1. Introduction

In recent years, the annual number of hours of critical care provided in emergency departments (EDs) has increased dramatically [1]. In addition to increases in the number of ED patients admitted to an intensive care unit (ICU), it is clear that critically ill patients are staying longer in the ED. In fact, more than 33% of critically ill patients now remain in the ED for more than 6 hours [1]. Emergency physicians (EPs) are the first clinicians to resuscitate and manage critically ill patients, so it is imperative for them to be knowledgeable regarding recent advances in critical care. This article reviews important articles published in 2014, pertaining to the care of critically ill patients in the ED. The following topics are covered: cardiac arrest, post–cardiac arrest, sepsis, pulmonary embolism (PE), ultrasound, and acute ischemic stroke (AIS).

2. Cardiac arrest


Cardiopulmonary resuscitation (CPR) is a critical lifesaving intervention in patients with out-of-hospital cardiac arrest (OHCA). Outcomes are improved when chest compressions are delivered at an adequate rate and adequate depth with minimal interruption. Current guidelines from the American Heart Association (AHA) recommend a chest compression rate of 100 per minute and a depth of 50 mm or more [2]. Importantly, the recommendation for chest compression depth is derived from scant human data. In addition, guidelines do not recommend an upper limit on chest compression depth. The current study sought to determine the optimal chest compression depth in a large population of adult patients with OHCA.

Stiell et al analyzed data from patients enrolled in the recent Resuscitation Outcomes Consortium (ROC) Prehospital Resuscitation Impedance Valve and Early Versus Delayed Analysis (PRIMED) trial and the ROC Epistry–Cardiac Arrest database. The study focused on all adult patients from the ROC PRIMED trial and from 95 emergency medical service agencies within the ROC network, who sustained nontraumatic OHCA, who were treated with defibrillation or compressions by emergency medical service providers, and for whom electronic compression depth data were available. Chest compression depth was measured and calculated using proprietary software from select automated external defibrillators. The primary outcome of the study was survival to hospital discharge, with secondary outcomes of return of spontaneous circulation (ROSC) and survival to the next calendar day.

A total of 9136 patients were included in the study. Overall, 31.3% achieved ROSC, 22.8% survived to the next calendar day, and 7.3% survived to hospital discharge. The mean compression depth was 41.9 mm, significantly less than the current AHA-recommended depth of 50 mm [1]. In fact, 36% of patients had a mean compression depth less than 38 mm. Survival to hospital discharge peaked at a compression depth of 45.6 mm, with the highest survival rates occurring at compression depths between 40.3 and 55.3 mm. Within this range, survival increased 1.45 times for every 5-mm increase in compression depth.

This study confirms that compression depth is strongly associated with survival to hospital discharge in patients with OHCA. However, it suggests that the optimal depth of chest compressions associated with increased survival is less than the current AHA-recommended target of 50 mm. In addition, it identifies an upper limit of chest compression depth, above which deeper compressions might be deleterious.

The study has several limitations. Investigators could examine only PRIMED and ROC-Epistry patients for whom electronic data were available, thereby creating the potential for selection bias. In addition, they
did not examine data beyond 10 minutes of CPR, nor did they have data regarding possible confounders of compression depth. The application of this study in the care of ED patients with OHCA is to press deeply, but not too deeply.


Current guidelines recommend the administration of epinephrine every 3 to 5 minutes for patients in cardiac arrest [3]. However, recent literature has questioned the benefit of epinephrine on long-term outcome for patients in cardiac arrest [4]. Olasveengen et al [5] performed a prospective, randomized controlled trial of adult patients with OHCA and found no statistical difference in survival to hospital discharge for patients who received advanced cardiac life support medications. Similarly, Hagihara et al [6] performed a prospective, nonrandomized, observational analysis of more than 400000 patients with OHCA in Japan and found the use of prehospital epinephrine to be associated with decreased chance of survival and good neurologic outcome. The authors of the current study sought to evaluate the relationship between epinephrine and survival among OHCA patients.

