CRITICAL CARE

REVIEW

Year in review 2012: *Critical Care* - out-of-hospital cardiac arrest and trauma

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Abstract

In 2012 *Critical Care* published many articles pertaining to the resuscitation of out-of-hospital cardiac arrest and trauma. In this review, we summarize several of these articles, including those regarding advances in resuscitation techniques and methods. We examine articles pertaining to prehospital endotracheal intubation, the use of specialized devices for cardiopulmonary resuscitation and policies regarding transport destinations for both cardiac arrest and trauma patients. Articles on the predictors of outcome in both pediatric and adult populations are evaluated, including articles on the effects of obesity on survival from hemorrhage and pediatric outcomes from traumatic cardiac arrest. The effects of the type and volume of resuscitation fluids for both adult and pediatric patients are discussed, as are the factors contributing to hypothermia in trauma patients.

Introduction

Many articles pertaining to resuscitation for out-of-hospital cardiac arrest (OHCA) and trauma were published in 2012. Several articles featured in *Critical Care* addressed various aspects of the prehospital and emergency department (ED) management of OHCA, including success rates for endotracheal intubation (ETI), the use of specialized devices and hospital destination policies. Likewise, the management of traumatic injuries was examined in articles evaluating the mode of transport for trauma, outcome predictors and the effects of volume resuscitation in adult and pediatric trauma populations. The articles also evaluated pediatric survival from traumatic cardiac arrest, the effects of obesity on survival and various factors related to the development of post-traumatic hypothermia. In this discussion, we

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review and annotate the findings of these studies that contributed to our evolving understanding of OHCA and trauma resuscitation in 2012.

Success rate of field endotracheal intubation depends on provider type

Previous studies have confirmed that ETI can prevent hypoxia and diminish the mortality rates in resuscitated patients with airway compromise [1,2]. Nevertheless, incorrectly performed ETI carries high morbidity [3]. The failure rates for ETI placement by nonphysician providers may be as much as 15% higher [4,5] than the failure rates documented for physicians in the prehospital and hospital settings [6]. Among several related factors, one explanation for this discrepancy may be the greater availability and use of rapid sequence induction (RSI) intubation techniques by physicians. The use of RSI can facilitate ETI and thus may decrease the adverse outcomes associated with difficult airway management [7].

In a 2012 article in *Critical Care*, Lossius and colleagues completed a meta-analysis to review physician versus nonphysician ETI success rates in the prehospital setting [8]. Data were extracted from 33 original studies comparing success rate by type of provider with respect to the availability of RSI medications, analgesics or anesthetics. The analysis revealed that the median ETI success rates for all intubation attempts were significantly higher for physicians (99%, 95% CI = 97 to 100%) than nonphysicians (85%, 95% CI = 49 to 99%). Nonphysician ETI was improved with RSI, with a median success rate of 97% for RSI versus 68% with no drug use and 81% with analgesia only. When comparing physician with nonphysician ETI success rates in the setting of RSI drug use only, there was a significant positive outcome with physician-performed procedures (99% vs. 96%, $P <0.05$) [8]. This study also suggests that this benefit of RSI exists in prehospital care as well as in the ED setting regardless of provider type.

Although it appears on the surface that physician performance of ETI both with and without RSI was

superior, there are other factors to consider. For example, the physician cohort may be a group that routinely performs RSI, as compared with nonphysicians who do not perform this skill as frequently. Infrequent performance can be confounded by variables such as deployment strategies for the prehospital care system and the type of initial training provided to those performing the ETI [9,10]. Success rates for nonphysicians can be exceptionally high, but only according to the nature of the emergency medical services (EMS) system and other factors such as initial training and intensive medical director oversight of the providers [9]. However, for the typical EMS system in which many of the frequency and oversight issues are less optimal, airway management in the prehospital arena remains a controversial topic, with the optimal management algorithm yet to be clarified. The higher failure rate among nonphysicians demonstrated in Lossius and colleagues' study suggests that alternative ventilatory and backup airway techniques might be more appropriate, although further prospective research is necessary before practice changes can be implemented.

