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Using epistemic network analysis to identify targets for educational interventions in trauma team communication

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ABSTRACT

Background. Epistemic Network Analysis (ENA) is a technique for modeling and comparing the structure of connections between elements in coded data. We hypothesized that connections among team discourse elements as modeled by ENA would predict the quality of team performance in trauma simulation.
Methods. The Modified Non-technical Skills Scale for Trauma (T-NOTECHS) was used to score a simulation-based trauma team resuscitation. Sixteen teams of 5 trainees participated. Dialogue was coded using Verbal Response Modes (VRM), a speech classification system. ENA was used to model the connections between VRM codes. ENA models of teams with lesser T-NOTECHS scores ($n = 9$, mean = 16.98, standard deviation [SD] = 1.45) were compared with models of teams with greater T-NOTECHS scores ($n = 7$, mean = 21.02, SD = 1.09).
Results. Teams had different patterns of connections among VRM speech form codes with regard to connections among questions and edifications (meanHIGH = 0.115, meanLOW = –0.089; $t = 2.21$; $P = .046$, Cohen d = 1.021). Greater-scoring groups had stronger connections between stating information and providing acknowledgments, confirmation, or advising. Lesser-scoring groups had a stronger connection between asking questions and stating information. Discourse data suggest that this pattern reflected increased uncertainty. Lesser-scoring groups also had stronger connections from edifications to disclosures (revealing thoughts, feelings, and intentions) and interpretations (explaining, judging, and evaluating the behavior of others).
Conclusion. ENA is a novel and valid method to assess communication among trauma teams. Differences in communication among higher- and lower-performing teams appear to result from the ways teams use questions. ENA allowed us to identify targets for improvement related to the use of questions and stating information by team members.

Trauma centers see 30 million trauma patients a year with injury being the leading cause of death in patients 1 to 44 years old. Studies estimate that 10% of trauma deaths are related to preventable errors.[1] Most of these errors occur during the trauma initial assessment.[1,2] Because of the complex, time-critical, and high-risk nature of the trauma initial assessment, errors of nontechnical skill, including decision making, communication, teamwork, and stress management, predominate over errors of technical skill.[2] Development of these nontechnical skills during trauma education is essential to improve trauma outcomes.

Global rating scales, such as the Modified Nontechnical Skills Scale for Trauma (T-NOTECHS),[3] are used currently to provide broad, subjective assessments of overall performance of nontechnical skills. T-NOTECHS evaluates globally the ability of the trauma team to use nontechnical skills, such as leadership, cooperation,

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and decision making, to complete tasks necessary for patient care. Improved T-NOTECHS scores have been found to correlate with clinical performance in both actual and simulated trauma resuscitations[4], however, there is no clear and objective way to identify the components of good or bad performance with these scales, which makes it challenging to use this approach alone to develop focused targets for improvement. Examples are often used to anchor scores, but these anchors are often too broad. For instance, asking a team to "clearly define a team leader" is not as simple as the team announcing a leader at the start because many different elements of team interaction affect leadership. A richer, quantifiable description of team performance is necessary to develop educational interventions for team trauma performance.

This gap can be addressed through the aspect of distributed cognition theory and speech acts theory. Distributed cognition theory suggests that cognition and knowledge are not confined to an individual but rather are distributed among individuals and tools in the environment.[5] The cognition of the team is, therefore reflected in their communication. One way of understanding team communication is by looking at the speech acts performed by group members. Speech acts theory evaluates the performative functions of utterances – the actions we perform by what we say.[6]

Verbal Response Modes (VRM) is a descriptive speech acts taxonomy that categorizes utterances based on the relationship created by what is said between the speaker and another who is the target of the speech act.[7] There are 8 categories in the VRM taxonomy: disclosure, edification, advisement, confirmation, question, acknowledgement, interpretation, and reflection (Table 1). In addition, each utterance is coded twice: once for the form (literal meaning), and once for the intent (pragmatic meaning). For instance, "Would you do the math?" has a question form and advisement intent. Overall, VRM describes how the speaker can be related to the other within each utterance. These "microrelationships" can then be combined to depict the relationships between team members and link observable speech with general psychologic principles.