Dumas et al performed an observational cohort study of all patients with nontraumatic OHCA who achieved ROSC and were admitted to a large, single center in Paris, France, between January 2000 and August 2012. Upon admission to the hospital, patients received standard post-arrest resuscitation care, including early coronary reperfusion and targeted temperature management (TTM). The primary outcome of the study was favorable neurologic outcome at discharge.

Overall, 1156 patients were included in this observational study. A total of 1134 patients (73%) received epinephrine, whereas 422 (27%) did not. Patients who received epinephrine were older, less likely to have a witnessed cardiac arrest, and less likely to present with a shockable rhythm and had longer periods of resuscitation compared with patients who did not receive epinephrine. Percutaneous coronary intervention (PCI) was performed in 44% of patients, whereas 70% received TTM. Survival with favorable neurologic outcome was lower in patients who received epinephrine (17%) compared with those who did not receive epinephrine (60%). In several subgroup analyses, the negative association of epinephrine with favorable survival persisted across groups based on initial rhythm, length of resuscitation, and post-arrest care. Furthermore, the use of early PCI and TTM did not alter the association of epinephrine with lower survival. Interestingly, for patients who received epinephrine, those who were given epinephrine within the first 9 minutes after cardiac arrest had a better outcome compared with those who received the first dose between 10 and 15 minutes after arrest.

The current study adds to the growing body of literature suggesting that epinephrine, at best, has no impact on long-term favorable survival of patients with OCHA. The study is limited by its single-center, observational design. It must also be noted that those patients who received epinephrine were older, more often presented with nonshockable rhythms, and were un witnessed cardiac arrest events—characteristics associated with less optimal outcome in general and perhaps not related to epinephrine administration. Nevertheless, no randomized human study has demonstrated that the use of vasopressor medications, namely, epinephrine, results in meaningful neurologic survival at hospital discharge for patients with OHCA.


Current guidelines and consensus statements for the management of patients with cardiac arrest emphasize the importance of delivering high-quality chest compressions [2,7]. In recent years, numerous trials have evaluated the use of mechanical CPR devices to determine if patient outcome is improved compared with manual CPR [8,9]. At present, no trial has demonstrated decreased mortality rates with a mechanical CPR device. Nonetheless, many resource-limited settings have implemented mechanical CPR devices with the intention of delivering high-quality CPR to patients with OHCA. These devices, however, reportedly cause a higher frequency of injuries compared with manual CPR [10,11]. The authors of the current study sought to evaluate CPR-related injuries associated with mechanical CPR devices compared with manual CPR in patients in whom attempted resuscitation after OCHA was unsuccessful.

The investigators performed a prospective, multicenter study of nonsurviving patients in the LUCAS in Cardiac Arrest (LINC) trial [9]. That trial included adult patients 18 years and older who experienced an unexpected OHCA. It used 2 models of the LUCAS (Physio-Control Inc., Lund, Sweden) device to deliver mechanical chest compressions at a rate of 100 per minute at a depth of 4 to 5 cm. For the current study, autopsies were performed on nonsurviving patients, during which pathologists followed a standard protocol for recording external and internal injuries.

A total of 222 patients were included in the current study; 139 were treated with mechanical CPR and 83 were treated with manual CPR. Compared with manual CPR, the mechanical CPR device resulted in more rib fractures (91% vs 76%), more sternal fractures (58% vs 54%), and a higher incidence of retrosternal bleeding (32% vs 23%). In addition, hemothorax, pneumothorax, and liver injury were also more common in patients who received CPR with the LUCAS device.

This study has several limitations that should be noted. Importantly, not all deceased patients in the LINC trial were included. In addition, most patients in the LINC study received manual CPR prior to initiation of CPR delivered by the mechanical device. Furthermore, the depth and quality of CPR were not measured. It could be suggested that patients in the manual compression group were less likely to receive deeper compressions and were thus less likely to sustain injury. Nonetheless, the study suggests a higher incidence of injuries for patients who receive CPR with a mechanical device. It is important for the EP to search for CPR-related injuries in patients with ROSC after cardiac arrest, especially in those who received mechanical CPR.


