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Rethinking vasopressor use in the trauma bay: a shifting perspective

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SUMMARY

The use of vasopressors during the acute resuscitation of severely injured patients with trauma has long been controversial. Building on the concept of permissive hypotension, damage control resuscitation focuses on hemostatic transfusion of blood products to maintain perfusion pressures. However, targeting lower perfusion pressures while awaiting definitive hemorrhage control is contraindicated in some patient subpopulations and may be detrimental. Coupled with the shift towards a circulation-first approach to resuscitation, there is increasing interest in the use of vasopressors in the trauma bay. This narrative review aims to summarize the evidence behind trauma bay vasopressors and identify the potential role of vasoactive medications in the early phases of trauma care.

INTRODUCTION

The use of vasopressors during the acute resuscitation of severely injured patients with trauma has long been controversial. While largely based on the surgical dogma that 'bleeding patients need blood', some observational studies have demonstrated an association between vasopressor use and an increase in mortality in patients with trauma.[1–5] Many of these studies, however, are retrospective and lack standardized protocols for vasopressor administration. Their design is inherently unable to establish a causal relationship.[1–5] Despite these shortcomings, pharmacologic adjuncts for hemodynamic support remain sacrilegious in the trauma bay and blood-based resuscitation is the standard of care.

As part of damage control resuscitation (DCR), blood products are given to critically injured, hypotensive patients in a balanced fashion while targeting a systolic blood pressure of 100 mm Hg.[6 7] The 'permissive hypotension' component of DCR was first introduced in 1994 by Bickell *et al* after their seminal work showed improved outcomes with delayed fluid resuscitation in penetrating trauma victims. The authors theorized that increasing blood pressure before definitive hemodynamic control disrupted natural clot formation, leading to worse outcomes in over-resuscitated patients.[7] Permissive hypotension was subsequently supported by later work correlating on-site intravenous fluid administration with increased mortality.[8] The strong belief in permissive hypotension runs contradictory to the idea of vasopressor use in trauma due to the potential to cause supraphysiologic pressures. While the practice of permissive hypotension has permeated early trauma care algorithms, it is contraindicated in a few key populations. Patients with traumatic brain and spinal cord injuries rely on increased mean arterial pressure (MAP) to provide tissue-saving perfusion to the central nervous system.[9 10] Elderly patients also do not tolerate reduced MAP well due to underlying comorbidities and frailty.[11]

More recently, push-dose vasopressors have gained traction as a means to achieve rapid hemodynamic stability in critically ill patients. A retrospective study of push-dose phenylephrine and epinephrine in hospitalized medical and surgical patients with hypotension demonstrated an appropriate response in blood pressure with a low frequency of adverse events. While this study demonstrates that push-dose vasopressors can be safe and effective in hospitalized patients, it is unclear how many of the included patients were presenting due to traumatic injury.[12] However, preintubation vasopressors are increasingly used in the trauma bay to prevent postintubation hypotension.[13]

Additionally, as the shift from an airway-first to circulation-first primary survey gains popularity, there may be an increasing role for vasopressors in the early phases of trauma care.[14 15] Furthermore, the addition of vasopressin in patients with hypotensive trauma has been shown to be safe and can reduce blood transfusion requirements.[16 17] Despite this, only European guidelines recommend the use of vasopressors for early hemodynamic support after failed response to fluid resuscitation. Currently, the Eastern Association for the Surgery of Trauma (EAST) and the Western Trauma Association do not encourage their use.[18] This narrative review aims to describe the potential role of vasoactive medications in the early phases of care for select subpopulations of trauma patients.

