Research Article

Journal of Pediatrics Research & Child Health Reports

# Hemorrhagic Shock Involve Inadequate Blood Circulation in Children

**Siniša Franjić***

*Independent Researcher*

***Correspondence Author:**
Siniša Franjić, Independent Researcher.

**Citation:** Siniša Franjić. Hemorrhagic Shock Involve Inadequate Blood Circulation in Children. *J Pediatr Res Child Health Rep.* 2026, 1(1), 01-04.

**Received Date:** 10 July 2026 **Accepted Date:** 18 July 2026 **Published Date:** 28 July 2026

## Abstract

*Shock is a medical condition resulting from sudden failure of the circulation, leading to insufficient blood flow and lack of necessary nutrients for tissues. All forms of shock involve inadequate blood circulation, prompting the body to initiate various compensatory mechanisms to sustain the circulation of essential organs.*

**Keywords:** Hemorrhagic Shock, UCHS, Circulation, Pediatrics, Health

## Introduction

Efforts to enhance survival rates after bleeding and to reduce complications that follow are ineffective if the bleeding is not promptly detected, and they become less effective if actions are delayed [1]. The early phases of hemorrhagic shock can be hard to recognize because the initial signs often resemble the body's typical stress responses. Recognizing hemorrhagic shock in children is particularly difficult compared to adults because their strong compensatory systems can keep blood pressure normal until loss of blood volume exceeds 40%. Relying solely on low blood pressure as a signal for hemorrhage in children may postpone needed treatment until shock progresses to a point where it could become fatal. Early indicators of hemorrhagic shock, such as a rapid heartbeat, might help spot serious bleeding sooner, yet they can also occur in other bodily conditions, which might lead to unnecessary blood transfusions if assessed in isolation. Quick response to hemorrhagic shock is linked to improved survival for adults and reduced complications in both children and adults while hospitalized. Rapid treatment of hemorrhagic shock has shown benefits in avoiding multiorgan failure, serious infections, and a reduction in time spent in hospitals, intensive care, and on ventilators. Although prompt management of hemorrhage likely enhances survival in injured children, there have been few studies focused on the effects of timely interventions in this group.

Several scoring systems have been created to help doctors recognize and manage bleeding after injuries in adults and have been adapted for use in children. These scoring systems take into account physical signs, imaging results, and lab results to formulate a score that indicates the likelihood or need for intervention in cases of hemorrhage.

## Shock

Shock stands as a serious pathophysiological state where there is not enough oxygen and other vital substances supplied to tissues, causing cell malfunction [2]. There are various reasons for shock, including hemorrhagic shock from injuries, obstructive shock due to a blockage in blood flow like a pulmonary embolism, and septic shock caused by infections like appendicitis. In all situations, quick detection and treatment of shock is crucial to avoid the progression to multiorgan failure and to save lives. Shock is identified based on clinical observation, but its diverse and nonspecific symptoms can make diagnosis difficult, particularly in children with intricate chronic illnesses. As shock advances, patients transition from a compensated state, where bodily systems can maintain sufficient blood flow to tissues, to an uncompensated state marked by severe damage to organs and tissues. Taking early action in this continuum of decline can potentially reverse the shock and lower the associated risks of complications and death linked to this significant medical condition.

Every doctor who treats children will see patients experiencing shock. The objectives of managing shock initially are consistent no matter what causes it: (1) quick identification,

(2) proactive cardiovascular support, and (3) assistance with organ failure. While these actions should start at the local level, effective treatment often necessitates transferring the patient to a more advanced care facility sooner rather than later.

**UCHS**

Typically, robust fluid replacement is necessary, often starting with a fluid bolus of 20 mL/kg (for severe situations, 40 to 60 mL/kg may be used) [3]. If it is hard to establish vascular access, an intraosseous needle should be utilized instead.

There are, however, some caveats to aggressive fluid resuscitation. When dealing with cardiogenic shock, trauma, or diabetic ketoacidosis, smaller boluses of 10 mL/kg are recommended.

In cases of uncontrolled hemorrhagic shock (UCHS), where bleeding might have ceased due to low blood pressure, quickly raising blood pressure can cause renewed bleeding ("popping the clot"), worsened bleeding control, and worse overall outcomes compared to a hypotensive approach. Thus, the main goal is to stop the bleeding before initiating extensive resuscitation.

• "Scoop and run"
–– If the journey to the surgical centre is <1 h, then following protection of the Airway and Breathing → immediate transport (with IV resuscitation along the way). If >1 h, then establish IV line and fluids first.