Left ventricular assist devices (LVADs) are surgically implanted pumps that improve cardiac output in patients with severe left ventricular (LV) dysfunction. These complex devices are placed primarily in patients awaiting heart transplantation, patients with severe LV failure but unable to undergo transplantation, and patients with a reversible cause of acute LV dysfunction (eg, viral myocarditis, β-blocker overdose). The number of patients with LVADs increases every year in the United States. As a result, it is likely that the EP will encounter a critically ill patient with an LVAD. There is no consensus on whether LVAD patients in cardiac arrest should receive CPR. The current recommendation from most LVAD manufacturers is to avoid CPR, for fear of dislodging the device. The authors of the current study sought to examine the effects of CPR in patients with LVAD and in cardiac arrest.

Shinar et al reported a case series of LVAD patients experiencing cardiac arrest at a single, urban, level II trauma center. Patients with LVADs were included in the study if they had no signs of systemic perfusion, as evidenced by the absence of the LVAD machine “hum,” a low-flow alarm signal, poor capillary refill, cool skin temperature, and no mean arterial pressure (MAP) measured by Doppler flow of the radial artery. Eight patients were included in this case series. All of them received chest compressions, which ranged in duration from approximately 1 minute to 2.5 hours. Six of the patients had experienced OHCA. Return of effective circulation (the LVAD equivalent of ROSC) was documented in 6 patients, with 4 of them returning to their pre–arrest neurologic function. No incidents of dislodgment or disruption of the inflow or outflow LVAD cannulas were noted.

Although this study is a small case series with inherent limitations, it is the first study to report the successful use of CPR in LVAD patients in cardiac arrest. Its results challenge manufacturers’ recommendations to

avoid CPR in this patient population. Larger studies are clearly needed before making a widespread recommendation to perform CPR routinely for LVAD patients in cardiac arrest. The clinical application of this study is that CPR should be considered in the arresting LVAD patient. The alternative remains death.

3. Post–cardiac arrest management


A critical component in the care of patients with ROSC from cardiac arrest is hemodynamic optimization, namely, maintaining an adequate MAP. Current AHA guidelines recommend a target MAP of 65 mm Hg or higher [12]. However, the guidelines acknowledge that there is a lack of high-quality evidence supporting this specific MAP goal. Recent retrospective human data suggest that higher MAPs in the postarrest patient might be associated with improved neurologic outcomes [13–15]. The authors of the current study sought to determine the association between post-ROSC blood pressure and neurologic outcome.

Kilgannon et al performed a prospective, observational cohort study at a single, urban, academic medical center from 2009 to 2012. Patients were included in the study if they were older than 18 years, sustained an in-hospital cardiac arrest or OHCA, were functionally independent prior to the arrest, had ROSC, and were unable to follow commands immediately after ROSC. Patients who experienced cardiac arrest secondary to trauma or whose blood pressure was not measured as defined by the study protocol were excluded. All patients were treated according to a standardized postarrest treatment protocol that included TTM, immediate evaluation for PCI, and evaluation and management by a critical care physician. Blood pressures were measured by a noninvasive cuff and recorded every 15 minutes for the first 6 hours of care. For data analysis, investigators calculated the time-weighted average MAP (TWA-MAP) for the first 6 hours. The primary outcome of the study was good neurologic function at hospital discharge, defined as a Cerebral Performance Category of 1 or 2.

A total of 151 patients were enrolled in the study. Most of them experienced in-hospital cardiac arrest (63%) and had an initial rhythm of asystole or pulseless electrical activity (79%). Approximately 57% of patients required a vasopressor medication to maintain MAP after ROSC. Overall, 29% of patients in this study had a good neurologic outcome at hospital discharge. A TWA-MAP greater than 70 mm Hg was the highest blood pressure threshold associated with good neurologic outcome. In fact, the best outcome occurred in patients who maintained a TWA-MAP between 70 and 80 mm Hg. Not surprisingly, patients able to maintain a TWA-MAP higher than 70 mm Hg without vasopressor medications did better than those who required vasopressor medications to maintain their pressure at that level.

