Review Article

# Polytrauma in Children

## Epidemiology, Acute Diagnostic Evaluation, and Treatment

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## Summary

**Background:** Inadequate clinical experience still causes uncertainty in the acute diagnostic evaluation and treatment of polytrauma in children (with or without coagulopathy). This review deals with the main aspects of the acute care of severely injured children in the light of current guidelines and other relevant literature, in particular airway control, volume and coagulation management, acute diagnostic imaging, and blood coagulation studies in the shock room.

**Methods:** This review is based on literature retrieved by a selective search in PubMed, Medline (OVIDSP), the Cochrane Central Register of Controlled Trials, and Epistemonikos covering the period January 2001 to August 2023. Review articles and the updated S2k clinical practice guideline on polytrauma management in childhood were considered.

**Results:** Most accidents in childhood occur at home and in the child's free time, with varying mechanisms and patterns of injury depending on age. The outcome of treatment depends largely on the presence or absence or traumatic brain injury, which affects 66% of children with polytrauma and is thus the most common type of injury in this group, and of hemorrhagic shock with or without coagulopathy. Acute care follows the ABCDE algorithms with attention to special features in children, including age-specific reference values. According to a registry study, coagulopathy and hypovolemic shock are associated with 22% and 17% mortality, respectively. Treatment in a pediatric trauma reference center of the trauma network is recommended. Computed tomography (CT) should be carried out in children in accordance with defined criteria (PECARN), as a team decision and with the use of age-specific low-dose CT protocols. In children as in adults, viscoelasticity-based point-of-care tests enable the prompt diagnosis of relevant coagulopathies and their treatment in consideration of age-specific target values. The administration of tranexamic acid remains controversial.

**Conclusion:** 4% of polytrauma patients are children. Because children differ from adults both anatomically and physiologically, the diagnostic evaluation and management of polytrauma in children presents a special challenge. The evidence base for pediatric polytrauma management is still inadequate; current recommendations are based on consensus, in consideration of the special features of children compared to adults.

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Even today, there is still uncertainty in the acute diagnostic evaluation and treatment of pediatric polytrauma patients with or without coagulopathy. While evidence-based guidelines and algorithms are available for adults (e1–e5), the state of evidence for pediatric polytrauma management is inadequate and the S2k clinical practice guideline "Polytrauma Management in Childhood" published in 2020 as a supplement to the S3 clinical practice guideline "Polytrauma" (e1) is largely based on consensus recommendations with attention to special features in children (1).

In this review, we summarize the main aspects of the acute care of severely injured children in the light of current guidelines and other relevant literature, focusing on airway control, volume and coagulation management, acute diagnostic imaging, and blood coagulation studies in the shock room.

**CME plus+**

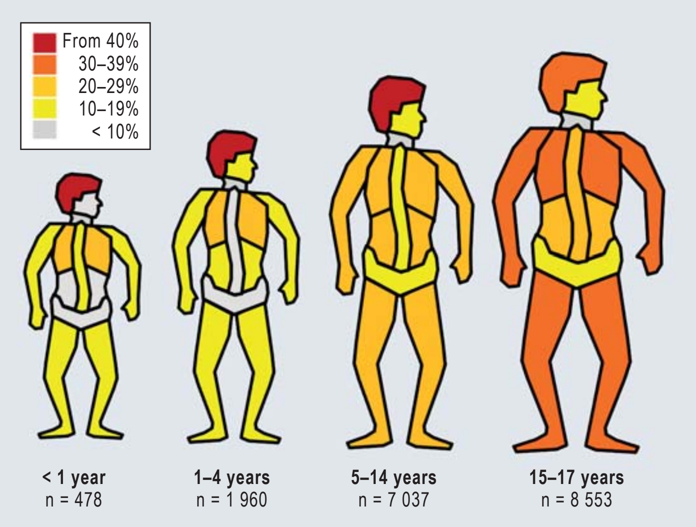
This article has been certified by the North Rhine Academy for Continuing Medical Education. The CME questions on this article can be found at http://daebl.de/RY95. The deadline for submission is 2 May 2025.

