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Hypothermia indices among severely injured trauma patients undergoing urgent surgery: A single-centred retrospective quality review and analysis

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ABSTRACT

Background: Hypothermia (<36 °C) exacerbates trauma-induced coagulopathy and worsens morbidity and mortality among severely injured trauma patients; there is a paucity of published data describing how well trauma centres adhere to standards regarding measurement of temperature, and best practices for preventing and treating hypothermia.
Methods: We completed a retrospective quality audit of all severely injured trauma patients (Injury Severity Score (ISS ≥ 20)) who had urgent surgery at Sunnybrook Health Sciences Centre (SHSC) between 2010 and 2014. Information regarding temperature monitoring was evaluated over the course of the initial resuscitation and admission. Independent risk factors for in-hospital mortality were elucidated through a multivariable regression analysis.
Results: Out of a total of 4492 trauma patients, 495 were severely-injured and went to the operating room (OPR) after being treated in the trauma bay (TB) at SHSC between 2010 and 2014. The majority of the patients were male (n = 384, 77.6%) and had a blunt mechanism of injury (n = 391, 79.0%). The median ISS score was 29 (interquartile range (IQR) 26, 35). Eighty-nine (17.9%) patients died; 26 (5.2%) of these patients died intra-operatively. Less than one fifth of patients (n = 82,16.6%) received a temperature measurement during pre-hospital transport phase. Upon arrival to the TB, almost two-thirds (n = 301, 60.8%) of patients had their temperature recorded and a similar proportion (n = 175, 58.1%) of those patients were hypothermic (<36 °C). In the OPR, close to 80% (n = 389, 78.6%) of patients had their temperature measured on both arrival; almost 60% (n = 223, 57.3%) were hypothermic on arrival. Almost all patients had their temperature measured upon arrival to the ICU or specialized ward (n = 450, 98.3%). Warming initiatives were documented in only 36 (7.3%) patients in the TB, yet documented in almost all patients in OR (n = 464, 93.7%). An increased risk of in-hospital mortality was correlated with not taking a temperature measurement in the TB (Odds Ratio (OR) 2.86 (95% Confidence Interval (CI) [1.64–4.99]) or OPR (OR 4.66 (95% CI [2.50–8.69]).
Conclusions: A majority of severely injured trauma patients are hypothermic well into the perioperative period after initial admission. An absence of having temperature measurement during initial hospitalization is associated with increased in-hospital mortality amongst this patient group. Quality

Abbreviations: ACS, American college of surgeons; BMP, beats per minute; CI, confidence interval; CT, computerized tomography; DCR, damage control resuscitation; EMS, emergency medical services; ICU, intensive care unit; INR, international normalized ratio; IQR, interquartile range; ISS, Injury Severity Score; LOS, length of stay; MVC, motor vehicle collision; OPR, operating room; OR, odds ratio; PACU, post-operative care unit; REB, research ethics board; RTS, Revised Trauma Score; SHSC, Sunnybrook Health Sciences Centre; TAC, trauma association of Canada; TB, trauma bay; TIC, trauma-induced coagulopathy; TQIP, trauma quality improvement program.

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improvement initiatives should aim to strive for ongoing temperature measurement as a key performance indicator and early prevention and treatment of hypothermia during initial resuscitation.
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Background

Hypothermia is commonplace amongst trauma patients. [1–13] It is associated with an inferior prognosis and an increased mortality rate. [2–7] In fact, the combined presence of acidosis (pH < 7.35), hypothermia ($< 36\,^{\circ}C$) and coagulopathy is associated with up to a 90% mortality for patients with severe trauma. [14] Similarly, hypothermia further exacerbates intrinsic trauma-induced coagulopathy (TIC) that occurs secondary to tissue injury. TIC can independently lead to an increase in the transfusion rate and lead to massive transfusion. [15,16] Transfusion, although can be life-saving, has been deemed an independent predictor of mortality, intensive care unit (ICU) admission and length of stay (LOS) and hospital LOS in this patient population. [17–19] Similarly, transfusion has been shown to increase nosocomial infections, including ventilator-associated pneumonia rates amongst trauma patients. [19–21]