Preventing neurologic dysfunction is a primary goal of post–cardiac arrest care. The mechanisms that result in neurologic dysfunction after cardiac arrest are complex and incompletely understood. It is known, however, that the brain loses its ability to autoregulate across a range of blood pressures. It is believed that targeting a higher MAP in the post–cardiac arrest patient preserves cerebral perfusion during a state of impaired autoregulation. The current study adds to the growing body of literature supporting a higher MAP in the initial treatment for post–cardiac arrest patients.

Primary limitations of the study include its observational design and the fact that it was performed at a single center, thereby limiting generalizability. Furthermore, these patients were inpatient with a higher percentage of pulseless electrical activity initial presentation. In addition, blood pressure was measured via a noninvasive cuff, with no requirement for an invasive arterial line. Finally, there was heterogeneity in selecting patients for interventions, namely, TTM. Nonetheless, the clinical application of this study is to target a higher MAP in the initial management of post–cardiac arrest ED patients. In fact, a target MAP between 75 and 80 mm Hg is common at many institutions in the care of postarrest patients. Thus, resuscitated, post–cardiac arrest patients in the ED may require a higher blood pressure.

4. Sepsis


Septic shock is the most common type of shock encountered by EPs. In a landmark trial published in 2001, Rivers et al [16] demonstrated a significant decrease in the in-hospital mortality rate for a cohort of patients at a single, urban, academic ED who received early-goal–directed therapy (EGDT). As a result of the significant decline in mortality rate in this trial, EGDT became a central recommendation in international guidelines for the treatment of severe sepsis and septic shock [17]. However, numerous criticisms arose over select components of the EGDT protocol, namely, the use of central venous pressure (CVP) for volume assessment and central venous oxygen saturation (ScvO2) for assessment of global tissue perfusion. The ProCESS investigators sought to compare alternative resuscitation strategies in a cohort of patients with septic shock.

The ProCESS trial was a multicenter, randomized trial performed at 31 sites in the United States. These sites were all academic hospitals with an ED census of at least 40,000 patient visits per year. In addition, the sites had to use serum lactate to screen patients for the presence of cryptogenic shock, had to adhere to the Surviving Sepsis Campaign (SSC) guidelines for all nonresuscitation aspects of sepsis care, and could not use measured ScvO2 or have an established resuscitation protocol for patients with septic shock. Patients included in the ProCESS trial were 18 years or older, had 2 or more criteria for the systemic inflammatory response syndrome with a suspected source of infection, and had refractory hypotension or a serum lactate concentration greater than 4 mmol/L. Refractory hypotension was initially defined as hypotension after administration of more than 20 mL/kg of intravenous fluids (IVFs). This definition was later changed to hypotension following 1 L of IVFs for 1 hour. Patients were randomized to 1 of 3 intervention groups: protocol-based EGDT, protocol-based standard care, and usual care. The protocol-based EGDT group received the EGDT protocol, as defined by Rivers and associates [16]. The protocol-based standard care group was resuscitated by a dedicated team given explicit treatment instructions, which included adequate peripheral intravenous access, fluid resuscitation until the team leader felt the patient was fluid replete, administration of vasoactive agents to maintain an adequate MAP, and red blood cell transfusion if the hemoglobin level fell to less than 7.5 g/dL. For patients randomized to the usual care group, all treatment decisions were made by the ED clinician. The primary outcome of the ProCESS trial was 60-day in-hospital mortality.