**Participation is possible at cme.aerztebatt.de**

## Methods

This narrative review is based on literature retrieved by a selective search in PubMed, Medline (OVIDSP), the Cochrane Central Register of Controlled Trials (CENTRAL), and Epistemonikos, using structured search strategies and search bundles and covering the period January 2001 up to and including August 2023. After review and removal of duplicates, abstracts were screened for relevance and articles were evaluated as full texts. The literature cited in the full-text

**Figure 1**




**Age-dependent distribution** of injury pattern in pediatric polytrauma patients (German Trauma Registry DGU 2008–2022, 15 years [4]); basic patient population with primary admission to a TR-DGU-associated hospital; n = 18 028; 66% male, mean Injury Severity Score/ISS 16 points; 5% died; four age groups: <1 year, 1–4 years, 5–14 years and 15–17 years). All injuries with a severity of AIS 2+ or higher were counted for each body region. The body regions are determined by the first digit of the AIS code with additional division of the lower extremity into pelvis and legs.
AIS, Abbreviated Injury Scale

articles, other reference publications, reviews, and some later published studies as well as the updated S2k clinical practice guideline on polytrauma management in childhood (1) were taken into account in the preparation of the manuscript.

### Epidemiology

According to the German Health Interview and Examination Survey for Children and Adolescents (KiGGS; 16 327 datasets), more than one in seven children/-adolescents (16%) sustain an accident-related injury requiring treatment every year (2, e6, e7). Most accidents involving toddlers occur at home (60%), while most accidents involving children of school age and older occur during play, sport and leisure activities (39%) or in educational facilities (29%); (e7). The number of accidents on public roads increases threefold from toddlers (6%) to adolescents (17%); (e7). In 2022, 25 800 children aged < 15 years were injured in road accidents (prevalence 0.2%; [3]). Severe polytrauma with/without hemorrhage accounts for 4% of all polytrauma cases and is rarely encountered in the emergency setting (4). The majority of road accidents (42%) occur on bicycles, a third in cars and about a fifth as pedestrians (3, e7). Across all age groups, road accidents are more common among boys compared to girls (5–7).

### Injury pattern

The injury pattern varies with age *(Figure 1)*. Traumatic brain injury (TBI) is the most common injury in all age groups (66%). This is, on the one hand, due to the proportionally larger head in children and, on the other hand, due to their shorter height and thus the increased exposure of the head in accidents as pedestrians/bicyclists. In addition, children tend to sustain injuries to the extremities (4, 6, 7).

### Prognosis and Outcome

In severely injured children too, both prognosis and mortality is strongly associated with TBI and hemorrhagic shock with/without coagulopathy (6, 8, 9). In a retrospective cohort (n = 744), early coagulopathy and hypovolemic shock were associated with mortality rates of 22% and 17%, respectively (10). According to data of the trauma registry of the German Society of Trauma Surgery (TR-DGU) (n = 2961), there is increased mortality in infants (8%) as well as increased all-cause mortality (15%) during the first 24 hours, followed by an age-dependent decrease (4, 7). The pediatric BIG score was developed for the purpose of prognostication. By combining the predictors base excess, INR (International Normalized Ratio) and GCS (Glasgow Coma Scale), it covers the most frequent causes of death (*Figure 2* [11]). Retrospectively evaluated in 30 000 children, this score achieved with an optimum mortality cut-off a sensitivity of 0.937 with a specificity of 0.938 and a positive predictive value (PPV) of 0.514 and a negative predictive value of 0.995 (11). The BIG score can assess the severity of blunt and penetrating injuries and provide information on a coagulopathy already requiring treatment in the shock room (12).

### Management

The aim of prehospital care is the urgent treatment of life-threatening injuries and transport to a pediatric trauma reference center of the trauma network (1). According to the white paper of the German Society of Trauma Surgery (DGU), this approach ensures that a pediatric surgery/ pediatric department with a pediatric intensive care unit and pediatric radiology are directly available. Data from the TR-DGU show that the mean prehospital care period of severely injured children is shorter compared to that in adults (13). Invasive measures, such as endotracheal intubation or tube thoracostomy, are less frequently performed in children than in adults; furthermore, children with trauma are more often transported by rescue helicopter (5). A swift procedure according to the well-established ABCDE approach is also recommended for children with severe trauma, using the following priorities (1):