Data suggests that reducing the severity and duration of hypothermia amongst severely injured patients increases the probability of successful resuscitation and survival. [22] As such, the idea of damage control resuscitation (DCR) was formulated partially in response to the recognition that early management of acidosis, coagulopathy and hypothermia, also known as the "lethal triad", may improve such outcomes. First described in a surgical context almost thirty years ago, this management paradigm represented a radical shift compared to the well entrenched strategy of early definitive management of injuries. [23] Currently, DCR is considered the standard of care in trauma patients with severe injury and has been shown to improve various patient outcomes. [23,24] The early diagnosis and management of hypothermia has been repeatedly described as an essential tenant to this treatment strategy. [4,24] Yet, there is limited data on the efficacy of hypothermia management in severe trauma settings – and anecdotal evidence to support that this management may be suboptimally performed. [16]

We sought to determine the incidence of hypothermia at different time points during the initial resuscitation and treatment of a large cohort of injured trauma patients requiring emergency surgery. Specifically, this study aimed to characterize the rates of hypothermia among trauma patients from the pre-hospital setting, through the resuscitative phase in the emergency department and through the operative phase, until the patient is admitted to the intensive care unit and/or ward bed. We also aimed to determine if a lack of measurement of temperature in itself at two-different time points in the initial admission process is associated with increased in-hospital mortality. The primary objective of this work was to determine whether there was opportunity for improvement in the identification and management of hypothermia at our trauma centre.

Methods

Overview

We performed a retrospective cohort quality audit of how often temperature was measured during the course of the initial evaluation and treatment of severely injured trauma patients requiring emergency surgery, adhering to Strengthening The Reporting of Observational Studies in Epidemiology (STROBE) guidelines. As well, we described the incidence of hypothermia amongst those patients who had their temperature measured, and described the management strategies employed to prevent and treat hypothermia amongst these patients at a large level 1 trauma center between July 2010 and June 2014. This quality initiative project was reviewed by the Research Ethics Board (REB) of SHSC and was deemed to be a quality improvement project not requiring a full REB review.

Subjects and setting

Sunnybrook Health Sciences Centre (SHSC) is a Canadian Level I trauma center serving a population of over 6 million. This center maintains a trauma registry consistent with the National Trauma Data Standard and participates in the American College of Surgeons (ACS) Trauma Quality Improvement Program (TQIP). Using this registry, we identified consecutive adult (> 18 years of age) patients who were treated in our trauma bay (TB) with an Injury Severity Score (ISS) score ≥ 20 (severely-injured) who required emergent surgery between the dates of 1 June 2010 and June 30, 2014. Preliminary analysis of our data suggested there were no deaths associated with those trauma patients requiring emergency surgery with an ISS <20, therefore further excluded patients from the analysis that had threshold ISS score <20.

Emergency surgical intervention was defined as any surgical procedure that required general anesthetic care, where the patient was transferred directly from the trauma bay/emergency department to the operating room (OPR) and within 6 h of being discharged from the trauma bay/emergency department. Patients were eligible for inclusion in this study, even if other diagnostic interventions were performed between admission and the surgical intervention, including angiography and computerized tomography (CT) scanning. Patients who required an operation at a later time for a relatively non-urgent injury were excluded. Major burns patients are managed through a separate care pathway and were also excluded from this cohort.

Data collection and variables

We categorized trauma care into distinct intervals: pre-hospital, TB, OPR, and final post-operative disposition phase (defined as admission to the post-operative care unit (PACU, ICU or ward). Demographic characteristics were extracted from the trauma registry. Patient and electronic charts were reviewed systematically by at least two research assistants following a predefined data extraction plan. Pre-hospital data was collected from chart abstraction of the ambulance call record, which is appended to the hospital medical record. We specifically documented pre-hospital transport time, circumstances of the incident, initial temperature, and environmental conditions.

Unless pre-hospital emergency medical services (EMS) recorded the specific time of injury, the time of injury was recorded by the trauma registry as the EMS call time rounded back to the nearest five minutes. We obtained the following data from the trauma registry: ISS, initial laboratory values taken upon admission into the TB, and initial vital signs upon entering the TB. We also collected temperature readings at the beginning and end of each phase, with the exception of the final post-operative disposition, where only the initial temperature reading was collected. We also collected information on the number and types of warming initiatives that were employed on the patient

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