A total of 1351 patients were included in the trial; 439 were randomized to the protocol-based EGDT group, 446 to the protocol-based standard care group, and 456 to the usual care group. During the first 6 hours of resuscitation, patients in the protocol-based EGDT group received 2.8 L of IVFs, whereas patients in the protocol-based standard care group received 3.3 L and those in the usual care group received 2.3 L. Vasopressor medications were used in 55% of patients in the protocol-based EGDT group, 52% of patients in the protocol-based standard care group, and 44% of patients in the usual care group. Surprisingly, there was no difference in 60-day in-hospital mortality rates among the 3 groups: 21% in the protocol-based EGDT group, 18.2% in the protocol-based standard care group, and 18.9% in the usual care group. Similarly, there was no difference in secondary outcomes of 90-day mortality rate, hospital length of stay, or discharge disposition.

The ProCESS trial was the first of 3 large multicenter studies to evaluate the external validity of the original EGDT trial by Rivers and colleagues. Importantly, the study demonstrated that the use of central hemodynamic monitoring (ie, CVP) and oxygen saturation monitoring (ie, ScvO2) did not improve patient outcomes. Limitations of the study
are few and primarily include the differences in baseline mortality rates and mean $\text{SvO}_2$ values between patients in the ProCESS and EGDT trials. The clinical implications of this study are significant and are likely to change practice. The use of CVP and $\text{SvO}_2$ monitors did not affect patient outcomes. The foundation of care for ED patients with septic shock should be early recognition, early administration of appropriate antibiotics, achieving adequate intravascular volume, maintaining adequate perfusion pressure, and assessing the adequacy of resuscitation.


ARISE is the second of 3 multicenter studies to evaluate the external validity of the EGDT trial by Rivers and colleagues [16]. The ARISE investigators sought to determine if EGDT, compared with usual care, would decrease the 90-day all-cause mortality rate for ED patients with septic shock.

The ARISE trial was a prospective, randomized, parallel-group trial conducted in 51 centers in Australia, New Zealand, Finland, Hong Kong, and Ireland. These centers were tertiary and nontertiary care centers in metropolitan and rural locations. Similar to ProCESS, these centers could not have existing sepsis resuscitation protocols or measure $\text{SvO}_2$. Patients included in the ARISE trial were 18 years or older, had 2 or more systemic inflammatory response syndrome criteria with suspected or confirmed infection, and had evidence of refractory hypotension ($\text{SBP} < 90$ mm Hg or MAP $< 65$ mm Hg after 1 L of IVFS or hypoperfusion (lactate concentration $> 4$ mmol/L).

Patients were enrolled if they were within 6 hours after presentation to the ED, and they had to have received their first dose of intravenous antibiotics before randomization. In contrast to ProCESS, patients were randomized to 2 groups: EGDT and usual care. Patients in the EGDT group received an arterial catheter and a proprietary central venous catheter to measure continuous $\text{SvO}_2$ and had all care provided by a dedicated study team trained in EGDT. For patients in the usual care group, all decisions about care were made by the treating ED team. No $\text{SvO}_2$ measurements were permitted. The primary outcome of the study was 90-day all-cause mortality.

A total of 1588 patients were included in the ARISE trial: 792 were randomized to the EGDT group and 796 to the usual care group. The groups were well matched, with no statistically significant differences in the patient demographics. Not surprisingly, patients in the EGDT group received more vasopressor medications, packed red blood cell transfusions, and inotropic therapy compared with patients in the usual care group. Similar to the ProCESS trial, there was no statistically significant difference in the primary outcome of 90-day all-cause mortality (EGDT group, 18.6%; usual care group, 18.8%). There was also no difference between groups in the secondary outcomes of ICU mortality, 28-day mortality, duration of mechanical ventilation, and need for renal replacement therapy.

The ARISE trial demonstrated that EGDT did not reduce mortality among ED patients with septic shock. Importantly, few patients in this study were lost to follow-up and outcomes were not subject to observer bias. Although the study was not blinded, the results are significant. Together, the ARISE and ProCESS trials are meaningful contributions to sepsis literature. They illustrate that usual care has improved substantially since the time of the original EGDT trial. The implications for clinical practice are noteworthy in that EGDT (ie, the use of central venous access and select catheters to monitor $\text{SvO}_2$) does not reduce the mortality rate.


