



Closed loop communication in the trauma bay: identifying opportunities for team performance improvement through a video review analysis

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Received: 8 December 2021 / Accepted: 9 March 2022 / Published online: 12 April 2022

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Abstract

Objectives Communication among trauma team members in the trauma bay is vulnerable to errors, which may impact patient outcomes. We used the previously validated trauma-non-technical skills (T-NOTECHS) tool to identify communication gaps during patient management in the trauma bay and to inform development strategies to improve team performance.

Methods Two reviewers independently assessed non-technical skills of team members through video footage at Sunnybrook Health Sciences Centre. Team performance was measured using T-NOTECHS across five domains using a five-point Likert scale (lower score indicating worse performance): (1) leadership; (2) cooperation and resource management; (3) communication and interaction; (4) assessment and decision making; (5) situation awareness/coping with stress. Secondary outcomes assessed the number of callouts, closed loop communications and parallel conversations.

Results The study included 55 trauma activations. Injury severity score (ISS) was used as a measure of trauma severity. A case with an ISS score ≥ 16 was considered severe. ISS was ≥ 16 in 37% of cases. Communication and interaction scored significantly lower compared to all other domains ($p < 0.0001$). There were significantly more callouts and completed closed loop communications in more severe cases compared to less severe cases ($p = 0.017$ for both). Incomplete closed loop communications and parallel conversations were identified, irrespective of case severity.

Conclusion A lower communication score was identified using T-NOTECHS, attributed to incomplete closed loop communications and parallel conversations. Through video review of trauma team activations, opportunities for improvement in communication can be identified by the T-NOTECHS tool, as well as specifically identifying callouts and closed loop communication. This process may be useful for trauma programs as part of a quality improvement program on communication skills and team performance.

Keywords Nontechnical skills · T-NOTECHS · Team performance · Communication · Closed loop communication · Callout

Résumé

Objectifs La communication entre les membres de l'équipe de traumatologie dans la salle de traumatologie est vulnérable aux erreurs, ce qui peut avoir un impact sur les résultats des patients. Nous avons utilisé l'outil de compétences non techniques en traumatologie (T-NOTECHS) précédemment validé pour identifier les lacunes en matière de communication pendant la prise en charge des patients dans la salle de traumatologie et pour informer les stratégies de développement visant à améliorer les performances de l'équipe.

Méthodes Deux examinateurs ont évalué de manière indépendante les compétences non techniques des membres de l'équipe au moyen de séquences vidéo réalisées au Sunnybrook Health Sciences Centre. La performance de l'équipe a été mesurée à l'aide de la T-NOTECHS dans cinq domaines à l'aide d'une échelle de Likert à cinq points (un score plus bas indiquant

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une performance plus faible) : (1) leadership ; (2) coopération et gestion des ressources ; (3) communication et interaction ; (4) évaluation et prise de décision ; (5) conscience de la situation/ gestion du stress. Les résultats secondaires ont évalué le nombre d'appels, de communications en boucle fermée et de conversations parallèles.

Résultats L'étude a porté sur 55 activations de traumatismes. Le score de gravité des blessures (ISS) a été utilisé comme mesure de la gravité du traumatisme. Un cas présentant un score ISS ≥ 16 était considéré comme grave. L'ISS était ≥ 16 dans 37 % des cas. La communication et l'interaction ont obtenu des scores significativement plus faibles par rapport à tous les autres domaines ($p < 0,0001$). Il y avait significativement plus d'appels et de communications en boucle fermée terminées dans les cas plus graves que dans les cas moins graves ($p = 0.017$ pour les deux). Des communications incomplètes en boucle fermée et des conversations parallèles ont été identifiées, indépendamment de la gravité du cas.

Conclusion Un score de communication plus faible a été identifié en utilisant le T-NOTECHS, attribué à des communications incomplètes en boucle fermée et à des conversations parallèles. Grâce à l'examen vidéo des activations de l'équipe de traumatologie, les possibilités d'amélioration de la communication peuvent être identifiées par l'outil T-NOTECHS, ainsi que l'identification spécifique des appels et de la communication en boucle fermée. Ce processus peut être utile pour les programmes de traumatologie dans le cadre d'un programme d'amélioration de la qualité sur les compétences de communication et la performance de l'équipe.

