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Prioritizing circulation over airway in trauma patients with exsanguinating injuries: What you need to know

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ABSTRACT: Hemorrhage remains a leading cause of preventable trauma-related mortality, with early resuscitation and hemorrhage control serving as crucial interventions. Emerging evidence suggests that prioritizing circulation before airway (Circulation, Airway, and Breathing [CAB]) during initial resuscitation in patients with exsanguinating injuries can improve survival by avoiding the deleterious effects of postintubation hypotension. This article reviews current evidence supporting the CAB approach and outlines best practices across prehospital, emergency department, and operative settings. Delaying advanced airway management while focusing on immediate hemorrhage control and blood product resuscitation has been associated with decreased 24-hour and 30-day mortality. This review synthesizes findings from recent multicenter trials and literature supporting the CAB paradigm, with practical recommendations for implementation in trauma care systems. (*J Trauma Acute Care Surg.* 2025;00: 00–00. Copyright © 2025 The Author(s). Published by Wolters Kluwer Health, Inc. on behalf of the American Association for the Surgery of Trauma.)

Exsanguination accounts for nearly 40% of trauma-related deaths worldwide, underscoring the urgent need for early interventions focused on hemorrhage control and restoring perfusion.[1] Emerging evidence supports a paradigm shift toward prioritizing circulation before airway management with intubation (Circulation, Airway, and Breathing [CAB]) in patients with exsanguinating injuries.[2–9] In the context of exsanguinating injuries, the patient exhibits gasping for air in order to centralize blood flow—redirecting circulation from the extremities and the splanchnic circulation to the heart and brain. Concurrently, compensatory peripheral vasoconstriction develops to maintain adequate perfusion of these critical areas, which is a normal physiological response during severe hemorrhagic shock[2–9](Fig. 1). Early endotracheal intubation in profoundly hypovolemic patients can exacerbate hypotension by disrupting catecholamine-mediated vasoconstriction and reducing venous return due to positive pressure ventilation, potentially leading to cardiac arrest[2–11] (Fig. 2). A growing body of literature suggests that improved survival and neurological outcomes can be achieved by prioritizing hemorrhage control and hemostatic resuscitation over advanced airway management with intubation. This review explores the rationale behind the circulation-first approach and its implications for trauma care across prehospital, emergency, and operative settings.

PREHOSPITAL CONSIDERATIONS: THE NEED FOR CAB IN THE FIELD

The continuum of hemorrhage control and resuscitation starts with first responders in the prehospital setting.[8] Through legislative advocacy by national and local prehospital blood coalitions, awareness has increased regarding the expansion of scope for advanced resuscitative care by EMS teams.[12–16] In the prehospital setting, the CAB approach is critical, especially for trauma patients with severe hemorrhage.[8]

The first component of a circulation-first approach is rapid control of bleeding using techniques such as extremity tourniquets, junctional hemorrhage control devices, and effective wound packing.[2–10] For extended prehospital transports or interfacility transfers, advanced interventions such as resuscitative endovascular balloon occlusion of the aorta (REBOA) can be crucial for stabilizing patients with noncompressible torso hemorrhage until they reach definitive care.[16]

Once hemorrhage control has been achieved, restoration of circulating blood volume must be prioritized to reverse shock and mitigate the potential adverse consequences of advanced airway management with intubation, including hypotension and cardiac arrest. Studies indicate that prioritizing circulation first reduces the need for intubation by improving shock parameters, mental status, and spontaneous airway control.[8,10–16]

TRAUMA BAY: RESUSCITATION FIRST, AIRWAY SECOND

Upon arrival at the emergency department, hemorrhage control and hemodynamic stabilization must remain the primary

Submitted: February 25, 2025, Accepted: March 3, 2025, Published online: July 4, 2025.

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Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (www.jtrauma.com).