HEMORRHAGIC SHOCK

After the introduction of permissive hypotension in the mid-1990s, many research groups sought to understand the association between vasopressor use and mortality in patients with trauma.[1–5] A summary of referenced studies is found in table 1. As trauma centers shifted away from the use of large-volume crystalloid resuscitation, vasopressors were seen as a plausible adjunct to blood products for increasing MAP.[1] Sperry *et al* performed a secondary analysis on multicenter data to assess the relationship between early vasopressor use and aggressive crystalloid resuscitation in bluntly injured patients with trauma. Patients given vasopressors within the first 12 hours of admission had a higher risk of mortality.[1] A similar increase in mortality risk with vasopressor exposure was found by Plurad *et al*. While they hypothesized that adequately resuscitated patients

Table 1 Summary of referenced studies demonstrating the association between vasopressor use and mortality in trauma patients with hemorrhagic shock

Author	Inclusion criteria	Exclusion criteria	Relevant findings
Aoki *et al*[5]	Trauma patients>16 years old with arrival SBP<90 mm Hg and blood transfusion within 24 hours	AIS=6, SCI, severe TBI, cardiopulmonary arrest, CPR or missing data	Vasopressor recipients had increased odds of in-hospital mortality than propensity score-matched counterparts not given vasopressors (OR=2.168, 95% CI: 1.442 to 3.320)
Barmparas *et al*[2]	Trauma patients>18 years old with MTP activation	Requirement of<3 units of PRBCs or SCI	Vasopressor cohort had higher mortality rate than those not exposed to vasopressors (AHR=9.9, p=0.03)
Plurad *et al*[3]	Trauma patients>15 years old requiring ICU admission	Severe TBI, SCI or death within 24 hours	Vasopressor cohort had higher mortality; increased risk of death in vasopressor group was independent of injury severity (OR=17.6, p<0.01)
Sperry *et al*[1]	Blunt trauma patients with SBP<90 mm Hg, base deficit≥6 mEq/L, transfusion within 12 hours of admission, or AIS≥2 of any region	< 16 or > 90 years old, cervical SCI, isolated TBI or death within 48 hours	Vasopressor use within 12 hours of injury had increased mortality risk (HR=1.81, p=0.013)
Uchida *et al*[4]	Blunt trauma patients>16 years old with torso trauma requiring intervention and SBP<100 mm Hg, Shock Index>1, or lactate>2.5 mmol/L	Cardiopulmonary arrest on arrival, death within 24 hours, probability of survival≥0.6 or transfer patient	Vasopressor exposure (OR=21.32, p<0.01) and vasopressor use within 1 hour of presentation (OR=10.56, p<0.01) were associated with increased mortality

AIS, Abbreviated Injury Score; CPR, cardiopulmonary resuscitation; MTP, massive transfusion protocol; PRBC, packed red blood cell; SBP, systolic blood pressure; SCI, spinal cord injury; TBI, traumatic brain injury.

may benefit from vasopressor support to increase perfusion pressure, their study found that fluid status did not impact mortality in the vasopressor cohort.[3] In an observational cohort study of patients with trauma requiring activation of massive transfusion protocol, Barmparas *et al* identified an association between vasopressor exposure and mortality. Their vasopressor group was also more likely to have a blunt mechanism of injury.[2] Uchida *et al* focused their retrospective review on patients with blunt torso trauma and physical or laboratory signs of hemorrhagic shock. Non-survivors were noted to have received vasopressors earlier in and for greater duration of their hospital course than survivors.[4] Notably, these studies relied on observational data; cohort demographics, including injury severity and prehospital interventions, were often found to be significantly different. Resuscitation interventions and endpoints were also variable between studies.[1–4] To combat these weaknesses, Aoki *et al* used propensity score matching to compare survival among patients with trauma who did and did not receive vasopressors. This analysis supported earlier findings of increased mortality rate among patients with trauma in hemorrhagic shock requiring vasopressors.[5] While the aforementioned data were only correlative, it continues to influence resuscitation protocols at trauma centers across the country. However, improved understanding of the neurohormonal response to hemorrhagic shock would allow for interest in vasopressor support to pique once more.

