skills, data are lacking regarding its effectiveness and impact across entire institutions. With this institutional "report card," we were able to establish a baseline assessment of communication and teamwork behaviors in critical situations at our institution. Using simulation, we identified and measured gaps in our institution's communication behaviors to target with further quality improvement interventions. We plan to continue to evaluate team performance in further

hospital-wide and unit-based interprofessional teams in in-situ simulations, adjusting curricula to address identified gaps. For future iterations, we plan to refine our evaluation instrument, including the descriptors, to achieve higher interrater reliability.

Limitations

This project has several limitations. First, in order to quickly identify areas of improvement across the entirety of our institution, we implemented a novel evaluation instrument with limited validity data. In the future, additional psychometric testing will be required to validate our novel instrument. Second, agreement among reviewers was not perfect. Fourteen percent of videos required a third reviewer to obtain consensus. This was largely a result of the limitation of the audio recordings and background noise rather than disagreement about the actual tasks. Third, agreement on the quality of task performance for graded items was only fair. Although the team decided to accept a difference of two points for graded items as a disagreement, Krippendorff's alpha took any disagreement (whether below or above two) into account, thus leading to a lower reliability result. We plan to modify anchor descriptors for graded items to have discrete constructs to improve inter-rater reliability. Fourth, scores in the two scenarios differed, suggesting sensitivity of our scale to the type of simulation setting, but may have been confounded by team learning (scenario 2 tested after scenario 1), debriefing provided between scenarios, or developing familiarity among team members. Finally, these scenarios occurred in the simulation lab and may not represent actual behaviors in clinical events on patient care units.

Conclusions

We implemented institution-wide simulation training to analyze the behavior of ad hoc teams and establish a baseline assessment of communication and teamwork behaviors across the

institution. This project established that ad hoc teams at our institution performed well in escalation and thinking out loud but had poorer performance in other key safety behaviors. Broadly, we demonstrated that simulation training applied across an institution is a feasible tool for identifying strengths and gaps in team safety and communication. To replicate successfully such training requires a mandate from hospital leadership, a proactive simulation program, and commitment of medical, nursing, and ancillary staff towards patient safety. As we progress towards becoming an HRO, this project defines the principles and behaviors that require greater focus. Future research will include refinement of the evaluation instrument to foster improved interrater reliability and targeted quality improvement interventions to improve specific critical safety behaviors and overall team performance.

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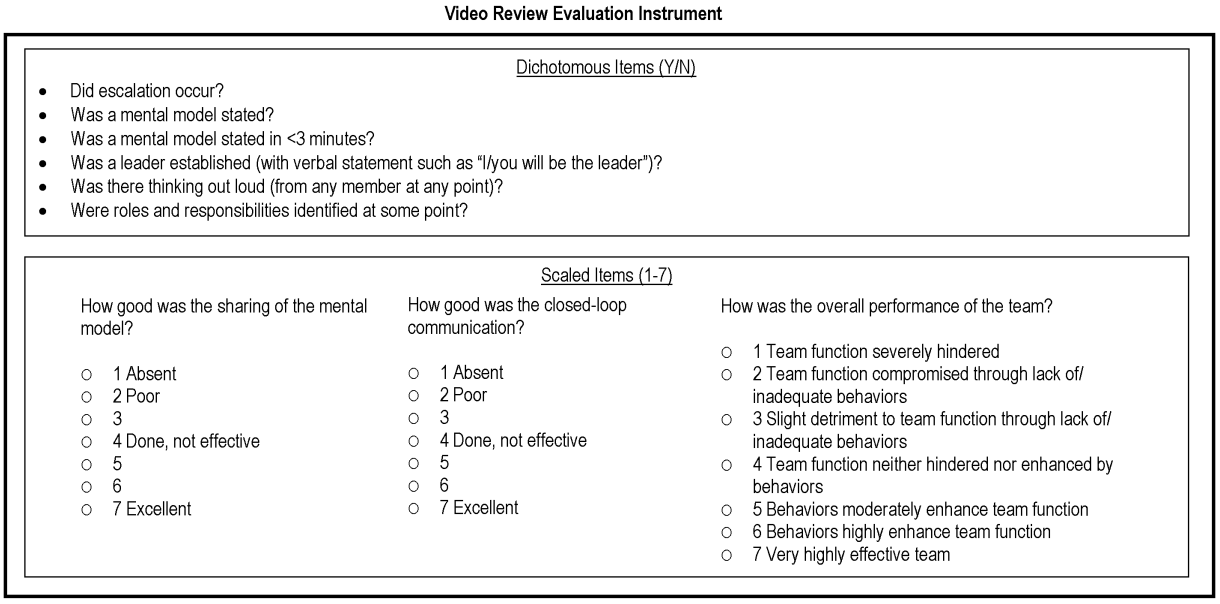
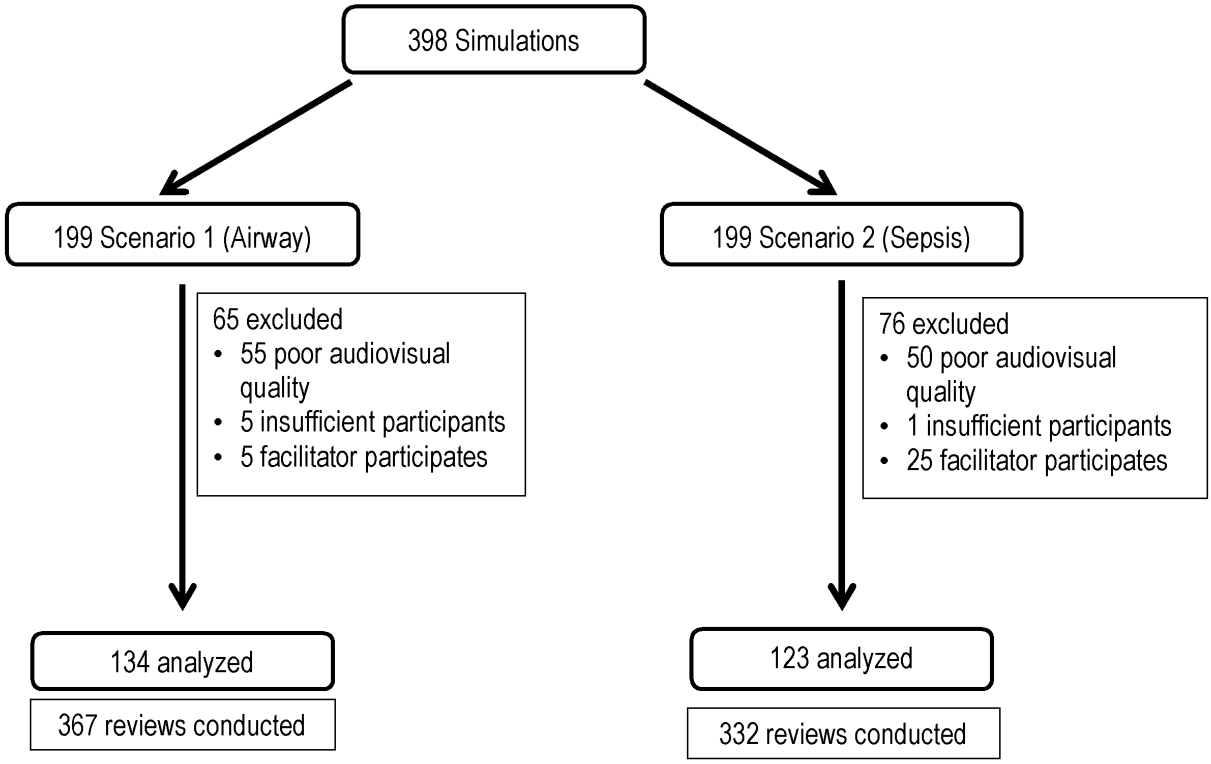
373 Figure 1. Evaluation instrument.