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DOI: 10.1097/TA.0000000000004618

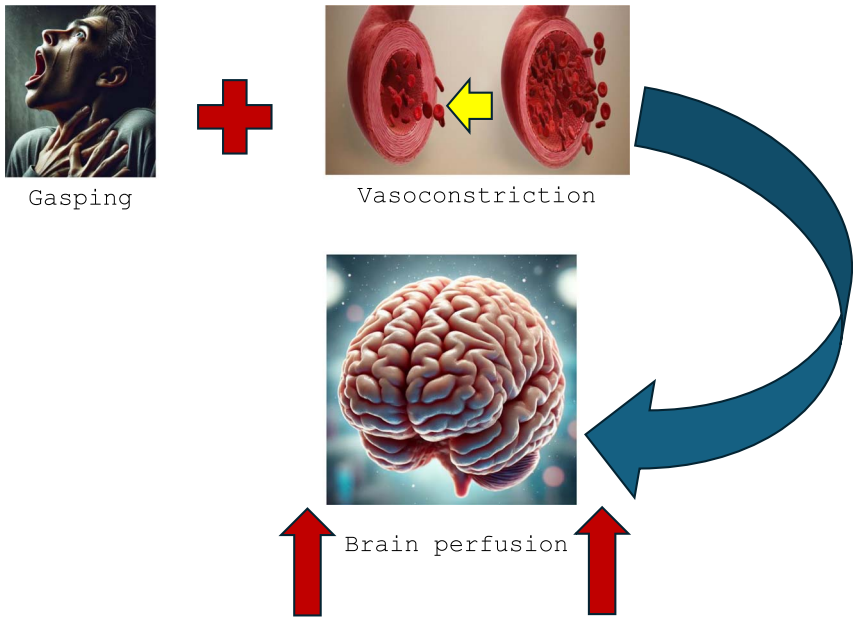

Figure 1. Normal physiology of the patient with exsanguinating injuries.

objectives, particularly in patients with exsanguinating injuries. While some guidelines suggest intubating patients with a Glasgow Coma Scale score of less than 8, this recommendation must be reconsidered in cases of profound hemorrhagic shock.[14] In these patients, a depressed Glasgow Coma Scale is often not due to a primary neurologic injury but rather to inadequate cerebral perfusion secondary to massive blood loss.[2–17] Addressing circulation first, through aggressive hemorrhage control and blood product resuscitation, can restore perfusion and potentially improve mental status without the immediate need for intubation.[2–17]

Securing the airway prematurely in these critically hypovolemic patients can be physiologically catastrophic.[2–16] Positive pressure ventilation reduces venous return, further exacerbating hypotension and increasing the risk of cardiovascular collapse and cardiac arrest. Current evidence supports delaying intubation in favor of early blood product resuscitation, which improves survival by restoring oxygen delivery to vital organs. Whole blood should be the first-line resuscitative fluid in these patients because of its ability to provide oxygen-carrying capacity, coagulation factors, and volume expansion simultaneously. When whole blood is not available, balanced blood product resuscitation, which is administering red blood cells (RBCs), plasma, and platelets in a 1:1:1 ratio, should be prioritized over crystalloids, which contribute to hemodilution, worsening coagulopathy, and exacerbation of acidosis.[1,10]

In situations where intubation cannot be avoided, the choice of induction medications is critical to minimizing hemodynamic collapse. Agents with lower cardiovascular impact, such as ketamine or etomidate, should be preferred over agents like propofol, which can cause profound hypotension. Similarly,