• "Permissive hypotension"
–– If UCHS consider small aliquots of fluid based on:
- Loss of radial pulse
- Mental awareness
- Systolic <80 mmHg (adults)

• Empirical observation suggests that the volume of crystalloid required is 3:1, the estimated deficit in CBV.

Example: 20% loss in CBV in 10 kg child—assumes 160 mL blood lost, which needs ~480 mL of saline to compensate.

Safe practice (neither under nor over) requires bolus administration and then review vital signs and status. The goal is a well-perfused child with warm peripheries (e.g. CRT <2 s), improved mental status (may start complaining and be more aware of pain), and improved vital organ function (e.g. renal—aim for urine output 1–2 mL/kg/h).

If fluid overloaded, stop further fluids and start inotropes. Remember to correct hypoglycaemia and hypocalcaemia (calcium may be low due to parathyroid hormone impairment, decreased circulating vitamin D hydroxylation, increased end-organ resistance and citrate from blood products binding free calcium). If signs of end-organ dysfunction persist, start peripheral or IO dopamine.

Transfusion of blood may be needed (typically for Class III/ IV shock):

• Urgently
–– Uncrossmatched O negative if >40% loss of CBV.

• Emergently
–– Crossmatched, type-specific.

• Electively
–– Following fluid resuscitation and hemodilution—aim for Hb > 80 g/L.

**Circulation**

The objectives of assessing and managing blood circulation are as follows: (1) detect shock, (2) rapidly secure intravenous access, and (3) properly start resuscitation [4]. While these aims seem straightforward, handling hemorrhagic shock in kids involves distinct difficulties. For instance, the blood volume in children is relatively small, around 70 mL for every kilogram of body weight (80 mL for infants). A toddler weighing 10 kg is on the verge of severe shock with blood loss equal to about a 12 oz. soda can. This volume can be lost unnoticed. Moreover, pediatric shock can quietly develop until it leads to cardiovascular failure. In contrast to adults, children usually do not boost their stroke volume; they rely on their heart rate to keep cardiac output steady. Blood pressure is sustained through cardiac output (increased heart rate) and higher vascular tone until the later stages of hemorrhagic shock. Blood pressure might remain stable even after losing up to 45% of the total blood volume. A child in the trauma area appearing calm but having a fast heartbeat and cool limbs should raise concerns for the doctor—this indicates a child in danger of immediate cardiovascular failure. Although a rapid heartbeat is the most reliable sign of shock, it is not exclusive to this condition. Anxiety, fear, and pain can also lead to a fast heartbeat in an injured child. Clinical experience plays a crucial role in interpreting the subtle signs that explain why a child might have a fast heartbeat. A slow heartbeat should also cause worry, as it can indicate looming cardiovascular failure.

When major external bleeding is noticed, immediate direct pressure should be applied. Otherwise, to evaluate circulation, one should promptly check for central pulses, measure blood pressure (using an appropriately sized cuff), and attach EKG leads. Next, gaining venous access is essential. However, securing venous access in a child with low blood volume can be difficult, often taking up valuable time and resources. At our facility, after 2 minutes or 2 unsuccessful attempts at gaining peripheral access, we will opt for ultrasound guidance before considering intraosseous access. The ideal site for intraosseous access is the upper tibia just beneath the tibial tuberosity, although the lower femur can also be used. It is advisable to avoid accessing injured limbs if possible. The potential complications from intraosseous access include infections, bone infections, compartment syndrome, and accidental fractures. While central venous access could be an option, it can be tricky and time-consuming in a child with low blood volume. Sometimes, if a child needs considerable resuscitation and other methods have not worked, cutting down the proximal or distal saphenous vein can be beneficial. Still, intraosseous access should be the first choice for a critically ill child without any access options.

After gaining access, the way to provide volume varies based on the child's weight and the severity of their low blood volume. If major resuscitation is needed for children weighing 50 kg, the push-pull method, which involves a 20- to 30-mL syringe and a three-way stopcock, is an effective way to quickly deliver volume. For older children requiring large volume resuscitation, pressure bags and rapid infusion systems are suitable. The strategies of damage control resuscitation have been integrated into pediatric trauma treatment, including prompt control of bleeding, limiting the use of crystalloid fluids, early blood product transfusion, and implementing massive transfusion protocols to ensure balanced distribution of blood components. Typically, children will initially receive a 20 mL/kg bolus of normal saline. In stable children with controlled bleeding, a second bolus of crystalloid may be given. However, for those in hemorrhagic shock, it is important to provide O-negative blood early. In cases of uncontrolled hemorrhagic shock, it may be necessary to consider activating the massive transfusion protocol. Pediatric trauma management has developed alongside adult trauma care to the point where there is no longer a required volume of crystalloid that must be administered before giving blood. As resuscitation progresses, it is crucial for the medical team to monitor the response to volume infusion. Signs that a patient is reacting positively to volume replacement include better mental status, reduced heart rate, increased urine production, and shorter capillary refill times with enhanced blood flow to extremities. The next objective for the clinician is to determine if this response is lasting or temporary, as this will influence further management.

