Trauma Surgery & Acute Care Open

Pushing boundaries of video review in trauma: using comprehensive data to improve the safety of trauma care

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Received 11 May 2020
Accepted 15 May 2020

To cite: Nolan B, Hicks CM, Petrosoniak A, *et al*. *Trauma Surg Acute Care Open* 2020;**5**:e000510.

ABSTRACT

Adverse events and lapses in safety are identified after the fact and often discussed through postevent review. These rounds rely on personal recollection, information from patient charts and incident reports that are limited by retrospective data collection. This results in recall bias and inaccurate or insufficient detail related to timeline, incidence and nature adverse events. To better understand the interplay of the complex team and task-based challenges in the trauma bay, we have developed a synchronized data capture and analysis platform called the Trauma Black Box (Surgical Safety Technologies, Toronto). This system continuously acquires audiovisual, patient physiological and environmental data from a sophisticated array of wall-mounted cameras, microphones and sensors. Expert analysts and software-based algorithms then populate a data timeline of case events from start to finish, retaining a handful of anonymized video clippings to supplement the review. These data also provide a consistent and reliable method to track specific quality metrics, such as time to trauma team assembly or time to blood product arrival. Furthermore, data can also be linked to patients' electronic medical records to explore relationships between initial trauma resuscitation and downstream patient-oriented outcomes. A video capture and data analysis system for the trauma bay overcomes the inherent deficiencies in the current standard for evaluating patient care in the trauma bay and offers exciting potential to enhance patient safety through a comprehensive data collection system.

THE CURRENT STATE OF SAFETY IN TRAUMA RESUSCITATION

Traumatic injuries result in almost 5 million deaths worldwide, accounting for 10% of the annual mortality in 2013.[1] Modern trauma systems have significantly reduced mortality for severely injured patients,[2] yet there is significant variability in practice and outcomes.[3] Resuscitation in the trauma bay has been identified as the area where most preventable errors in trauma care occur,[4] yet little is known on the types and frequency of these errors.

Severely injured patients require a rapid and coordinated assessment of injuries while simultaneously performing resuscitative maneuvers. This requires the coordination of multiple overlapping priorities in a dynamic, time-pressured environment. These critical decisions are further confounded by the urgency of potential life-threatening injuries, variability in trauma team members and environmental challenges such as crowd control and noise levels.

Adverse events and lapses in safety are identified after the fact and discussed through postevent review by way of morbidity and mortality (M&M) rounds. These rounds rely on personal recollection, information from patient charts and incident reports that are limited by retrospective data collection. This results in recall bias and inaccurate or insufficient detail related to timeline, incidence and nature adverse events.[5] Accordingly, conclusions drawn from after-action reviews are bounded by the same limitations and may fail to address root causes when implemented. We are proposing to integrate a video capture technology augmented by artificial intelligence to strengthen our analysis of patient safety in the trauma bay.

LEVERAGING TECHNOLOGY TO GET MORE COMPREHENSIVE DATA

To better understand the interplay of the complex team and task-based challenges in the trauma bay, we propose using a synchronized data capture and analysis platform (Trauma Black Box, Surgical Safety Technologies, Toronto). This system continuously acquires audiovisual, patient physiological and environmental data from a sophisticated array of wall-mounted cameras, microphones and sensors that can capture team positioning, movements, noise levels and vital sign data. All data are anonymized, synchronized, encrypted, and stored on a secure server for further analysis. Expert analysts and software-based algorithms then populate a data timeline of case events from start to finish, retaining a handful of anonymized video clippings to supplement the review. The entire trauma resuscitation is mapped out into four distinct phases: prearrival, paramedic handover, acute resuscitation and predeparture. Data points include procedures performed, medications and blood products given, disruptive environmental and organizational factors, nontechnical team skills, safety threats and resilience supports, as well as adverse events and errors. Data are used for limited and specifically stated purposes, kept safe and secure, and only stored for as long as necessary.[6 7] There has been extensive work from some of our group using simulation to study how the trauma team functions in our current space. That work, along with a review of recent M&M

cases, is being used to inform areas to address and focus on with a video review platform.[8]

At our institution, any research using video review is subject to standard institutional research ethics approval processes, whereas data collected for the sole purpose of healthcare quality improvement are subject to a separate process of review and approval.[7]