The connections between VRM codes can then be analyzed with Epistemic Network Analysis (ENA). ENA software was designed to describe and compare epistemic frames which are the connections between the different domain-specific skills and knowledge used by professionals in problem solving.[8] ENA identifies connections among elements of interest in segments of discourse data and models the weighted structure of these connections. ENA software can be used to create communication networks that similarly depict team communication as the connections between different communicative elements. We hypothesized that comparing communication networks of speech acts performed by trauma teams to other markers of team performance can help to describe how higher-performing teams communicate compared with lower-performing teams.

Methods

Participants and setting

This study was determined to be exempt by the Institutional Review Board of the University of Wisconsin, but informed consent for the use of data was still obtained from participants. Sixteen teams of 5 participated in interdisciplinary trauma team training simulations. Each team consisted of a trauma chief resident, surgery resident, emergency medicine resident, and 2 emergency medicine nurses. All resident physicians were certified in Advanced Trauma Life Support (ATLS). In keeping with their usual roles, trauma chief residents were always the trauma team leader. The surgery resident and emergency medicine resident performed the primary survey, secondary survey, and adjuncts. The emergency medicine nurses alternated among their usual roles in the trauma initial assessment. There was 1 circulating nurse and 1 nurse scribe. Although some trauma trainees participated in more than 1 session throughout the year, they never repeated the same scenario.

The simulations were performed in a simulated trauma resuscitation room equipped with a high-fidelity manikin (Laerdal, SimMan 3G, Wappinger Falls, NY), advanced audiovisual streaming, capture and playback systems, and 1-way mirrors for direct observation. Each team was randomly assigned 1 of 8 standardized trauma scenarios randomly (Table 2). Three faculty members (trauma surgery, emergency medicine, and emergency medicine nursing) participated in the educational elements of the program and facilitated the simulation scenario. The sessions were audio- and video-recorded.

Data collection and coding

After completion of each scenario, the T-NOTECHS scale was used to evaluate the overall simulation performance of the trainee team. The T-NOTECHS scale consists of 5 behavior domains that were identified by an expert panel of trauma practitioners based on scoring instruments for the existing teamwork and nontechnical skills: (1) Leadership, (2) Cooperation and Resource Management, (3) Communication and Interaction, (4) Assessment and Decision Making, and (5) Situation Awareness/Coping with Stress. Each domain is scored on a 5-point Likert scale. Each of the faculty facilitators scored the performances individually. The intraclass correlation among the 3 raters was 0.73. T-NOTECHS scores were averaged among the 3 raters for an overall score for each simulation performance. The mean overall T-NOTECHS score was 18.8. Based on the position of their T-NOTECHS scores to the mean overall T-NOTECHS score, the teams were divided into high- ($n = 7$, mean $= 21.02 \pm 1.09$) and low-performing groups ($n = 9$, mean $= 16.98 \pm 1.45$). This was an acceptable division of groups for our analysis, because the average T-NOTECHS behavioral domain scores were approximately 3 for lower-performing teams and 4 for higher-performing teams. Using the scoring guidelines of the instrument, this incremental difference in performance represents teams missing some critical

Table 1
Verbal Response Modes (VRM) classifications.

VRM code	Form	Intention
Disclosure	I, we; first person, declarative	Reveals thoughts, feelings, perceptions, intentions
Advisement	Second person with a verb of permission, imperative	Attempts to guide behavior, suggestions, commands
Edification	He, she, it; third person, declarative	States objective information
Confirmation	We; first person plural	Agreement, disagreement, shared experience or belief
Question	Interrogative; ?	Requests information or guidance
Interpretation	You; second person, verb implies an attribute or ability of the other	Explains or labels the other, judgments or evaluations of behavior
Reflection	Second person, verb implies internal experience	Repetition, restatements, puts other's experience into words
Acknowledgment	Terms of address or salutation	Conveys receipt of communication

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