The physiologic response to hemorrhage can be described in two distinct phases. In the initial sympathoexcitatory phase, arterial baroreceptors sense a lack of blood volume and pressure. The resulting sympathetic response leads to increased peripheral vasoconstriction and heart rate; presenting as tachycardia with relatively unchanged blood pressure.[19] Clinically, this is described as class I or II shock per Advanced Trauma Life Support (ATLS).[20] This initial phase continues until almost one-third of blood volume has been lost. As hemorrhage progresses, peripheral vasoconstriction is reduced, and bradycardia develops. It is during this second phase that catecholamine secretion increases in response to hypotension.[19] Despite the increase in endogenous vasopressor secretion, the ability of vascular smooth muscle to constrict is greatly hindered and shock can become irreversible in this stage.[21] The current ATLS hemorrhagic shock classification system does not accurately reflect the second phase of this physiologic paradigm. Rather, current teaching is focused on catecholamine-driven tachycardia as one of the defining features of later stages of shock. Data have shown that up to 50% of patients with severe hemorrhagic shock are not properly identified as the classification system is currently written, in part due to the emphasis placed on tachycardia as a class-defining characteristic.[20]

Arginine vasopressin (AVP) is one of the hormones secreted in response to hypovolemia. It is rapidly released from the posterior pituitary gland before plasma levels dramatically decrease during the second phase of hemorrhagic shock.[21 22] When available, AVP inhibits vasodilation by interrupting pathways involved in nitric oxide production and smooth muscle cell hyperpolarization.[21] While animal data have shown an association between AVP deficiency and vasoplegia in the late stages of hemorrhagic shock, serum AVP levels have proven difficult to measure in clinical settings.[23] Copeptin, part of the precursor molecule of AVP, is easier to measure due to its longer half-life and has shown promise as a marker of potential vasopressin deficiency in patients.[24] Hypotensive patients with trauma have elevated AVP and copeptin levels at the time of initial presentation, but levels of both decrease significantly over the next 16 hours.[22] Notably, one study found that all patients requiring massive transfusion early in their hospital course were found to be deficient in AVP at the time of admission.[22] Due to its critical role in preventing vasodilation and associated clinical significance in patients with trauma, AVP has been a target for pharmacologic intervention in hemorrhagic shock.

Based on the known AVP deficiency in patients with hemorrhagic shock, multiple investigators have explored the therapeutic potential of vasopressin in patients with trauma. Cohn *et al* conducted a double-blinded, randomized controlled trial assessing the safety and efficacy of concurrent vasopressin use with fluid resuscitation in hypotensive patients with trauma.[16] Vasopressin plus saline was given as a bolus followed by a

continuous infusion for 5 hours in the experimental group; the control group received a saline bolus followed by a continuous infusion for the same duration. Infusions were not titrated to a goal MAP or blood pressure. Patients enrolled in the experimental vasopressin group received lower fluid volumes and had similar 30-day mortality rates to the control group.[16] Almost a decade later, Sims *et al* sought to evaluate how vasopressin supplementation affects blood transfusion requirements in adult patients with trauma. Control and experimental groups received similar bolus and infusion regimens as those in Cohen *et al*'s study; however, Sims *et al* titrated infusions to MAP ≥65 mm Hg for 48 hours.[16 17] Intention-to-treat analysis showed patients in the vasopressin group had lower transfusion requirements, fewer deep venous thromboses and similar mortality rates to the control group.[17] Both studies enrolled 100 or fewer patients and took place at single centers. Notably, Sims *et al* featured mostly patients with penetrating trauma, while Cohn *et al* recruited mostly patients with blunt mechanisms of injury. While the results of each study may be difficult to generalize, both represent a shifting perspective on the utility of vasopressors in the acute phase of trauma care[16 17]

Despite concerns from older studies associating vasopressor use with increased mortality in patients with hemorrhagic shock secondary to trauma, the retrospective nature of these analyses cannot be used to imply causation of poorer outcomes with vasopressor use.[1 2] The reduced risk of DVT in patients receiving vasopressin identified by Sims *et al* highlights the non-trivial inflammation associated with blood product resuscitation, a concern that was similarly noted with large-volume crystalloid infusions.[17] Critics of vasopressor use often express concern over secondary injury due to the compounding effects of hypovolemia and pharmacologic vasoconstriction. This effect has not been noted in vasopressin-focused studies.[16 17] Additionally, a murine model of hemorrhagic shock secondary to trauma demonstrated a lack of disruption in intestinal villi microcirculation among mice resuscitated with crystalloid plus norepinephrine.[25] While larger, multicenter studies are needed to fully understand the clinical outcomes associated with vasopressin's use in hemorrhagic shock, the existing evidence demonstrates potential benefit from its use in this subpopulation of patients with trauma.