## Binary Scoring System

Binary scoring systems can be analyzed using a 2 × 2 confusion matrix, which shows the counts for true positives, true negatives, false positives, and false negatives [1]. Earlier trauma assessments have utilized common metrics to interpret the confusion matrix, such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, F1 score, and Matthew's correlation coefficient (MCC). Additionally, the area under the receiver operating characteristic curve (AUROC) has also been noted. For every reporting scoring system, we pinpointed these performance metrics when they were used. When data was unavailable, we created a 2 × 2 confusion matrix with the information presented in the study and derived the other metrics.

The evaluation of a binary scoring system's effectiveness relies on whether the occurrence of positive (intervention for hemorrhage) and negative (no intervention for hemorrhage) cases is equal or not. Since instances of hemorrhage following injuries in children are rare, there are far more negative cases than positive ones, leading to an unbalanced 2 × 2 confusion matrix. Metrics like accuracy and AUROC may not be trustworthy indicators of performance for the broader group of injured children because they are affected by the larger group (e. g. , children who do not undergo hemorrhage intervention), which can create an inaccurately positive view of effectiveness. The F1 score and Matthew's Correlation Coefficient (MCC) are better metrics to use than accuracy and AUROC when dealing with unbalanced data. The F1 score mitigates the impact of a dominant group of negative events by leaving these cases out of the calculation. While the F1 score offers a clearer assessment of performance for predicting positive events, it does not reflect the scoring system's capability to accurately identify negative events unless the positive cases are treated as negative cases (class swapping). On the other hand, the MCC provides a single metric that is not limited by data imbalance or class swapping and gives an evaluation of the scoring system's accuracy in classifying both positive and negative events.

## Scoring Systems

Scoring structures consist of the pediatric age-adjusted shock index (SIPA), inclusion of the Glasgow Coma Scale [GCS] rating to kids with improved SIPA values (SIPA+GCS), the pediatric shock index (PSI), the fast pediatric shock index (rPSI), the reverse shock index with GCS rating (rSIG), the pediatric evaluation of blood consumption rating (ABC-D), the scoring gadget combining base deficit, international normalized ratio [INR] value, and SIPA (BIS), and the Bayesian probabilistic model: Transfusion pRobability After Injury (TRAIN) [1]. All scoring structures had been retrospectively validated the use of single group or multi-institution trauma registry data. Six scoring structures envisioned if any quantity of blood transfusion occurred inside four h of to predict if huge transfusion occurred, inclusive of the SIPA, ABC-D, and BIS scoring systems. Massive transfusion was once described in all manuscripts as forty mL/kg inside the first 6 h of clinic arrival. None estimated the want for surgical or interventional radiology intervention for hemorrhage control.

The SIPA, PSI, rPSI, and rSIG scoring structures use a ratio of the HR and SBP to generate an age-based score. rSIG additionally consists of the GCS rating in addition to shock index its calculation. The standards used to outline binary thresholds are particular to every scoring device and the effect of interest. For example, the thresholds of SIPA are based on whether or not it was once used to predict large transfusion or blood transfusion inside four h of arrival. The age at which these scoring structures had been validated additionally varied, limiting their applicability to older or youthful teenagers relying on standards used in model.

The ABC-D, BIS, and TRAIN scoring structures use a mixture of physiological values, damage characteristics, laboratory findings, and imaging points to generate a score. The ABC-D scoring gadget consists of the patient's arrival SBP, HR, mechanism of injury, imaging features, base deficit, and lactate level, whilst the BIS rating consists of the arrival SIPA score, base deficit, and INR. The Bayesian community TRAIN makes use of age, arrival SBP, HR, oxygen saturation, and GCS, the mechanism of injury, the presence of a thoracic and stomach injury, and the wide variety of physique areas injured. While the ABC-D and BIS scoring structures had been designed to use a threshold like SIPA, PSI, rPSI, and rSIG, TRAIN generates a likelihood that a affected person will get hold of a blood transfusion.