### A (airway) and B (breathing) management

In patients with apnea, bradypnea or agonal breathing (respiratory rate < 6/min), the S2k clinical practice guideline recommends emergency anesthesia, securing the airway and mechanical ventilation with normoventilation (1). The goal is to achieve adequate oxygenation/ventilation, if necessary, using non-invasive measures, especially in cases where the chances of successful endotracheal intubation are limited. Given the more challenging situation arising from special anatomical features in children, the manual in-line stabilization of the cervical spine and usually a lack of routine on the part of the first responders, an indication for intubation should be strictly established—not “automatically” assumed—and time management aspects should be taken into account as well (1). A shoulder pad supporting anteflexion of the head can improve the conditions for intubation (14). Primary mask-bag ventilation is a good option, also in the two-rescuer situation (e8); if correctly performed, it can maintain adequate oxygenation. Alternatively, a laryngeal mask airway can be used as a supraglottic airway device (1). A basic requirement is to achieve a depth of anesthesia sufficient to prevent laryngospasm/bronchospasm (14). Cognitive aids are available for laryngeal mask size/volume assessment and dosing of intravenous emergency medication for analgosedation in children (e9). The principle of "primum non nocere" is the paradigm, requiring knowledge/application of pediatric pharmacological references after prior (body-height-based) weight assessment and adherence to the rule of the 5 rights of medication administration (e10).

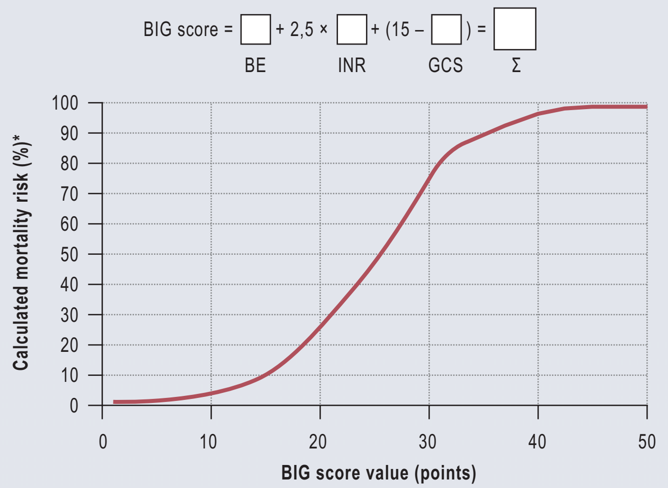
Since infants/toddlers have a greater oxygen consumption and a smaller oxygen reserve, hypoxia can quickly develop during periods of apnea, requiring immediate rapid-sequence induction [RSI]) with protection against regurgitation/aspiration (1). In the severely injured child, a difficult airway should always be anticipated. A meta-analysis showed a 3.5-fold increase in the rate of incorrect endotracheal tube placement in children in the prehospital setting (15); a Finnish study found that more than every third endotracheal tube was incorrectly positioned (e11). Furthermore, retrospective data showed an association between prehospital intubation and increased mortality in children (16), even after successful intubation (e12). However, multivariate data revealed that age, injury severity and neurological status are the key prognostic factors in severely injured children (e13).

The gold standard for checking the tube position is capnometry/capnography (1). Excessively deep intubation is a common cause of unilaterally diminished or absent breath sounds; however, once the position of the tube has been checked, the possibility of pneumothorax/hematothorax also needs to be considered. If indicated, decompression is achieved by means of tube thoracostomy in children < 14 years, using the Seldinger (trocar) technique in the 4th intercostal space (ICS) on the anterior axillary line (1)—in pediatric trauma resuscitation also bilaterally. Attention must be paid to the narrower intercostal spaces in infants/children, which means that, besides pediatric chest tubes, intravenous catheters can be used. Thoracotomy should be mentioned here as a last resort; however, in a population-based retrospective study, it was associated with a mortality rate of 90% in children, regardless of the injury pattern (17).

### C (circulation) management

Age-specific vital parameter reference values have to be taken into account when assessing blood and volume losses *(Table)*. Furthermore, these can be altered by pain, anxiety and stress (14). Children have the ability to compensate for volume loss over a prolonged period of time; their blood pressure only starts to drop when there is a blood loss/volume loss of 30% or more (14). Since even one third of the blood volume of a child may not be a large amount, depending on age and weight, blood loss is often underestimated in pediatric patients. The capillary refill time is used as an early indicator of hypovolemia, as it starts to be prolonged when the depletion of intravascular volume reaches 15% (14). To minimize bleeding-related secondary conditions, acute bleeding must be stopped by applying compression/tamponade and controlling the source of bleeding. As a last resort, a tourniquet can be applied (1). In case of suspected pelvic injury, stabilization with a fitting pelvic sling is required (1). If fluid resuscitation is needed, at least one large-bore vascular access should be established and treatment should be started urgently (1). A vascular access should primarily be established peripherally; alternatively, an intraosseous access can be used if no intravenous access is achieved within 60 seconds (e14). In infants/small children, the proximal tibia is the puncture site of first choice, the distal tibia the