NEUROLOGIC INJURY

Traumatic brain injury

Traumatic brain injury (TBI) may be caused by a blunt or penetrating injury to the head that disrupts normal brain function. These injuries are classified as mild (concussion), moderate or severe based on the initial GCS assessment.[26] Although only comprising 2% of the body's weight, the brain receives 15% of cardiac output; oxygen delivery and cerebral blood flow (CBF) are essential to maintain normal function.[27] Anaerobic metabolism is inadequate to maintain cellular energy states in the brain, and appropriate CBF is important to prevent secondary injury in the post-traumatic period.[28] After TBI, CBF autoregulation is impaired or sometimes abolished. The resulting inability to constrict or dilate cerebral vasculature to modulate cerebral perfusion pressure (CPP) can present immediately or in a delayed fashion and may be transient or persistent. With inappropriate CBF autoregulation, the risk of secondary injury is increased. Cerebral hypoperfusion can lead to worsening tissue ischemia as well as a mismatch in oxygen supply and demand; both of which have been associated with poor neurologic outcomes after injury.[28] Given this understanding of the importance of CBF in augmenting CPP and tissue oxygenation for severe patients with TBI, the Brain Trauma Foundation recommends target CPP between 60 and 70 mm Hg, target systolic blood pressure ≥100–110 mm Hg, and target intracranial pressure <22 mm Hg.[29] To maintain these hemodynamic targets, vasopressor usage has been investigated as a management strategy to augment cerebral perfusion in the post-traumatic period.

Vasopressor support to maintain CPP is common practice at many trauma centers. Although this review evaluates current literature on trauma bay vasopressor usage, most of the TBI studies evaluate their utilization in the intensive care unit (ICU). Select referenced studies are summarized in table 2. Early results from a 2013 RCT by Van Haren *et al* compared vasopressin to catecholamine agents (norepinephrine, dopamine, phenylephrine) in severe patients with TBI to maintain CPP.[30] Adverse events were not increased with vasopressin and there were no differences in mortality, suggesting that vasopressin is a safe and effective vasopressor option for CPP management after severe TBI.[30] A smaller 2004 RCT evaluated the cerebrovascular effects comparing norepinephrine to dopamine in TBI ICU patients (n=10), demonstrating that norepinephrine may be a more predictable option for increasing CBF.[31]

Other investigations have reached conflicting conclusions. A 2024 prospective study investigated the effect of increasing blood pressure on brain tissue oxygenation ($PbtO_2$) in severe patients with TBI. Overall, increasing MAP increased CPP with modest rise in $PbtO_2$. However, when patients were grouped by impaired or intact cerebral autoregulation, some patients had improved $PbtO_2$ and others experienced cerebral hypoxia, demonstrating a heterogenous response to MAP augmentation with vasopressors.[32] It is important to note that individual vasopressors have diverse mechanisms of action and can evoke varying effects on cerebral oxygenation.[33] Limited research is available evaluating the influence of distinct vasopressors on cerebral oxygenation.

Although vasopressor support for CPP maintenance may be common, there is evidence noting a higher risk of in-hospital mortality with their use. A large 2020 single-center retrospective review compared outcomes of TBI ICU patients who received vasopressors to those who did not. The mortality was significantly higher in the vasopressor cohort (42.2% vs 3.4%, p<0.01) and this trend persisted after accounting for confounding factors (HR 2.77, p=0.01).[34]

Guidelines support maintaining a target CPP for patients with TBI, and it appears commonplace to use vasopressors to achieve these targets. Studies have shown varied effects on improved tissue oxygenation with vasopressor support, but evidence is lacking on morbidity and mortality benefits with vasopressors for patients with TBI.