Clinician's capsule

What is known about the topic?

Communication during patient management within the trauma bay presents opportunities for errors, which may impact team performance and patient outcomes.

What did this study ask?

Can the T-NOTECHS tool be leveraged through video review to identify communication gaps in the trauma bay for improvement purposes?

What did this study find?

A lower communication score was identified using T-NOTECHS, attributed to incomplete closed loop communications and parallel conversations.

Why does this study matter to clinicians?

Evaluating trauma team performance using T-NOTECHS through video review may be useful to trauma programs for quality improvement purposes.

may contribute to excess length of stay and mortality [4]. Quality improvement studies have demonstrated that training designed to improve nontechnical skills (such as teamwork and communication) amongst trauma teams may improve patient metrics, such as time from arrival to CT scanner, to endotracheal intubation, and to the operating room [5].

Evidently, communication amongst trauma team members is critical to patient care. As such, standardized communication techniques such as callouts and closed loop communication play a key role in effective communication in trauma [2]. A callout is defined as when a trauma team member states an important patient finding for other team members to hear clearly. Closed loop communication is a communication technique in which a sender gives a message, and a receiver repeats back the message confirming understanding. The aviation industry has demonstrated that adopting standardized behavior (such as callouts and closed loop communication) and assessment tools is highly effective in improving teamwork and reducing risk [6]. One such assessment system is the non-technical skills (NOTECHS) tool, used to define cognitive and social skills needed to carry out safe operations [7]. The NOTECHS tool has since been modified and implemented within healthcare, such as in the operating room [8–10] and trauma bay [11]. In 2012, Steinmann et al. evaluated the reliability and correlation of the trauma non-technical skills (T-NOTECHS) tool with clinical performance parameters at a level II trauma centre [11]. T-NOTECHS was rapidly adopted after minimal rater training and was used for assessment and debrief. Furthermore, a significant improvement in clinical parameters, as assessed using the T-NOTECHS tool, was reported after teamwork training [11]. This suggests clinical relevance of the tool.

Video review of care provided in the trauma bay has also grown in the past decade and provides an ideal opportunity to apply the T-NOTECHS tool to assess the effectiveness of team communication, and evaluate the use of callouts and

Introduction

It is estimated that approximately 70–80% of healthcare errors are due to poor communication [1]. Communication techniques within the trauma bay are diverse and present opportunity for errors, such as misunderstanding, interruptions, and a hesitation to speak up [2]. Additionally, environmental noise such as equipment noise and side conversations may interrupt the flow of communication [3]. Ultimately, poor teamwork (and inherently poor communication) impacts patient safety and outcomes. Previous literature has suggested that human error in the context of trauma care

closed loop communication [12]. Studies have shown that T-NOTECHS may be used to evaluate nontechnical skills in the trauma bay for quality improvement purposes [11, 13]. Furthermore, video review technology can be applied in a healthcare setting [14]. However, there is limited research to suggest whether trauma team communication can be assessed and improved upon using video review technology in Canada. The purpose of this study was to use the T-NOTECHS tool using video review technology to identify communication gaps during the assessment and management of patients in the trauma bay and to develop strategies for improvement.

Methods

Study design and time period

This was a quality improvement study which followed SQUIRE 2.0 guidelines [15]. Two reviewers (medical student and emergency department nurse) independently assessed non-technical skills of team members during the care of trauma patients through video footage via the Trauma Team Video Review Program. Reviewers were responsible for video footage review and data collection. The study was deemed exempt from full Research Ethics Board review and approval because it was considered a quality improvement study. Furthermore, Research Ethics Board approval for quality improvement initiatives and research projects had already been attained and is part of the Trauma Team Video Review Program policy. Two out of three trauma bays beds were outfitted with audio–video recording equipment including omnidirectional microphones which collected high-quality audio and cameras positioned over each bed. One camera was positioned to provide a bird’s eye view of the bed, while the other was positioned over the head of bed to observe any airway interventions. Data were prospectively collected for all cases by two data collectors over eight consecutive weeks from July 1st, 2020 to August 31st, 2020. This timeline included a 1-week pilot period where eight footages were reviewed allowing for calibration between data reviewers and for refining of data forms.