Current SSC guidelines recommend maintaining a hematocrit of 30% or higher during the initial 6-hour resuscitation period for patients with severe sepsis and septic shock who demonstrate persistent tissue hypoperfusion despite adequate IVFS and an MAP greater than 65 mm Hg [17]. This recommendation is based primarily on the hematocrit target used in the EGDT trial by Rivers et al [16]. After the initial resuscitation period, SSC guidelines recommend maintaining a hemoglobin value between 7 and 9 g/dL in patients without evidence of myocardial ischemia, severe hypoxemia, or hemorrhage [17]. Importantly, the data supporting this recommendation are limited. In fact, blood transfusions are associated with an increased risk of health care–associated infections and death [18–20]. The authors of the current study sought to evaluate the mortality-related effects of leukoreduced blood cell transfusions at a lower vs higher hemoglobin threshold in ICU patients with septic shock.

Holst et al performed a multicenter, stratified, parallel-group trial in 32 ICUs in Denmark, Sweden, Norway, and Finland. Patients included in the study were at least 18 years of age, were in septic shock, and were admitted to the ICU with a hemoglobin value less than 9 g/dL. Patients were randomized in a 1:1 ratio to a lower threshold group or higher threshold group. Patients in the lower threshold group received a blood transfusion if their hemoglobin value was 7 g/dL or less, whereas patients in the higher threshold group received a transfusion if the hemoglobin value was 9 g/dL or less. Patients were given 1 unit of cross-matched, leukoreduced, packed red blood cells at a time. Subsequent transfusions were based on repeat hemoglobin values obtained 3 hours after the initial transfusion. The primary outcome of the study was 90-day mortality. Secondary outcomes were the use of vasopressor medications, the need for mechanical ventilation or renal replacement therapy, and the number of serious adverse reactions or ischemic events.

A total of 998 patients were included in this study; 502 were randomized to the lower threshold group and 496 to the higher threshold group. Most patients were admitted to the ICU from a general ward (53%), and approximately 18% were admitted to the ICU from the ED. Not surprisingly, patients in the lower threshold group received significantly fewer blood transfusions than did the higher threshold group. In fact, 36% of patients in the lower threshold group never required a blood transfusion in the ICU. Importantly, there was no difference in 90-day mortality between the groups (43% for the lower threshold group vs 45% for the higher threshold group). In addition, there was no difference in the number of ischemic events or the use of mechanical ventilation, renal replacement therapy, or vasopressor medications.

This study adds to the literature because it demonstrates the benefit of a restrictive transfusion strategy in critically ill patients. The primary limitation of the study is the fact that it was not blinded. In addition, almost 10% of patients in the lower threshold group received a transfusion despite having a hemoglobin value greater than 7 g/dL. Finally, patients with acute coronary syndrome were not included in the study. Despite these limitations, the clinical application of this study is that a restrictive hemoglobin threshold (7 g/dL) should be used for blood transfusion in patients with septic shock.

5. Pulmonary embolism


Thrombolytic therapy is recommended for patients with acute PE associated with hypotension (SBP <90 mm Hg) [21]. However, the literature on thrombolytic therapy for patients with acute PE and evidence of right ventricular strain but without hypotension (ie, submassive PE) remains less clear. Current guidelines recommend against thrombolytic therapy for most patients with submassive PE [21]. The authors of the current study sought to investigate the efficacy and safety of fibrinolytic therapy, in addition to heparin therapy, in normotensive patients with intermediate-risk PE (submassive PE).

The Pulmonary Embolism Thrombolysis (PEITHO) trial was a randomized, double-blind, placebo-controlled study performed at 76 sites in 13 countries. Patients in this trial were 18 years or older with objectively confirmed PE, elevated troponin, and evidence of right ventricular dysfunction on echocardiography or computed tomography. Patients
were randomized to a tenecteplase group or placebo. Patients in the tenecteplase group received a single, weight-based dose of tenecteplase (30-50 mg) followed by unfractionated heparin, titrated to maintain an activated partial thromboplastin time between 2.0 and 2.5 times the upper limit of normal range. Patients in the placebo group received a single bolus dose of placebo along with the same heparin infusion as the tenecteplase group. The primary efficacy outcome of the study was the composite of death from any cause or hemodynamic decompensation within 7 days. The primary safety outcomes of the study were ischemic or hemorrhage stroke within 7 days, major extracranial bleeding within 7 days, and serious adverse events within 30 days after enrollment.