Specialized devices for resuscitation in out-of-hospital cardiac arrest
Comparison of monophasic and biphasic defibrillators in a pediatric population
Standard resuscitation algorithms recommend defibrillation attempts for the management of unstable ventricular tachycardia (VT) or ventricular fibrillation (VF) in children [11,12]. However, data are lacking in terms of how best to deliver the defibrillation current in the pediatric population. Previous studies have demonstrated the utility of biphasic defibrillators in adult OHCA [13-19], but complementary data for the pediatric population remain limited. A 2012 study published by Tanabe and colleagues in *Critical Care* was therefore an important contribution, in that the researchers specifically evaluated the outcomes of pediatric OHCA patients who received defibrillation attempts with either monophasic or biphasic defibrillators [20].

Using the prospectively collected information secured in a nationwide Utstein-style registry of all OHCA patients in Japan, the investigators sought to identify the outcomes of pediatric patients (1 to 17 years of age) who were defibrillated between 2005 and 2009. A unique aspect of this study was that all EMS providers in this system use only epinephrine and defibrillation as therapies for OHCA. Also, defibrillators are used in the automated external defibrillation mode and they deliver standard adult doses of electricity with pediatric attenuation pads for children, ages 1 through 8. The primary outcome was 1-month survival with good neurologic outcome as defined by cerebral performance category (CPC) score of 1 or 2.

Of a total 5,628 pediatric OHCA patients enrolled during the multiyear study period, 430 receiving defibrillation attempts for VF or VT were included for analysis – 303 (70%) with biphasic attempts and 127 (30%) with monophasic attempts. The overall rate of return of spontaneous circulation before hospital arrival for those receiving biphasic defibrillation attempts was 27.4% versus 24.4% for those receiving monophasic attempts (not significant). Survival rates at 1 month were 32.3% and 35.6%. Of 303 patients receiving biphasic defibrillation, 74 (24.4%) survived with good neurologic outcomes at 1 month. This is in contrast to 22 of 127 patients (17.5%) receiving monophasic defibrillation attempts. However, despite the superficial trend in improved neurological outcomes, none of these primary outcome measures could be demonstrated to be statistically significant.

These results mirror previous adult literature showing no difference in long-term outcomes between monophasic and biphasic defibrillation for OHCA. Nevertheless, as is the case in such investigations, particularly those involving the pediatric OHCA population, a major limitation of the study was a lack of statistical power given the limited number of subjects. Also, the data evaluated did not directly address the termination of the ventricular arrhythmia by the defibrillation attempts. As such, this study did not definitively demonstrate which type of defibrillator was more effective at terminating the arrhythmia nor did it demonstrate any difference in outcome. However, this lack of significant difference may simply be due to a type II statistical error and such a comparison should be reconsidered in future studies. Nevertheless, as the first study of its kind, this study confirms the efficacy of biphasic defibrillation in the resuscitation of pediatric patients with OHCA due to VF or VT.

Use of a load distributing band compression device for out-of-hospital cardiac arrest after hospital arrival
In another article appearing in *Critical Care* in 2012, Hock Ong and colleagues investigated a load-distributing band (LDB) device as a substitute for manual chest compressions [21]. There is a substantial amount of literature demonstrating improved survival with improved quality of chest compressions, including higher compression fractions [22], markedly limited hands-off time [23,24] and maintenance of a recommended rate of 100 to 120 compressions/minute [25,26]. The LDB device was developed in an attempt to provide a more evenly distributed force over the entire chest as well as improved compressive forces and a consistent compression rate and depth while also decreasing provider fatigue. Despite these theoretical

benefits, previous studies of LDB devices have had conflicting results [27,28]. Although these previous studies have investigated the use of LDB devices for OHCA in the out-of-hospital setting, they have not specifically examined their use after arrival in the ED.