HOW NOVEL TECHNOLOGY CAN ENHANCE PATIENT SAFETY

A video capture system in the trauma bay overcomes the limitations of after-action reviews by prospectively capturing and analyzing direct observational data of trauma resuscitations. An 'enhanced M&M' process including selective video review paired with detailed black box data analytics will allow for a deeper and more comprehensive understanding of safety hazards. For example, in a case where there was a perceived delay to blood product arrival, our current M&M process involves a review of physician and nursing notes to identify when blood was asked for and then arrived. This documentation may be incorrect or absent and often lacks meaningful details. Video review can record accurate times for these events and identify potentially actionable safety threats (eg, request for blood not acknowledged, no porter in the trauma bay, blood arrived but not announced, level 1 infuser not set-up). Use of an advanced data capture system can also leverage principles of Safety II, whereby safety is defined by the presence of protective individual, team and system factors, not just as the absence of error. Lessons from reviewing 'what went right' can be made more evident when assisted by live data capture and review.[9]

Video review also provides a consistent and reliable method to track specific quality metrics, such as time to trauma team assembly or time to blood product administration. These data can be linked to patients' electronic medical records, allowing us to explore relationships between initial trauma resuscitation and downstream patient-oriented outcomes. We envision this will play a key role in ongoing continuous quality improvement efforts. The use of machine learning algorithms streamlines the data analysis process and creates a more robust data set by offloading the number of tasks required by a human reviewer.

Lastly, the proposed data collection system we are integrating is equipped with a 'flag for review' function. This allows any member of the trauma team to anonymously flag a case for a more thorough review. The reasons for flagging a case may include issues surrounding perceived safety threats, communication breakdown, equipment failure, rare procedures or cases perceived to be good teaching cases. This function provides an opportunity for all members of the trauma team, regardless of profession or level of training, to be able to raise concerns or highlight well-performing teams. We hope this use of the feature will allow us to overcome the current state of physician-identified cases that are reviewed at interdisciplinary rounds and create a more open safety culture where all members of the trauma team have a voice.

IS THERE EVIDENCE FOR THIS TECHNOLOGY?

Currently, there are limited reports from institutions that are using this type of technology, and no reported uses in the trauma bay. Although there are limited data on such a technology in the trauma bay, the Operating Room (OR) Black Box (Surgical Safety Technologies) has proven successful in characterizing adverse events and identifying latent safety threats in the OR.[10] A study of 1 year of data demonstrated auditory distractions occurred a median of 138 times per operative case, with medians of 20 intraoperative errors and eight events identified per case.[10] The authors identified device failure, improper assembly of devices and absent or wrong devices as being the most frequent causes of intraoperative device-related interruptions.[11] A black box system in the OR has been used to detect previously missed or unreported intraoperative needle injuries,[12] and assess team performance in the OR.[13] The technology we are proposing to implement uses a similar data capture and analytic platform.

CHALLENGES AND MITIGATION STRATEGIES

Data privacy and security are chief among the concerns related to any live data capture platform. Questions about how that data will be retained, and when and by whom reviews take place are central to discussions around implementation. Implementing a new video data capture system necessitates input from hospital privacy, legal and quality personnel to ensure data are captured, stored and used appropriately.

One of the largest barriers we are experiencing with implementation of this technology is related to the culture change of having video recordings in the trauma bay. Although in Canada, the use of audio video recordings in the trauma bay is relatively limited, trauma video review is common at level 1 trauma centers in the USA.[14] At our center, the placement of cameras in the trauma bay is unfamiliar and some trauma team members have expressed concerns over being recorded. Buy-in from the trauma team is essential to implementation of this technology and we are actively seeking input from our frontline trauma care providers to better understand the specific facilitators and barriers towards implementation to inform future education and training. We also wish to reach out to patient advocacy groups to ensure the patient perspective is accounted for.

As with all new technologies there are significant costs associated with equipment installation, data management and storage. We were able to minimize the disruptions to our trauma bay by coupling the installation of all required devices with the opening of a new trauma bay. Installation of audiovisual equipment in a functioning trauma bay would likely require some planned downtime.

CONCLUSION

Trauma care has significantly improved during the past few decades; however, there is still room for improvement. A video capture and data analysis system for the trauma bay overcomes the inherent deficiencies in the current standard for evaluating patient care in the trauma bay and offers exciting potential to enhance patient safety through a comprehensive data collection system.

Contributors All authors contributed to the planning, writing and editing of this work. All authors have approved the final version of this article.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests TG is a founder and equity holder of Surgical Safety Technologies. JJ receives funding as a scientific advisor for Surgical Safety Technologies.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; internally peer reviewed.

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