A total of 1005 patients were included in the PEITHO trial. The mean age of patients in the trial was 70 years, and all patients were normotensive at the time of randomization. The primary efficacy outcome of death from any cause or hemodynamic decompensation within 7 days occurred in 2.6% of patients in the tenecteplase group compared with 5.6% of patients in the placebo group (P = .02). This difference between the groups was caused almost entirely by a reduction in hemodynamic decompensation rather than decreased 7-day mortality. Major extracranial bleeding within 7 days occurred in 6.3% of patients in the tenecteplase group compared with 1.25% of patients in the placebo group. In addition, the rate of intracerebral hemorrhage was higher in patients who received tenecteplase compared with patients who received placebo (2% vs 0.2%). When results of the study were stratified according to age, the primary efficacy outcome was improved, with fewer major bleeding events, in patients younger than 75 years.

Thrombolytic therapy for patients with submassive PE remains controversial. The PEITHO trial adds to the current literature and, although overall mortality was unchanged, suggests improved outcome for younger patients who receive thrombolytic therapy for submassive PE. A recent meta-analysis by Chatterjee et al [22] included patients from the PEITHO, MOPETT, and TOPCOAT trials and concluded that the use of thrombolytic therapy for submassive PE was associated with a lower mortality rate. It is important to note that any benefit from thrombolytic therapy comes at the cost of significantly higher risks of major bleeding and intracerebral hemorrhage, especially in older patients. In fact, the meta-analysis by Chatterjee et al [22] demonstrated a number needed to harm for major bleeding of just 18. It is likely that select patients with submassive PE will benefit from this medication. However, it remains uncertain which patients are the best candidates for thrombolytic therapy.

6. Ultrasound


Patients in septic shock require aggressive resuscitation, often with the combination of IVFs and vasoactive medications. Current SSC guidelines for the management of severe sepsis and septic shock recommend the use of CVP to guide fluid therapy [17]. Unfortunately, CVP has been shown to be inaccurate in the assessment of fluid status and management of fluid administration [23,24]. Accurate administration of IVFs is critical, because excessive fluid administration is associated with poor outcomes [25]. Ultrasound has recently emerged as a useful tool in resuscitation, allowing the clinician to make rapid assessments in patients with undifferentiated shock [26]. In fact, ultrasound might be more accurate in evaluating fluid responsiveness and cardiac contractility than traditional monitoring methods (eg, CVP monitoring). The authors of the current study sought to determine if recommendations for fluid therapy and inotropic medication administration based on limited echocardiography (LE) assessment, compared with standard management, improved the survival rate among patients with undifferentiated vasopressor-dependent shock.

Kanji et al performed a prospective, observational cohort study in the ICU of a single, quaternary hospital in Vancouver, British Columbia. Patients were included in the study if they exhibited vasopressor-dependent shock despite a CVP between 8 and 12 mm Hg after a fluid challenge. All patients in the study were intubated and mechanically ventilated. During the first 24 hours after ICU admission, patients in the LE group underwent LE with a handheld device, performed by an intensivist with advanced ultrasound training. The LE examination consisted of standard echocardiographic views (ie, parasternal long-axis, parasternal short-axis, apical 4-chamber view, subxiphoid view) along with an assessment of the size and respiratory variation of the inferior vena cava. Treatment recommendations regarding additional IVFs and inotropic medication were based on the results of the LE examination. The authors used patients previously managed in the standard fashion for shock resuscitation at the participating institution as the control group. The primary outcome was 28-day mortality. Secondary outcomes included the amount of fluid given during the first 4 days and organ dysfunction, as measured by days alive and being free of the need for mechanical ventilation and renal replacement therapy.