Spinal cord injury

Acute spinal cord injury (SCI) can result in hypotension and autonomic dysfunction.[35] The acute interruption of the sympathetic nervous system can lead to neurogenic shock, defined by hypotension, bradycardia and peripheral vasodilation.[36] The sympathetic nervous system interruption seen in SCI is more commonly seen in cervical injuries and less common in lower thoracic and lumbar injuries. Summaries of referenced studies reviewed in this section are found in table 2.

Aggressive blood pressure targets for cervical SCIs were supported in the 1990s by Levi *et al* and Vale *et al*, whose works have been cited to support consensus guidelines.[37 38] These guidelines supported an MAP goal of 85–90 mm Hg for 7 days for acute cervical SCI.[39] A 2015 study analyzed minute-by-minute

Table 2 Summary of referenced studies assessing impact of vasopressor use for blood pressure augmentation in TBI and SCI patients

	Author	Inclusion	Intervention	Relevant findings
TBI	Van Haren *et al*[30]	TBI ICU>18 years w/ ICP monitor	Randomized to catecholamines or AVP for CPP management	Adverse events were not increased with AVP; no differences in mortality
	Steiner *et al*[31]	TBI ICU>16 years w/ ICP monitor	Randomized to norepinephrine or dopamine for CPP management	Norepinephrine demonstrated predictable and significant increases in CBF whereas dopamine was variable and inconsistent
	Kunapaisal *et al*[32]	TBI ICU>18 years w/ ICP monitor	Cerebral autoregulation testing with ICP and $PbtO_2$ monitoring during MAP augmentation	For impaired vs intact cerebral autoregulation, some patients had improved $PbtO_2$ and others had cerebral hypoxia
	Dhillon *et al*[34]	TBI ICU w/ ICP monitor	Comparison of patients who received vasopressors to those who did not	Mortality was higher in the vasopressor cohort (42.2% vs 3.4%, p<0.01); trend persisted after accounting for confounding factors (HR 2.77, p=0.01)
SCI	Hawryluk *et al*[10]	Acute SCI ICU	Analyzed physiologic data and neurologic recovery over 30 days	Higher average MAP and proportion of MAP>85 mmHg correlated with improved neurologic recovery
	LaRiccia *et al*[42]	Blunt SCI ICU>18 years	Assessed neurologic recovery in patients receiving vasopressors	No difference in time spent at a MAP>85 (75% no improvement vs 78% in the improvement, p=0.91) or the total duration of MAP augmentation
	Inoue *et al*[43]	SCI ICU>18 years	Assessed neurologic recovery in patients receiving vasopressors	No difference in neurologic recovery and increased cardiac complications
	Readdy *et al*[44]	Complete penetrating SCI>18 years	Assessed neurologic recovery in patients receiving vasopressors	10 patients experienced cardiac complications and only 1 patient experienced neurologic recovery

TBI, traumatic brain injury; ICU, intensive care unit; AVP, arginine vasopressin; ICP, intracranial pressure; CPP, cerebral perfusion pressure; CBF, cerebral blood flow; $PbtO_2$, brain tissue oxygenation; MAP, mean arterial pressure; SCI, spinal cord injury.; .

blood pressure data in 100 acute patients with SCI and correlated this data with neurologic recovery up to 30 days from the injury. Higher average MAP and proportion of MAP >85 mm Hg correlated with improved neurologic recovery, which is concordant with guidelines recommending MAP >85 mm Hg.[10]

For thoracic and lumbar SCI, consensus guidelines published in 2019 on the topic note insufficient evidence for specific blood pressure targets in the acute setting.[40] However, they refer to pooled data of cervical and thoracolumbar patients with SCI and state that a treating physician may choose to target an MAP goal >85 mmHg. Recent 2024 consensus guidelines support a more modest MAP goal of 75–80 mm Hg for 3–7 days.[41] These guidelines investigate which vasopressor is preferred to maintain this goal and note conflicting data on the preferred agent, ultimately recommending it be left to the discretion of the treating physician.[41]