Hock Ong and colleagues evaluated the use of the AutoPulse™ LDB device (Revivant Corporation, Sunnyvale, CA, USA) in patients with nontraumatic OHCA transported to two EDs in Singapore [21]. The primary endpoint was survival to hospital discharge and analysis was intention to treat. The study population also included those cases of cardiac arrest that occurred after arrival in the ED. This EMS system does not allow for termination of resuscitation in the field and therefore all OHCA patients were transported to hospital. Prior to 2007, the standard of care was manual chest compressions for patients treated in the ED. The change to LDB compressions occurred in 2007. A before and after comparison was made and a total of 1,011 patients were enrolled, with 459 patients in the manual compression phase and 552 patients in the LDB compression phase. During the LDB phase, a majority (82%) of the patients had the LDB device applied.

The authors found a significant advantage for the LDB cohort in terms of survival to discharge (odds ratio (OR) = 2.55, 95% CI = 1.00 to 6.47), survival to admission (OR = 1.49, 95% CI = 1.07 to 2.09) and CPC at discharge (OR = 8.7, 95% CI 1.1 to 71.6 for CPC 1 or 2). However, there was a significantly lower frequency of VF and VT cases among patients in the manual compression group. Because VF and VT presentations are associated with better outcomes [29], this may have contributed to the increased survival rates in the LDB group. This may also indicate improvements in the systems of care or other factors that changed between study phases, typical concerns when historical controls are employed. The blending of prehospital and ED cases also creates methodological issues. Another confounding concern is that the study was funded by the device manufacturer and the lead author holds patents filed for this technology.

While this study has methodological flaws, the findings may also indicate that this is a way to improve outcomes, especially if the quality of cardiopulmonary resuscitation (CPR) performed in the ED is less than optimal. Prior studies in the out-of-hospital setting employing this device have indicated improvement in outcomes when manual CPR is suboptimal but no significant difference with high-quality manual CPR. In those studies, chest compressions were most often performed in systems with firefighter crews who are comprised of very strong personnel capable of robust compressions as well as enough depth of staffing that they can routinely take turns to avoid fatigue. It is not clear who was performing ED compressions in the current study. If less robust

compressions with fewer substitute compressors were involved, the LDB could prove advantageous. In the end, the current evidence neither supports nor refutes the utility of LDB devices [30]. Once again, this study calls attention to a better understanding and better study design regarding LDB use for OHCA.

Transport choices for out-of-hospital cardiac arrest and trauma
Consequences of choice of hospital in out-of-hospital cardiac arrest

Depending on definitions, survival to hospital discharge after OHCA ranges from 1 to 31% [31-34]. Studies have shown survival benefit with the use of induced hypothermia (IH) following OHCA [35,36] as well as percutaneous cardiac intervention (PCI) [37] or the combination of both [38]. Previous literature has also shown survival benefit after OHCA with admission to hospitals with PCI capabilities [39], but data are lacking in terms of independently evaluating the benefit of IH or PCI.

In a 2012 *Critical Care* article, Wnent and colleagues performed a retrospective analysis of destination hospital capabilities and interventions performed for patients who had OHCA [40]. Of 889 resuscitation attempts evaluated, 360 (40.5%) achieved return of spontaneous circulation. Those patients were then categorized based on the PCI capability of the initial hospital admission and interventions including IH and PCI, with a primary endpoint of discharge with good neurological outcome defined as CPC 1 or 2 [40].

The analysis demonstrated that patients who received PCI (OR = 4.57, 95% CI = 2.20 to 9.50) or IH (OR = 5.31, 95% CI = 1.91 to 14.77) had improved survival to hospital discharge. Interestingly, this survival benefit with good neurological outcome held for any patient admitted to a PCI-capable hospital regardless of any intervention (OR = 3.14, 95% CI = 1.51 to 6.56). However, overall compliance with IH and PCI guidelines in this cohort was not frequent.

While Wnent and colleagues demonstrated that PCI and IH protocols do improve outcomes, admission to a PCI-capable center actually improves outcomes independent of intervention. These interventions may therefore be surrogate variables for other factors, be they higher skills or resources in such centers, selection bias in terms of patients transported or some other sublime element. Although the reasons for this finding warrant further scrutiny, they also give EMS providers the opportunity to re-evaluate guidelines for choice of destination in OHCA.