Study setting and population

This study was conducted at Sunnybrook Health Sciences Centre (SHSC)—a regional trauma centre located within Toronto, Ontario, Canada. SHSC is a leading academic and clinical institution in the country that receives over 2000 trauma patients each year [16]. Trauma cases brought to the trauma bay by emergency medical services for whom a trauma code was activated and required attention from the full trauma team [trauma team leader, a junior

trainee trauma team leader, two nurses, general surgery resident, orthopedics resident, anesthesia resident, respiratory therapist, and an X-ray technologist] were included. For critically injured patients with possible indication of an emergent surgical procedure, the trauma surgeon was also paged as part of the full trauma team. Team members from obstetrics, burns/plastic surgery and neurosurgery were activated ad hoc as necessary.

Outcome measures

Our study assessed for patient demographics, team performance (primary outcome), and secondary characteristics specific to team communication (secondary outcomes), using video recordings within the Trauma Team Video Review Program. The T-NOTECHS tool (Online Resource 1), as described by Steinmann et al. [11], was used to collect primary outcome data. Final data collection metrics included: (1) Patient demographics [age; male sex; Injury Severity Score (ISS) as a measure of trauma severity (ISS ≥ 16 was considered more severe at SHSC, a threshold commonly used to define major trauma [17]); impaired airway, breathing, and/or circulation as determined by the trauma team; mechanism of injury]; (2) Primary outcome: team performance as assessed across the five domains of T-NOTECHS (Leadership; Cooperation and resource management; Communication and interaction; Assessment and decision making; Situation awareness/coping with stress) on a five-point Likert scale; (3) Secondary outcomes (Number of callouts during patient assessment and management; number of times closed loop communication was properly completed; number of times closed loop communication was initiated and not properly completed; number of times parallel conversations occurred; number of times the charting nurse had to ask a team member to repeat themselves; number of times the trauma team leader or other team member had to reinforce the crowd and noise control during patient care).

Data analysis

All statistical tests were conducted using IBM SPSS v24.0 [18] and SAS software v9.4 [19]. Descriptive statistics such as median and interquartile ranges (IQR) were calculated after averaging scores between data collectors. A Wilcoxon signed rank test was performed to assess significance amongst the five T-NOTECHS domains. A Wilcoxon two sample test was conducted to assess significance amongst secondary outcome characteristics. A *p* value of less than 0.05 was considered statistically significant for all calculations.

Results

Participant demographics

Fifty-five trauma activations were included in the study. The ISS was ≥ 16 in 37% of cases. Table 1 demonstrates further

Table 1 Demographic features of 55 patients admitted to trauma bay as full trauma activations

Demographic feature	Value
Age, Median (IQR)	35 (25–61)
Male sex, <i>n</i> (%)	35 (65)
ISS ≥ 16 , <i>n</i> (%)	19 (37)
Airway, Breathing, and/or Circulation Impaired, <i>n</i> (%)	15 (27)
Motor vehicle collision, <i>n</i> (%)	15 (27.8)
Cyclist injury, <i>n</i> (%)	4 (7.4)
Pedestrian injury, <i>n</i> (%)	5 (9.3)
Fall, <i>n</i> (%)	13 (24.1)
Gunshot injury, <i>n</i> (%)	8 (14.8)
Stab injury, <i>n</i> (%)	6 (11.1)
Other mechanism, <i>n</i> (%)	3 (5.5)

Injury Severity Score (ISS) was used as a measure for trauma severity. Less severe cases were defined as ISS < 16. More severe cases were defined as ISS ≥ 16 . One patient with unreported data for patient demographic and mechanism of injury information was missing. Three deceased patients excluded from ISS calculations used to describe secondary outcomes

Table 2 Primary outcomes as measured using the T-NOTECHS scale across five domains for 55 full trauma activations