Although these recommendations of targeting elevated MAP goals for acute patients with SCI have persisted, strong evidence supporting this practice is lacking. One prospective multicenter study involving 222 patients with SCI across 19 centers assessed for improvement in American Spinal Injury Association (ASIA) Impairment Scale scores during hospitalization and factors associated with improvement. There was no statistical difference in the percentage of time patients spent at an MAP >85 mm Hg during treatment (75% no improvement vs 78% in the improvement, p=0.91) or the total duration of MAP augmentation treatment.[42]

In addition to the lack of strong evidence supporting MAP augmentation, some studies emphasize the possible harmful impact of vasopressor use in patients with SCI. A 2014 retrospective study analyzed 131 SCI patients who received vasopressor support and found no difference in neurologic recovery and increased risk of cardiac complications (ventricular tachycardia, troponinemia, atrial fibrillation).[43] A 2016 study assessed 14 patients with complete penetrating SCI who received vasopressor-assisted MAP augmentation and found that 10 patients experienced cardiogenic complications and only one patient experienced neurologic recovery.[44]

Many neurosurgical and trauma guidelines support elevated MAP goals for patients with SCI, but strong evidence is lacking regarding the benefit of this management strategy. Moreover, the potential complications of vasopressor usage may outweigh its benefits.

TRAUMATIC CARDIAC ARREST

Successful resuscitation with intracardiac and intravenous injection of epinephrine chloride in acute cardiac failure was first introduced by Dennis Crile, employing massive doses.[45] In one case report, Paul Champlin described a patient admitted to the hospital for suprapubic prostatectomy who sustained cardiac arrest intraoperatively following caudal anesthesia administration. An injection of 10 c.c. of a 1:1000 epinephrine chloride solution was immediately given afterward, directly into his left ventricle. Return of spontaneous circulation (ROSC) was achieved; the patient showed no ill effect of the procedure and went on to have a successful prostatectomy.[45]

Currently, the use of epinephrine in cardiac arrest is a recommended component of the ACLS algorithms, however, these are not specific for traumatic cardiac arrests (TCA).[46] Data extrapolated from pooled medical and traumatic cardiac arrest patients have been cited to support persistent use of epinephrine in TCA. In a randomized, double-blinded trial by Perkins *et al*, outcomes were compared between patients with out-of-hospital cardiac

arrest who received intravenous/intraosseous epinephrine versus a saline placebo.[47] It is important to note that the patient population was largely composed of medical cardiac arrest patients, with less than 2% having a traumatic cause in either group (n=66/4015 in the Epinephrine group; and n=57/3999 in the Placebo group). Epinephrine use resulted in higher 30-day survival than placebo. There was no difference between the rate of favorable neurologic outcome among the two groups, but more survivors in the epinephrine group had severe neurologic impairment.[47]

More importantly, evidence in the literature regarding the impact of epinephrine on traumatically injured with cardiac arrest is largely inconsistent. A systematic review analyzing the impact of intravenous epinephrine in patients with traumatic out-of-hospital cardiac arrest (TOHCA) did not demonstrate any benefit for prehospital ROSC, in-hospital survival or short-term survival.[48] Similarly, in a single-center retrospective study of adult patients with prehospital traumatic cardiac arrest, no difference in 24-hour survival or survival to discharge was found between the group who received prehospital epinephrine compared with those who did not.[49] However, the administration of prehospital epinephrine was associated with increased odds of sustained ROSC in the former group compared with the latter.[49] In their retrospective cohort study, Chiang *et al* examined the outcomes in adult patients with TCA with and without the administration of epinephrine. The researchers found a higher sustained ROSC and survival-to-discharge rate with the use of epinephrine, with a greater benefit observed on patients with ROSC with a longer prehospital time.[50] Conversely, a prospective observational study using propensity score-matched groups of patients with TOHCA showed that the administration of epinephrine was linked with lower 7-day survival odds.[51] The lack of robust evidence supporting or refuting the use of epinephrine in TOHCA highlights an important future area of research to guide care for these critically injured patients.