Helicopter transport to a trauma center to improve outcome after severe blunt trauma

Access to a trauma center has been shown to reduce mortality for trauma patients [41], and many factors

affect this access including the modality of transport [42]. Studies have also shown that trauma patients transported by helicopter can have greater survival compared with transport by ground, even despite longer transport times and more severe injuries [43-45].

Last year in *Critical Care*, Desmettre and colleagues sought to study the impact of mode of transport on mortality in blunt trauma patients transported directly from scene to a university hospital using secondary analysis of data from the multicenter French Intensive Care Research for Severe Trauma cohort study [46]. The authors evaluated data from 1,958 patients, 74% of whom were transported by ground and 26% by helicopter. All patients received prehospital care from a physician-led emergency response team. The primary endpoint was survival to discharge as determined through a multivariate analysis of 1,817 patients evaluated in terms of mode of transport and whether or not the patient died before discharge from the ICU during the first 30 days after injury.

The authors found that patients transported by helicopter had no reduction in crude mortality before hospital discharge. However, after adjustment for initial patient status, helicopter-transported patients showed a significant reduction in mortality (OR = 0.68, 95% CI = 0.47 to 0.98, *P* <0.05) even after adjustment for injury severity. The helicopter-transported group did have increased time to admission and received more aggressive prehospital interventions, but the time to admission had no effect on mortality.

In conclusion, this study by Desmettre and colleagues demonstrates a survival benefit with helicopter transport for blunt trauma patients despite longer transport times. However, this benefit may rely at least in part on the aggressive administration of prehospital interventions by the air medical team, countering previous research suggesting prehospital intervention for trauma has no mortality benefit [47]. These results provide further support to the utility of using helicopter transport for critical trauma patients. They also prompt the need for further investigation into which subsets of patients may benefit most from this transport modality, as well as the effect of aggressive prehospital interventions in critically injured trauma patients.

Hemorrhage and volume replacement in hypovolemic shock following trauma
Comparison of prediction tools for massive transfusion in severe trauma
As many as one in four patients presenting to the ED after major trauma will have a unique coagulopathy [48]. Early activation of massive transfusion (MT) protocols with balanced ratios of blood products and coagulation factors has been shown to improve outcomes in patients

with traumatic hemorrhage [49-51]. However, identification of those patients who will benefit from early transfusion remains a challenge.

Although early screening for the acute coagulopathy of trauma should be an important step in patient management [48], the results of standard coagulation profiles including the International Normalized Ratio and the activated partial thromboplastin time are often delayed or inaccurate [52]. Newer studies including rotational thromboelastometry [52] and rapid thromboelastography [53] show promise, but are costly and currently have limited availability. In a 2012 *Critical Care* article, Brockamp and colleagues compared six scoring systems for the identification of patients requiring MT in an attempt to better delineate those patients at the highest risk for requiring MT [54].

The authors utilized the multicenter prospective TraumaRegister DGU® to identify all patients receiving ≥10 units of packed red blood cells between ED presentation and arrival in the ICU. Patients were included only if records included all variables necessary to calculate six MT prediction scores and the patient survived to ICU admission. Of the total of 56,573 patients entered into the registry between 2002 and 2010, 5,147 (9%) met the inclusion criteria. Of these patients, 95% had experienced blunt trauma with an overall MT rate of 5.6%.

The tools evaluated were the trauma-associated severe hemorrhage (TASH) score [55], the Prince of Wales Hospital/Rainer (PWH) score [56], the Vandromme score [57], the assessment of blood consumption score [58], the Schreiber score [59], and the Larson score [60].