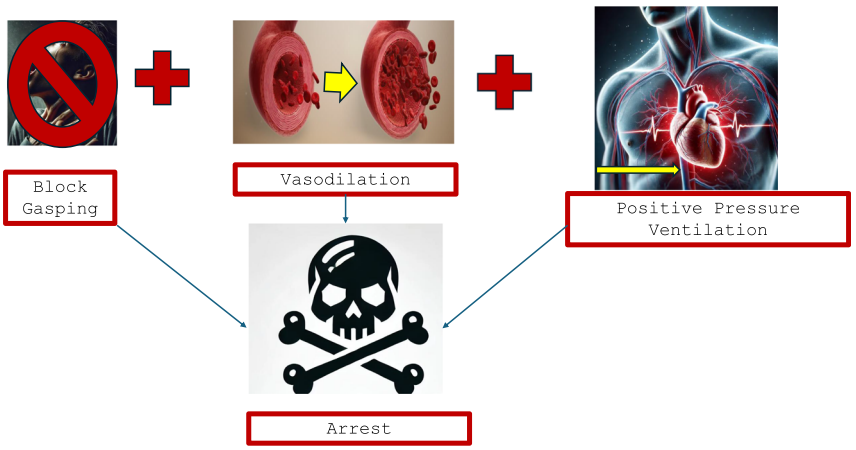

Figure 2. Physiology after intubation.

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using lower doses of paralytics and considering blood product resuscitation before induction can help mitigate peri-intubation cardiovascular instability.[2–9]

The successful implementation of these resuscitation strategies requires strong partnerships between trauma teams, emergency medicine, anesthesia, and critical care providers. Effective communication ensures that intubation decisions are made with consideration of the patient's volume status, that blood product administration is prioritized, and that airway management strategies are optimized to prevent avoidable cardiac arrest. In the context of hemorrhagic shock, the paradigm must shift away from a rigid adherence to early intubation and instead emphasize circulation-first resuscitation to maximize survival.

OPERATIVE AND INTERVENTIONAL SETTINGS: INTEGRATING CAB IN SURGERY AND IR

The principles of CAB extend seamlessly into both the operating room and interventional radiology (IR), emphasizing the critical importance of rapid hemorrhage control. In the setting of trauma and massive bleeding, every moment and every drop of blood count. Prioritizing immediate and expeditious control of bleeding before airway management with intubation can be lifesaving, as premature intubation in an unstable patient may precipitate cardiovascular collapse.[1,5–8]

In patients with severe hemorrhage, delaying intubation until hemodynamic stabilization is achieved can prevent peri-intubation cardiac arrest. When feasible, IR-guided interventions should proceed without intubation, using deep sedation and analgesia to minimize disruption of physiological compensatory mechanisms.[18] In cases where airway management is unavoidable, preemptive measures such as REBOA can help improve central perfusion and mitigate further hemodynamic deterioration before induction.[19,20]

In the operating room, damage-control surgery should be prioritized—swiftly identifying and controlling sources of hemorrhage with the intent of staging interventions rather than prolonging operative time. Techniques such as temporary abdominal closure, vascular shunting, and adjunctive hemostatic interventions should be used with the understanding that definitive repair can be safely deferred until resuscitation and coagulopathy are optimized.[21,22]

Resuscitation strategies must be aligned with these principles, ensuring minimal reliance on crystalloids, which can exacerbate the lethal triad of trauma. Instead, whole blood and balanced transfusion protocols (1:1:1 ratio of plasma, platelets, and RBCs) should be the mainstay. Effective communication with anesthesia is paramount to synchronizing resuscitative efforts, ensuring that blood product administration matches the patient's ongoing losses and that every aspect of the perioperative strategy is geared toward hemostasis.[1,21]

Ultimately, every action taken in the management of a bleeding patient must be aimed at minimizing blood loss and preserving perfusion. Whether through surgical intervention, endovascular techniques, or strategic resuscitation, the guiding principle remains the same—every drop of blood matters, and control of hemorrhage must never be delayed.