## Limitations

All scoring structures in this assessment predict whether or not blood used to be transfused as an alternative than if blood transfusion was once wanted or hemorrhagic shock used to be existing [1]. This big difference is applicable due to the fact hemorrhagic shock can be puffed up by way of inclusive of sufferers receiving useless transfusions due to the fact of concurrent clinical sickness or except a scientific need. A retrospective evaluate of injured adults who obtained at least one unit of blood transfusion discovered that about 30% obtained a probably avoidable transfusion. Hemorrhagic shock can additionally be underestimated via misclassifying bleeding sufferers who died due to the fact of hemorrhage (survivorship bias) or with the aid of every other motive of demise (competing danger bias) earlier than blood is given. In a learn about of injured adults, a latent classification mannequin used to be developed to extra precisely classify adults who had extreme hemorrhage, described as doubtlessly wanting or receiving huge transfusion protocol. Using this model, 84% of adults who died earlier than attaining the big transfusion protocol definition had been categorised as having extreme hemorrhage suggesting survivor bias. Future scoring structures must be developed after rigorous adjudication of whether or not blood transfusion and huge transfusion was once wanted with the aid of along with an assessment of medical examination features, laboratory values, imaging characteristics, operative reports, and autopsy results.

Physiological values are dynamic and are influenced with the aid of age, stress, anxiety, medications, harm progression, and resuscitative interventions. Although the use of the preliminary SBP and HR can also permit early identification of hemorrhage, these values by myself supply an incomplete photo of physiological reputation in sufferers with evolving clinical, a aspect contributing to worse predictive performance. The have an impact on of serial physiological values on hemorrhagic shock prediction has been evaluated in person trauma patients, displaying that evolving SBP, HR, shock index, and pulse oximeter values enhance predictive performance. Future scoring structures need to examine and be validated the use of up to date physiological values at some point of the preliminary assessment and administration of an injured infant to tackle the evolving medical reputation of injured patients.

Implementation of these scoring structures into scientific exercise is difficult for countless reasons. First, most scoring structures in this evaluate require complete data to generate a score. TRAIN is an exception due to the fact it estimates the conditional likelihood of the missing variable primarily based on found metrics. Missing data is frequent in exercise and are therefore lacking in massive trauma databases like the National Trauma Data Bank used for validating most scoring systems. Exclusion of sufferers with lacking information might also lead to biased estimates throughout mannequin development, validation, and implementation. Second, the ABC-D and BIS scoring structures require imaging and laboratory findings that are frequently no longer reachable straight away after affected person arrival. Delays might also appear in producing an output whilst looking ahead to these results. Finally, TRAIN requires pc guide to calculate a chance estimate that is no longer presently reachable to the public. Although the different scoring structures can be calculated in real-time, even easy mathematical computation can be hard in fast-paced, time-critical settings like a trauma activation. Automatic seize of enter values from the digital clinical report and affected person video display units might also tackle this challenge.

## Conclusion

Hemorrhagic shock is a situation that at once threatens the patient's life, and its most frequent reason is trauma. Recognizing a affected person in hemorrhagic shock lets in for on the spot treatment, accordingly growing the hazard of survival. Since a patient in hemorrhagic shock has attribute signs, the physician need to apprehend them as quickly as possible.

## References


1. Sullivan, T. M.; Sippel, G. J.; Burd, R. S. (2025.): „What Scoring System Should We Use to Evaluate for Hemorrhage-Related Interventions in Pediatric Trauma Patients?" in Slidell, M. B.; Henry, M. C. W. (eds): „Difficult Decisions in Pediatric Surgery", Springer Nature Switzerland AG, Cham, Switzerland, pp. 95. – 102.
2. Lindell, R. B.; Weiss, S. L. (2022.): „Shock" in Mattei, P. (ed): „Fundamentals of Pediatric Surgery, Third Edition", Springer Nature Switzerland AG, Cham, Switzerland, pp. 101.
3. Sinha, A.; Davenport, M. (2022.): „Shock" in Sinha, C. K.; Davenport, M. (eds): „Handbook of Pediatric Surgery, Second Edition", Springer Nature Switzerland AG, Cham, Switzerland, pp. 34. – 35.
4. Nace, G. W. (2022.): „Trauma Resuscitation" in Mattei, P. (ed): „Fundamentals of Pediatric Surgery, Third Edition", Springer Nature Switzerland AG, Cham, Switzerland, pp. 170. – 171.