The TASH score was found to have the highest accuracy (area under the curve = 0.889, 95% CI = 0.871 to 0.907), followed by the PWH score (area under the curve = 0.860, 95% CI = 0.839 to 0.881). The assessment of blood consumption had the lowest accuracy (area under the curve = 0.763, 95% CI = 0.732 to 0.794). The highest sensitivity for predicting MT was attained using the Schreiber score (85.8%), but this score also had the lowest specificity (61.7%). The TASH and PWH scores still had sensitivities of 84.4% and 80.6%, respectively, but also had specificities of 78.4% and 77.7%, respectively. The TASH score and the PWH were found to be significantly better than the other scores (*P* = 0.0413) in terms of predicting MT.

When examining these results, one must note that both the TASH and PWH scores, while having the best accuracy, are also the most complicated to use [55,56]. Both of the military derived scores (Schreiber and Larson) had reasonable sensitivity but they may not be applicable to a civilian cohort with 95% blunt trauma. Importantly, the best performing TASH score was initially derived and validated using the same registry data as the current study [55]. One should also note that 91%

of the dataset was excluded, including all patients receiving hemostatic factors and antifibrinolytics.

Despite these limitations, this study by Brockamp and colleagues was an important exercise because it attempted to directly validate and compare multiple scoring systems for the prediction of patients requiring MT. Future studies might integrate rotational thromboelastometry, rapid thromboelastography and antifibrinolytics into prediction algorithms, with an ultimate goal of deriving a quick, simple and accurate method of determining which patients will benefit from early MT. However, all of the described scoring methods should be used with caution and resuscitative efforts should be tailored to each patient's mechanism of injury and physiologic needs until more accurate prediction tools are available.

Impact of obesity on survival from trauma

Obesity, defined as body mass index (BMI) ≥30 [61], carries a higher risk of organ dysfunction, hospital stay and ICU days following trauma [62,63]. The direct relationship between obesity and mortality, however, is less clear [63-66]. Nelson and colleagues published a study in *Critical Care* in 2012 evaluating factors associated with the outcomes of obese trauma patients treated at a single Swiss trauma center from 1996 to 2009 [67]. Using a retrospective registry cohort, they identified 1,084 adult patients with Injury Severity Score ≥16. The authors stratified this cohort into four groups: underweight (BMI <18.5), normal weight (BMI = 18.5 to 24.5), overweight (BMI = 25 to 29.9) and obese/morbidly obese (BMI ≥30), with 2.8%, 55.6%, 33.3% and 8.3% of the cohort in each group, respectively.

The authors found the mortality rate in obese patients to be 24.4%, as compared with 16.6% in the normal group, although this difference was not statistically significant. Logistic regression did, however, show obesity to be an independent predictor of mortality (OR = 2.52, 95% CI = 1.3 to 4.9). Admission hypotension was most prevalent in the obese cohort, but again this difference was not statistically significant. Obese patients received more total volume of resuscitation fluid, but when corrected for BMI they received relatively less fluid resuscitation per kilogram of body weight. A larger number of the more obese patients died of hemorrhagic shock as compared with normal weight patients, and this was a significant difference (6.7% vs. 1.7%, P = 0.024).

This significantly increased risk of death from hemorrhage in the obese cohort is an interesting finding and possibly a result of relative under-resuscitation, which has been described previously [68]. However, whether it is appropriate to correct for body weight when providing resuscitation is unclear, and resuscitative efforts should be tailored to the patient's hemodynamic physiology. Further, these results should be interpreted

cautiously as the obese cohort in this study was a relatively small cohort and the mortality rate was also relatively low. Furthermore, the majority of trauma overall in the cohort was due to blunt injury (>90%) and this may not be generalizable to all trauma centers or applicable to all trauma cases. While the work by Nelson and colleagues does support previous studies suggesting increased mortality in obese patients [63,64,69], this trend is not consistent throughout the literature [62,65,66] and additional well-designed studies are needed to determine the actual effect of obesity on mortality in trauma.

Survival and neurologic outcomes following pediatric trauma

Better than expected survival following post-traumatic arrest in pediatric patients

Reported survival rates for out-of-hospital post-traumatic cardiac arrest (OHPTCA) are uniformly poor [70-72]. Guidelines have been published regarding when to withhold resuscitative efforts following OHPTCA [73], yet withholding cardiopulmonary resuscitation, particularly in children, is often a difficult decision. In a 2012 *Critical Care* article, Zwingmann and colleagues sought to evaluate and compare outcomes following OHPTCA in both adult and pediatric populations [74].