T-NOTECHS domain	Median (IQR)	<i>p</i> value (relative to Communication and Interaction)
Communication and Interaction	4 (3–4.5)	–
Leadership	4.5 (4.5–5)	< 0.0001
Cooperation and Resource Management	4.5 (4–5)	< 0.0001
Assessment and Decision Making	4.5 (4.5–5)	< 0.0001
Situation Awareness and Coping with Stress	4.5 (4.25–5)	< 0.0001

p values calculated relative to the communication and interaction domain

Table 3 Secondary outcomes collected by both data collectors after reviewing 55 consecutive full trauma activations

Secondary outcome	ISS < 16 Median (IQR)	ISS ≥ 16 Median (IQR)	<i>p</i> value
Number of callout's	4 (2.5–6.5)	6 (5–10)	0.017
Number of times closed-loop communication was properly completed	5 (3–8)	9 (5–12)	0.017
Number of times CLC was initiated and not properly completed	1.5 (0.5–2)	2 (0.5–4)	0.30
Number of times that parallel conversations occurred	2 (1–4)	1 (0.5–3)	0.35
Number of times the charting nurse had to ask a team member to repeat themselves	1 (0.5–2)	1.5 (1–2)	0.33
Number of times the TTL or other team member had to reinforce the crowd and noise control during patient care	0 (0–0.5)	0 (0–0.5)	0.96
Total # of times TTL was asked to repeat themselves	0.5 (0–1)	1.5 (0.5–2)	0.084

demographic characteristics of cases included in our study.

Primary outcome (team performance assessment)

As seen in Table 2, the median/IQR score on the domain of communication and interaction was significantly lower ($p < 0.0001$) compared with each of the other T-NOTECHS domains. However, when comparing each of the other domains amongst themselves, no statistical difference was identified.

The intraclass correlation coefficient (ICC) between the two data collectors was 0.52 for overall T-NOTECHS score.

Secondary outcomes

Table 3 shows there were significantly more callouts and completed closed loop communications in more severe cases compared to less severe cases ($p = 0.017$ for both). No statistical difference was identified in more severe cases for number of incomplete closed loop communications compared to less severe cases [2 (0.5–4) vs. 1.5 (0.5–2), $p = 0.30$]. There was no significant difference between more severe and less severe cases in terms of number of parallel conversations, number of times charting nurses asked a team member to repeat themselves, or number of times the trauma team leader had to conduct noise control.

Discussion

Main findings

Our study identified that communication and interaction scored significantly lower relative to all other domains using the T-NOTECHS tool. The low communication score in our study could be explained by incomplete closed loop communications and parallel conversations amongst trauma team members, which were present in both severe and less severe cases. Closed loop communication was often not completed when communication was not directed towards specific team members. This may be due to the high level of trainee turnover in the trauma bay who often have limited training in crisis resource management, which implements closed loop communication techniques. We also identified that there were significantly more callouts and completed closed loop communication in more severe cases compared to less severe cases. This phenomenon could largely be explained by the increase in verbal communication expected in increasingly complex cases seen in the trauma bay. According to the Yerkes–Dodson law, team performance improves as pressure and arousal increase as cases become more and more severe and challenging, explaining an increase in callouts and completed closed loop communication [20].

Comparison to previous literature

The presence of incomplete closed loop communication (irrespective of case severity) likely contributed to the deficit in overall communication score identified on the T-NOTECHS scale. However, deficits in closed loop communication can also lead to a decrease in overall team performance which may impact patient care. Bowers et al. [21] found that flight crews using closed loop communication were higher performing compared to crews not using closed loop communication. Furthermore, in a study conducted by Abd El-Shafy et al. [22], their team suggests closed loop communication not only prevents medical errors, but also has the potential to increase the speed and efficiency of tasks in the setting of pediatric trauma resuscitation. As such, it is possible that the lack of closed loop communication within the trauma team could have contributed to decreases in task efficiency and consequent team performance.

Parallel conversations were also noted throughout our study which may have impacted team member's communication, including closed loop communication. As seen in the study conducted by Andersen et al. [23], multiple simultaneous orders called out “in the air” led to task overload in resuscitation teams. Härgestam et al. [2] further suggest multiple orders in the context of trauma teams

may have a negative influence on team performance, as reflected by decreased T-NOTECHS communication scores in our study.