PEDIATRIC TRAUMA CONSIDERATIONS

The principles of CAB are particularly relevant in pediatric trauma resuscitation because of the unique physiological responses of children to hemorrhagic shock. Unlike adults, pediatric patients maintain stability through remarkable compensatory mechanisms until they experience sudden and profound decompensation. Hypotension is often a late sign of shock in children, occurring only after they have lost more than 40% of their blood volume. Given this, a proactive approach to hemorrhage control, early blood product administration, and delayed intubation when possible is crucial for optimizing survival outcomes. Circulation, Airway, and Breathing represents a paradigm shift in trauma resuscitation, emphasizing early transfusion, adherence to massive transfusion protocols, and prioritization of circulation before airway management with intubation. While securing the airway is often a priority in trauma care, in pediatric patients with hemorrhagic shock, early intubation can precipitate cardiovascular collapse. Postintubation hypotension is a well-documented risk, reinforcing the need to optimize circulation before proceeding with airway management with intubation.[23,24]

A key challenge in pediatric trauma resuscitation is the early recognition of hemorrhagic shock and the timely initiation of damage-control resuscitation.[23,24] Studies indicate that delays in recognizing life-threatening hemorrhage and initiating transfusion significantly impact survival. The prolonged duration of massive transfusion protocols in pediatric trauma cases compared with adults underscores the need for streamlined resuscitative efforts and improved coordination among trauma teams, anesthesia, and blood banks.[23,24] Early and balanced transfusion of blood products is crucial, as excessive crystalloid resuscitation is linked to poorer outcomes, including prolonged mechanical ventilation, increased intensive care unit stays, and higher mortality. The Pediatric Traumatic Hemorrhagic Shock Consensus Conference recommends limiting crystalloid resuscitation to a single 20 mL/kg bolus before transitioning to blood products, with whole blood as the preferred resuscitative fluid. In facilities without access to whole blood, a 1:1:1 ratio of RBCs, plasma, and platelets should be prioritized. Data from the Trauma Quality Improvement Program indicate that higher plasma-to-RBC ratios significantly improve survival, with a plasma/RBC ratio of at least 1:2 associated with a 51% reduction in 24-hour mortality in massively transfused children. Implementing institution-wide protocols, including pediatric-specific massive transfusion protocols and activation teams composed of trauma surgeons, anesthesiologists, pharmacists, and nursing leadership, has been shown to improve transfusion ratios, expedite blood product administration, and optimize resuscitation outcomes. By integrating these evidence-based strategies, CAB can be effectively applied to pediatric trauma care, ultimately improving survival and long-term outcomes for critically injured children.[23,24]

PRACTICAL IMPLEMENTATION OF CAB

Circulation, Airway, and Breathing is not just a concept or a single intervention; it is a resuscitation bundle that integrates multiple coordinated actions to optimize survival in trauma patients.[9] It encompasses delaying intubation when feasible, using airway adjuncts to maintain oxygenation while prioritizing

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circulation, and fostering close collaboration with IR to pursue minimally invasive hemorrhage control when appropriate. Effective communication with anesthesia is critical to ensure hemostatic and euvolemic resuscitation using blood and blood products while minimizing crystalloid use, which can exacerbate coagulopathy and acidosis. Circulation, Airway, and Breathing also demands engagement with emergency medical services to facilitate early recognition of hemorrhagic shock and prehospital resuscitation strategies that align with in-hospital care. Partnerships with emergency medicine colleagues further ensure seamless transitions of care, expediting hemorrhage control in the operating room while using techniques to prevent cardiovascular collapse. Ultimately, CAB is a dynamic, multidisciplinary approach that unites trauma surgery, anesthesia, critical care, and emergency medicine in a shared mission to preserve circulation, optimize perfusion, and prevent avoidable deaths.

To effectively implement CAB in trauma resuscitation, a structured approach is necessary:

Circulation (C)

- Immediate hemorrhage control when feasible (tourniquets, wound packing, hemostatic dressings)
- Use REBOA when appropriate for noncompressible hemorrhage
- Initiate whole blood and balanced transfusion ratios early
- Avoid excessive crystalloid use to prevent dilutional coagulopathy
- Engage surgical teams early for rapid operative intervention

Airway (A)

- Delay intubation until resuscitation is initiated
- Use adjuncts such as passive oxygenation, supraglottic airways, and sedation-based approaches
- Avoid paralytics until volume resuscitation is optimized
- Use medications that have less hemodynamic consequences if intubation is unavoidable

Breathing (B)

- Use lung-protective ventilation strategies (low tidal volumes, permissive hypercapnia when tolerated)
- Consider noninvasive ventilatory modalities if appropriate
- Optimize perfusion before positive pressure ventilation.