The authors performed a meta-analysis of literature published from 1964 to 2011, including a total of 47 studies with 6,634 total patients for analysis. Of these, 5,391 patients were adult or mixed populations and 1,243 patients were identifiable as ≤8 years of age. Overall mortality in the adult/mixed group was 96.7%, and was 86.4% in the pediatric group (P <0.001). More specifically, mortality rates in blunt trauma were 96.7% and 73.8%, respectively (P <0.001), while penetrating mortality rates remained similar at 96.4% and 97.8%, respectively. The authors also found what appeared to be differential mortality rates between European and US studies, with mortality rates of 94.1% in the European studies and 96.1% in the US studies (P = 0.0013).

As is the problem with such methodologies, the meta-analysis by Zwingmann and colleagues is based on generally low-quality evidence and analyzes a small set of clinical parameters. However, the findings do summarize the previous literature demonstrating low overall survival rates from OHPTCA. European studies demonstrated a higher survival rate than the US counterpart, possibly a result of the European model often providing prehospital care at the scene by highly trained physicians. While no difference was found in the adult population between penetrating and blunt trauma, a significant survival difference was noted in pediatric patients with blunt OHPTCA. Previous literature has also demonstrated survival benefit in children [72], particularly for blunt trauma [71]. Therefore, as an important conclusion from this publication,

this population warrants further scrutiny and has implications for current guidelines on terminating resuscitation efforts for OHPTCA.

Low-volume resuscitation may be beneficial in pediatric trauma patients

Traumatic injury is a leading cause of morbidity and mortality in children worldwide [75] and hemorrhagic shock from blood loss plays a significant role in poor outcomes [76]. Although it seems intuitive to rapidly replace lost volume, studies in adult populations have shown coagulopathy and increased mortality in patients receiving large-volume crystalloid resuscitation [77-80]. Some guidelines still suggest aggressive hospital fluid replacement in pediatric patients with significant injuries and presumed blood loss [81]. However, there is growing evidence that suggests poor outcomes with this approach [82].

In a 2012 article published in *Critical Care*, Hussmann and colleagues explored the consequences of fluid resuscitation on pediatric trauma patients through a retrospective analysis of data collected in the German TraumaRegister DGU® [83]. Thirty-one severely injured patients <15 years old were selected and demographically matched from each of two major groups based on the reception of low-volume resuscitation (0 to 500 ml) or high-volume resuscitation (>500 ml) with crystalloid and colloid fluids. The authors found an association between high-volume resuscitation and increased mortality (low-volume resuscitation, 19.4%; high-volume resuscitation, 25.8%), although these results were not statistically significant. Increased need for more blood transfusions (low-volume resuscitation, 9.7%; high-volume resuscitation, 25.8%), multiple organ failure rates (low-volume resuscitation, 36.7%; high-volume resuscitation, 41.4%), and rescue time (low-volume resuscitation, 62 minutes; high-volume resuscitation, 71.5 minutes) for high-volume transfusion were also nonsignificant.

This study by Hussmann and colleagues was hampered by the small number of patients evaluated and the resulting lack of statistical power. However, the results did suggest a trend toward increased mortality and coagulopathy with large-volume resuscitation in pediatric trauma patients, mirroring recent adult data [78-80]. Based on these results, more formalized studies with adequate power should be performed to determine specific guidelines in pediatric resuscitation in the setting of trauma.

Factors predicting hypothermia in trauma

Hypothermia in trauma is associated with poorer prognosis and increased mortality [84,85]. Causes of hypothermia are multifactorial and probably contribute to the acute coagulopathy of trauma [86]. Injury affecting thermoregulation may result from shock, severe head injury [85] and iatrogenic factors, including the administration of resuscitation fluids [87]. Further, environmental factors such as cold exposure may also contribute. In a 2012 study by Lapostolle and colleagues published in *Critical Care*, the authors attempt to quantify the contribution of various factors to the development of hypothermia in trauma patients receiving prehospital care [88].