Strengths and limitations

Our study effectively demonstrated that video review technology in a Canadian setting can be used to perform a comprehensive performance assessment of trauma team members using the T-NOTECHS tool, which accounts various communication characteristics intrinsic to trauma teams. The introduction of video review technology at our centre provided opportunity to assess team performance remotely during the first wave of the COVID-19 pandemic, avoiding presence of research personnel in the trauma bay to collect data. The ability to replay cases further highlights the advantages of the Trauma Team Video Review Program, as it limited the possibility of recall bias and allowed for details related to case specifics to be reviewed and accurately collected [14]. In addition, we used two reviewers, corroborating with the study performed by Maarseveen et al. [24] which suggested that video analysis of trauma team performance by multiple raters using T-NOTECHS leads to a higher ICC compared to resuscitations observed by live raters, suggesting greater reliability. As such, from a methodological perspective, having two reviewers collect data using video review technology allowed for more robust data collection in our study.

Our study was susceptible to limitations. Firstly, given its observational nature, it is possible that trauma team members unconsciously performed better than usual [i.e. the Hawthorne effect—the notion that participants may alter their behavior when studied] [25]. However, the Trauma Team Video Review program had been instituted at SHSC seven months prior to the initiation of our study. Thus, it is possible this “observer” bias played a smaller role after having become desensitized to video monitoring. Secondly, due to COVID, we implemented different initiatives to protect trauma team members in case patients needed aerosol generating procedures, such as endotracheal intubation, cricothyrotomies, and chest tube insertions. We isolated one of the trauma bay beds with walls, limited the number of providers inside the room (including the charting nurse), which affected communication flow. However, after an initial phase where communication was more challenging, our teams ended up adapting to these initiatives. We believe that, at the time of conducting this study, communication was not importantly affected. Furthermore, despite the professional-grade omnidirectional microphones, some conversations were inaudible due to overlapping conversations and extraneous noise in the environment. As such, during video review, it was unclear if some messages were received and silently being acknowledged, or simply not received and

therefore neglected. The multiple raters allowed for some conversations to be captured that were not noted by one rater but noted by the other. The microphone placed closest to the trauma team leader's position had the highest quality audio for any team member in that area due to proximity to the microphone. Conversations outside of the trauma bay or off-camera were not captured. However, most conversations occurred within proximity of the microphones.

Clinical and research implications

The implementation of the T-NOTECHS tool in the trauma bay allowed for the identification of communication gaps, which our team aims to improve in subsequent plan-do-study-act cycles. On a local scale, we will first introduce a mandatory crisis resource management training video for incoming trainees. Furthermore, we plan to reinforce closed loop communication during the pre-briefing checklist, in situ simulations, and Trauma Team Video Review rounds for all trauma team members. Finally, we will use the Trauma Team Video Review Program and the T-NOTECHS tool to re-assess trauma team communication after these measures have been implemented.

On a broader scale, studies have shown that teamwork and communication in trauma care can be improved through using validated assessment tools such as T-NOTECHS, and subsequently implementing programs such as in situ simulation [26, 27]. In our study, we used the T-NOTECHS tool to assess team communication during trauma care, as it has demonstrated robust reliability and validity to assess non-technical skills and trauma team performance in authentic and simulation settings [28]. Furthermore, our study has shown that video review technology can be leveraged to assess nontechnical skills (such as team communication) using T-NOTECHS. Introducing video review in trauma institutions is not an insurmountable feat, as previous studies have shown important considerations and challenges in implementing such a program [29, 30]. Of course, quality improvement initiatives may be unique and trauma program specific. Therefore, it is important to gather input from front line healthcare professionals involved in trauma team interactions, communicate the vision to key stakeholders, and demonstrate tangible improvements in team communication to create the necessary culture change to implement standardized closed loop communication within trauma care.

Conclusion

Through video review of trauma team activations, opportunities for improvement in communication can be identified by the T-NOTECHS tool, as well as specifically identifying callouts and closed loop communication. This process may be useful for trauma programs as part of a quality improvement process on communication skills.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s43678-022-00295-z>.

Funding None.

Declarations

Conflict of interest The authors declare that there is no conflict of interest.

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