SPECIAL POPULATIONS

Pediatrics

Similarly to adults, hypotension is associated with an increased risk of death in pediatric patients with trauma.[52] Despite its importance in establishing prognosis, there is considerable variability among guidelines used to even define pediatric hypotension.[53] A retrospective chart review of medical and surgical patients admitted to a single pediatric hospital showed increased in-hospital mortality associated with vasopressor requirements in pediatric patients. The odds of death approximately doubled with the addition of each vasopressor. While only 6% (n=99/1654) of patients included in the study were admitted with a trauma-related diagnosis, 15% (n=15/99) of patients with trauma who received a vasopressor died.[54] A similar trend has been identified in patients with pediatric trauma with blunt liver or spleen injuries. Patients with these injuries requiring vasopressors for hypotension in the emergency department had an 11-fold increase in mortality compared with those who did not.[55] The limited, existing observational data demonstrates a significant association between the need for hemodynamic support and mortality in pediatric patients; however, additional data are needed to understand the potential risks and benefits of early vasopressors in this population. Moreover, patient mortality is likely due to patient injury severity and not exposure to vasopressors.

Geriatrics

As seen in the pediatric trauma literature, there are few studies assessing the risks and benefits of vasopressors in geriatric trauma patients. The 2023 World Society of Emergency Surgery Guidelines on the Management of Trauma in Elderly and Frail Patients recommend vasopressor use in this population if a trial of volume resuscitation is unsuccessful. However, this recommendation was made based on studies done in adult patients with trauma, not data collected on an exclusively elderly cohort.[56] The most recent EAST Practice Management Guidelines on Geriatric Trauma do not make any recommendations regarding the use of vasopressors.[57] Existing observational data in geriatric trauma patients raises concern over the benefits of vasoactive medications. A retrospective review of senior polytrauma patients with orthopedic injuries showed patients who did not survive admission were more likely to have required vasopressors.[58] In patients >65 years of age with acute spinal cord injuries, vasopressors are frequently required to maintain MAP goals consistent with current practice guidelines.[41 59] Despite maintenance of MAP within the goal range, fewer than 10% of elderly patients with SCI were shown to have improvement in ASIA impairment scale in one observational study. In this same cohort, over 90% of those exposed to vasopressors experienced a cardiovascular complication.[59] Future research must intentionally recruit senior trauma patients to further understand what, if any, role vasopressors have in this subpopulation.

Pregnancy

Increased blood volume and heart rate coupled with fluctuations in blood pressure throughout pregnancy can complicate the typical hemodynamic signs of shock in pregnant trauma patients.[60] These adaptations are critical to support the developing fetus and make permissive hypotension deleterious in this patient population.[61] While EAST does not mention vasopressors in their Practice Management Guidelines on Pregnancy and Trauma, the American College of Obstetricians and Gynecologists supports their use as a 'last resort' due to reductions in uterine blood flow.[62 63] The Society of Obstetricians and Gynaecologists of Canada makes similar recommendations, noting the increased sensitivity of uteroplacental vasculature to catecholamines.[64] Consistent with data showing the safety of norepinephrine use for hypotension associated with spinal anesthesia during cesarean delivery, the French Society of Anesthesiology and Critical Care support its use for hypotension not responsive to fluids.[61] All of the aforementioned recommendations relied on data extrapolated from non-pregnant trauma patients or pregnant patients presenting for non-trauma-related care. Despite a critical need for research focused on this subgroup of patients with trauma, recruitment of pregnant women into trials can be difficult due to frequent concern over harm to the fetus with experimental interventions.[65]

CONCLUSION

Historical resistance to early vasopressor use in trauma patients is being challenged by the recent literature. Beneficial effects of vasopressin supplementation in hemorrhagic shock have been seen in small randomized controlled trials, while clinical outcomes data on patients with TCA, SCI and TBI are mixed. Pending larger multicenter trials, it is plausible that the role of vasopressors in trauma care will become more commonplace in hemorrhagic shock. Data on vasopressor use are limited in the pediatric, geriatric and pregnant trauma patient populations; therefore, special attention should be given to understanding

how the unique physiology of these groups is impacted by these medications.

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