Lapostolle and colleagues undertook a prospective observational study in eight French hospital-based EMS systems from January 2004 through November 2007 [88]. All trauma patients ≥18 years of age who received prehospital care and were transported to hospital were included. The primary endpoint was hypothermia on arrival, defined as body temperature <35°C measured tympanically. Of 448 total patients included, 14% were hypothermic upon arrival at the hospital. Two of the most significant factors associated with hypothermia were the Revised Trauma Score (OR = 1.68, 95% CI = 1.29 to 2.20) and ETI (OR = 4.23, 95% CI = 1.61 to 11.02), with 50% of the hypothermic group intubated as compared with 7% of euthermic patients. However, these markers may be surrogate variables for a sicker population with increased baseline mortality risk.

Cooler air temperature (11.5°C vs. 17.9°C, *P* <0.0001) and ground temperature (11.4°C vs. 18.1°C, *P* <0.0001) were associated with more hypothermia, as were patients found on the ground (80% vs. 56%, *P* <0.01) or found in wet conditions (22% vs. 9%, *P* <0.01). Colder temperatures of resuscitation fluids (19.5°C vs. 22.0°C, *P* <0.0001) and longer scene times (65 minutes vs. 60 minutes, *P* <0.01) were also associated with more cases of hypothermia.

As demonstrated by Lapostolle and colleagues in this paper, the various factors contributing to hypothermia in trauma patients are multifactorial. This work provides some enhanced guidance for prevention, particularly in terms of diminishing risk in the prehospital arena. These include efforts to decrease the scene time, protecting patients from environmental exposures, and keeping patients clothed when possible. Resuscitation fluids should be temperature controlled, as should the internal temperature of the ambulance unit.

Conclusions

In articles published in *Critical Care* in 2012, prehospital resuscitation from trauma and cardiac arrest were of particular interest. Prehospital ETI may have improved success rates when utilizing RSI intubation, particularly in experienced providers. The use of a LDB device for CPR may have some benefit in the prehospital arena and this benefit may extend to the ED setting, although further high-quality studies are needed. With regard to patient transport decisions, transport of patients resuscitated from OHCA to a PCI-capable center may be beneficial. Additionally, air

medical transport of blunt trauma patients was shown to lead to improved outcomes, although this may be due in part to aggressive prehospital interventions.

The need for MT was evaluated using several prediction models. Of these models, the TASH and PWH scores performed the best, although all models are limited and future models using more advanced parameters need to be developed. Obese patients were shown to have increased mortality from hemorrhage, possibly a result of under-resuscitation. However, there is still much debate around this topic and further well-designed evaluations are needed. Factors surrounding the etiology of hypothermia in trauma patients were also examined and found to be multifactorial.

In the pediatric population, biphasic defibrillators have again been demonstrated to have similar outcome profiles to monophasic defibrillators. In line with previous studies conducted in adult populations, large-volume resuscitation may be detrimental in the pediatric population. Additionally, a large meta-analysis demonstrated better than expected survival from OHPTCA, suggesting the need for a re-evaluation of current guidelines for field termination of resuscitative efforts in this population.

Abbreviations
BMI: Body mass index; CPC: Cerebral performance category; CPR: Cardiopulmonary resuscitation; ED: Emergency department; EMS: Emergency medical services; ETI: Endotracheal intubation; IH: Induced hypothermia; LDB: Load-distributing band; MT: Massive transfusion; OHCA: Out-of-hospital cardiac arrest; OHPTCA: Out-of-hospital post-traumatic cardiac arrest; OR: Odds ratio; PCI: Percutaneous cardiac intervention; PWH: Prince of Wales Hospital/Rainer; RSI: Rapid sequence induction; TASH: Trauma-associated severe hemorrhage; VF: Ventricular fibrillation; VT: Ventricular tachycardia.

Competing interests
The authors declare that they have no competing interests.

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