374

375 Figure 2. Videos reviewed.



376

377

Table 1. Safety behaviors and their application in relationship to principles of high reliability organizations

Principle of high reliability organizations	Corresponding safety behaviors	Application
Preoccupation with failure	Sharing a mental model	Prevents crucial data from being forgotten or dismissed.
	Thinking out loud	Recognizes that knowledge of each individual is often incomplete.
	Using closed-loop communication	Continuous attention to details allows the entire team to be attuned to discrepancies and anticipate errors.
Reluctance to simplify	Thinking out loud	Allows all team members to express their views to ensure everyone is on the same page.
Sensitivity to operations	Escalating care	Employs standard methods to get the right care to the patient at the right time.
Commitment to resilience	Verbally establishing leadership	Verbal creation of team structure and assigning tasks allows ad hoc teams to maintain functions in emergent situation.
	Identifying roles and responsibilities	Encourages all personnel to identify expertise and assume appropriate roles in emergent situations.
Deference to expertise	Sharing a mental model	Recognizes that knowledge often exists in silos.
	Verbally establishing leadership	Recognizes that a hierarchy where physicians are default leaders may be ineffective in providing care.
	Identifying roles and responsibilities	Encourages all personnel to identify expertise and assume appropriate roles in emergent situations.

Table 2. Outcomes of desired behaviors assessed as dichotomous items

Desired behaviors ***(Related HRO principles)***	**Scenario 1 (N = 367)**	**Scenario 2 (N = 332)**	**All scenarios (N = 699)**
Escalating care *Sensitivity to operations*	324 (88.3%)	269 (81.0%)	593 (84.8%)
Sharing a mental model *Preoccupation with failure, deference to expertise*	193 (52.6%)	265 (79.8%)	458 (65.5%)
Sharing mental model in less than 3 minutes *Preoccupation with failure, deference to expertise*	154 (41.0%)	190 (57.2%)	344 (49.2%)
Verbally establishing leadership *Commitment to resilience, deference to expertise*	13 (3.5%)	27 (8.1%)	40 (5.7%)
Thinking out loud *Preoccupation with failure, Reluctance to simplify*	295 (80.4%)	311 (93.7%)	606 (86.7%)
Identifying roles and responsibilities *Commitment to resilience, deference to expertise*	75 (20.4%)	110 (33.1%)	185 (26.5%)

Table 3. Outcomes of desired behaviors assessed as graded items

Desired behaviors ***(Related HRO principles)***	**Mean (SD), on scale of 1 to 7**		
	Scenario 1 (N = 367)	**Scenario 2 (N = 332)**	**All scenarios (N = 699)**
Quality of the shared mental model *Preoccupation with failure, deference to expertise*	2.2 (1.4)	3.6 (1.8)	2.8 (1.8)
Quality of closed-loop communication *Preoccupation with failure*	2.8 (1.4)	3.9 (1.5)	3.3 (1.5)
Overall team performance	2.9 (1.3)	3.5 (1.3)	3.2 (1.4)