CONCLUSION

The paradigm shift toward prioritizing circulation over airway in exsanguinating trauma patients is supported by growing evidence indicating improved survival and reduced postintubation hypotension. Circulation, Airway, and Breathing is not a single intervention, but rather a bundled approach encompassing early resuscitation with blood and blood products, hemorrhage control, and thoughtful airway management. Implementing a CAB-first approach in prehospital, emergency department, and operative settings aligns with modern resuscitation strategies, ensuring that hemorrhage control and perfusion restoration remain the primary focus of early trauma care. Continued research and education on CAB implementation are essential to optimizing trauma resuscitation and reducing preventable mortality.

DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/E662).

REFERENCES

1. Lammers DT, Holcomb JB. Damage control resuscitation in adult trauma patients: what you need to know. *J Trauma Acute Care Surg*. 2023;95(4):464–471.
2. Ferrada P, Dissanaike S. Circulation first for the rapidly bleeding trauma patient—it is time to reconsider the ABCs of trauma care. *JAMA Surg*. 2023;158(8):884–885.
3. Dunton Z, Seamon MJ, Subramanian M, et al. Emergency department versus operating room intubation of patients undergoing immediate hemorrhage control surgery. *J Trauma Acute Care Surg*. 2023;95(1):69–77.
4. Ferrada P. Shifting priorities from intubation to circulation first in hypotensive trauma patients. *Am Surg*. 2018;84(2):e75–e76.
5. Ferrada P, Callcut RA, Skarupa DJ, et al. Circulation first—the time has come to question the sequencing of care in the ABCs of trauma. *World J Emerg Surg*. 2018;13:8.
6. Ferrada P, García A, Duchesne J, et al. Comparing outcomes in patients with exsanguinating injuries: an EAST multicenter, international trial evaluating prioritization of circulation over intubation. *World J Emerg Surg*. 2024;19(1):15.
7. Green RS, Butler MB, Erdogan M. Increased mortality in trauma patients who develop postintubation hypotension. *J Trauma Acute Care Surg*. 2017;83(4):569–574.
8. Ritondale J, Piehl M, Caputo S, et al. Impact of prehospital exsanguinating airway-breathing-circulation resuscitation sequence on patients with severe hemorrhage. *J Am Coll Surg*. 2024;238(4):367–373.
9. Ferrada P, Ferrada R, Jacobs L, Duchesne J, Ghio M, Joseph B, Taghavi S, Qasim ZA, Zakrison T, Brenner M, Dissanaike S, Feliciano D. Prioritizing circulation to improve outcomes for patients with exsanguinating injury: a literature review and techniques to help clinicians achieve bleeding control. *J Am Coll Surg*. 2024;238(1):129–136.
10. Buzzard L, Schreiber M. Trauma-induced coagulopathy: what you need to know. *J Trauma Acute Care Surg*. 2024;96(2):179–185.
11. Deeb AP, Guyette FX, Daley BJ, Miller RS, Harbrecht BG, Claridge JA, Phelan HA, Eastridge BJ, Joseph B, Nirula R, Vercruysse GA, Sperry JL, Brown JB. Time to early resuscitative intervention association with mortality in trauma patients at risk for hemorrhage. *J Trauma Acute Care Surg*. 2023;94(4):504–512.
12. Doucet J, Shatz DV, Kaplan LJ, Bulger EM, Capella J, Kuhls DA, Fallat M, Remick KN, Newton C, Fox A, Jawa R, Harvin JA, Blake DP, Bukur M, Gates J, Ficke J, Gestring ML, American Association for Surgery of Trauma Disaster Committee. Are trauma surgeons prepared? A survey of trauma surgeons' disaster preparedness before and during the COVID-19 pandemic. *Trauma Surg Acute Care Open*. 2023;8(1):e001073.
13. Committee on Trauma. *ATLS. Advanced Trauma Life Support. Student Course Manual*. 10th ed. Chicago, IL: American College of Surgeons; 2018.
14. Broome JM, Nordham KD, Piehl M, et al. Faster refill in an urban EMS system saves lives. *J Trauma Acute Care Surg*. 2024;96(5):702–707.
15. Gumeniuk KV, Sivash YY, Rogovskyi VM, et al. First experience of endovascular balloon occlusion of the aorta in the wounded during war in Ukraine. *Emerg Med*. 2024;20(6):433–447.
16. Anand T, Hejazi O, Conant M, Joule D, Lundy M, Colosimo C, Spencer A, Nelson A, Magnotti L, Joseph B. Impact of resuscitation adjuncts on postintubation hypotension in patients with isolated traumatic brain injury. *J Trauma Acute Care Surg*. 2024;97(1):112–118.
17. Prichayudh S, Rajruangrabin J, Sriussadaporn S, Pak-Art R, Sriussadaporn S, Kritayakirana K, Samorn P, Narueponjirakul N, Uthaipaisanwong A, Aimsupanimitr P, Chaisiriprasert P, Kranokpiraksa P, Chanpen N, Pinjaroen N, Ouwongprayoon P, Charoenvisal C, Jantarattana T. Trauma hybrid operating room (THOR) shortened procedure time in abdominopelvic trauma patients requiring surgery and interventional radiology procedures. *Injury*. 2023;54(2):513–518.
18. Brenner M, Moore L, Dubose J, Scalea T. Resuscitative endovascular balloon occlusion of the aorta (REBOA) for use in temporizing intra-abdominal and pelvic hemorrhage: physiologic sequelae and considerations. *Shock*. 2020;54(5):615–622.
19. Cralley AL, Vigneshwar N, Moore EE, Dubose J, Brenner ML, Sauaia A, AAST AORTA Study Group. Zone 1 endovascular balloon occlusion of