A total of 220 patients were included in the final analysis of this study: 110 in the LE group and 110 in the standard management group. Baseline patient characteristics did not differ between the 2 groups. Most patients were diagnosed as having vasodilatory shock (76.3%) or cardiogenic shock (13.5%). For patients in the LE group, the most common treatment recommendations based on echocardiography results were to restrict additional IVFs (65%) and add an inotropic medication (25%). Overall, 28-day survival was higher for patients in whom therapy was guided by LE results than among those in the standard management group (66% vs 56% \(P = .04\)). In addition, patients in the LE group had a lower incidence of acute kidney injury and the need for renal replacement therapy.

The study by Kanji and colleagues demonstrates the utility of focused echocardiography in the resuscitation of critically ill patients. bedside echocardiography is rapid and noninvasive and can be easily repeated to evaluate and manage critically ill patients. The study has several limitations, which include a nonrandomized study design performed at a single center and the use of historical controls to compare the effects of LE. The clinical application of this study is that echocardiography is a valuable tool in the resuscitation of critically ill patients and can be associated with improved patient outcome.

7. Acute ischemic stroke


Most critically ill patients with an acute cerebrovascular accident present to the ED with elevated blood pressure. In the setting of an acute intracerebral hemorrhage, recent literature has demonstrated the safety of rapidly lowering blood pressure to less than 140 mm Hg [27]. However, the literature on blood pressure reduction in patients with AIS is less clear. Only small studies have been conducted, and they yielded conflicting results [28,29]. A primary concern with acute blood pressure reduction in patients with AIS is that it will reduce perfusion to the ischemic penumbra. The authors of the current study sought to evaluate whether immediate blood pressure reduction in patients with AIS reduced the rates of death and major disability.

The China Antihypertensive Trial in Acute Ischemic Stroke (CATIS) was a single-blind, blinded-endpoints randomized trial conducted in 26 centers in China. Patients in the study were 22 years or older and came to an ED within 48 hours after symptom onset; they had an SBP between 140 and 220 mm Hg, and their stroke was confirmed by computed tomography or magnetic resonance imaging. Patients given thrombolytic therapy and those with an SBP greater than 220 mm Hg or a diastolic blood pressure greater than 120 mm Hg were excluded. Patients randomized to the intervention group were given antihypertensive medications with the goals of lowering SBP 10% to 25% within

the first 24 hours and achieving an SBP less than 140 mm Hg and diastolic blood pressure less than 90 mm Hg by day 7. Antihypertensive medications that could be used to lower blood pressure included angiotensin-converting enzyme inhibitors, calcium-channel blockers, and diuretics. Patients in the control group had all home antihypertensive medications discontinued upon admission. The primary outcome of the study was death or major disability, defined by a modified Rankin scale score of 3 to 5, within 14 days. Secondary outcomes included death or major disability within 3 months.

A total of 4071 patients were included in the CATIS trial. Overall, 72% of patients in the intervention group and 39.5% of the control group met the target SBP blood pressure goal. Not surprisingly, blood pressure was significantly lower at 24 hours and at 14 days in the intervention group. Importantly, there was no difference in the primary composite outcome of death or major disability between the groups (33.6% in both). Furthermore, there was no difference between the groups in regard to the rates of death or major disability at 3 months (25.2% vs 25.3%).

The CATIS trial is an important contribution to the care of critically ill patients with an AIS. The trial failed to demonstrate a benefit to acutely lowering blood pressure in this patient population. The study has several limitations: The patients were all from China, thereby limiting the generalizability of the findings to other populations. In addition, most patients had relatively mild strokes, with a median National Institute of Health Stroke Scale score of 4. The median time to randomization was greater than 15 hours, raising the question of whether reducing blood pressure during the acute period (between 1 and 10 hours) might have been beneficial. The clinical application of this study for EPs and critical care physicians is that lowering blood pressure in the early period after an AIS is not warranted.

References