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the aorta vs resuscitative thoracotomy for patient resuscitation after severe hemorrhagic shock. *JAMA Surg*. 2023;158(2):140–150.
20. Holcomb JB, Tilley BC, Baraniuk S, Fox EE, Wade CE, Podbielski JM, del Junco DJ, Brasel KJ, Bulger EM, Callcut RA, Cohen MJ, Cotton BA, Fabian TC, Inaba K, Kerby JD, Muskat P, O'Keeffe T, Rizoli S, Robinson BR, Scalea TM, Schreiber MA, Stein DM, Weinberg JA, Callum JL, Hess JR, Matijevic N, Miller CN, Pittet JF, Hoyt DB, Pearson GD, Leroux B, van Belle G, PROPPR Study Group. Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma: the PROPPR randomized clinical trial. *JAMA*. 2015;313(5):471–482.
21. Dhillon NK, Kwon J, Coimbra R. Fluid resuscitation in trauma: what you need to know. *J Trauma Acute Care Surg*. 2025;98(1):20–29.
22. Russell RT, Leeper CM, Spinella PC. Damage-control resuscitation in pediatric trauma: what you need to know. *J Trauma Acute Care Surg*. 2023;95(4):472–480.
23. Sullivan TM, Gestrich-Thompson WV, Milestone ZP, Burd RS. Time is tissue: barriers to timely transfusion after pediatric injury. *J Trauma Acute Care Surg*. 2023;94(1S Suppl 1):S22–S28.
24. Russell RT, Esparaz JR, Beckwith MA, Abraham PJ, Bembea MM, Borgman MA, et al. Pediatric traumatic hemorrhagic shock consensus conference recommendations. *J Trauma Acute Care Surg*. 2023;94(1S Suppl 1):S2–S10.

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