**Figure 2**




**BIG score:** Formula for calculating the BIG score and estimating the individual mortality risk (adapted from 5, 11, 12) BE, base excess; GCS, Glasgow Coma Scale; INR, international normalized ratio.
* Calculation formula: $1/(1 + e^{-[0.2 \times (\text{BIG score}) - 5.208]})$

**Table**

**Age-specific reference values for vital parameters[*1]**

| Age | Heart rate (min) | Blood pressure (mm Hg) | | Respiratory rate (min) |
|---|---|---|---|---|
| | | Systolic | MAD | |
| 1 month | 110–180 | 50[*2]–75[*3] | 40[*2]–55[*3] | 25–60 |
| 1 year | 100–170 | 70[*2]–95[*3] | 50[*2]–70[*3] | 20–50 |
| 2 years | 90–160 | n.s. | n.s. | 18–40 |
| 5 years | 70–140 | 75[*2]–100[*3] | 55[*2]–75[*3] | 17–30 |
| 10 years | 60–120 | 80[*2]–110[*3] | 55[*2]–75[*3] | 14–25 |

[*1] The age-specific standard values are shown as the respective lower and upper limits for heart rate and respiratory rate, as well as the fifth*2 and fiftieth*3 age-specific percentiles for systolic blood pressure and mean arterial blood pressure (MAD). Newborns have a total blood volume of 80–90 mL/kg, infants of 70–80 mL/kg and children of 70 mL/kg. Adapted from (14, e33). n.d., not documented

**Box 1**

### Criteria for the selective performance of a computed tomography (CT) scan in pediatric patients with abdominal injury and traumatic brain injury*1

**Abdominal trauma (PECARN)**

- Signs of abdominal wall injury (seat-belt sign)
- Glasgow Coma Scale (GCS) ≤ 13
- Abdominal symptoms with tenderness, resistance, pain on pressure, and guarding (free fluid in eFAST)
- Abdominal pain
- Vomiting
- Signs of chest injury/thoracic wall injury
- Diminished breath sounds/change in respiratory rate

**Traumatic brain injury (TBI)**

- Glasgow Coma Scale (GCS) <14 or GCS <15 in children <1 year
- Unconsciousness >5 min (in children aged <2 years unconsciousness > 5 sec*2); amnesia (anterograde/retrograde) > 5 min
- Increased sleepiness/ personality changes
- Signs of open/depressed skull fracture or basilar skull fracture
- Focal neurological signs
- Hematoma (occipital, parietal, temporal), excoriation or laceration >5 cm in children aged <1 year
- ≥ 3 × vomiting*3
- Seizure without known epilepsy
- Severe headache*2
- Mechanism of injury:
  - High-energy trauma >40 km/h
  - Fall from >3 m height
  - High-speed trauma caused by projectiles or other objects
  - Suspected child abuse

*1 Based on the PECARN (Pediatric Emergency Care Applied Research Network) recommendations for abdominal trauma (e15, e16) as well as the CHALICE study (Children´s Head Injury Algorithm for the Prediction of Important Clinical Events; [e17]) for traumatic brain injury

*2 Supplementary information based on PECARN recommendations for traumatic brain injury (e18); the NICE guidelines from the UK are also based on the PECARN recommendations. In a retrospective validation study, the PECARN decision rule for abdominal trauma had a sensitivity of 91% with a negative predictive value of 99.5% (e15). The mentioned algorithm for traumatic brain injury had a sensitivity of 98% and a specificity of 87% for the identification of children requiring an intervention (e19).

*3 According to a secondary analysis of almost 20 000 children included in the Australasian Pediatric Head Injury Rule study, a CT scan is not required in children with blunt traumatic brain injury, provided vomiting less than 3× is the only symptom (e20). Even with isolated vomiting >3×, the incidence of clinically relevant traumatic brain injury (3/1000) or traumatic brain injury confirmed by CT scan (6/1000) was extremely low; thus, a CT scan is not required in cases of isolated vomiting as the only symptom (e20).

site of second choice; in older children, the proximal humerus is also used, as in adults.

To maintain an age-specific blood pressure, the S2k clinical practice guideline recommends a bolus injection of a dose of 20 mL/kg body weight isotonic, balanced crystalloid solution, using 50 mL syringes (1). It is important to accurately document each bolus to prevent overinfusion (18); intravenous fluid administration > 20 mL/kg in the first hour and > 60 mL/kg in the first 24 hours was associated with poorer outcomes and increased mortality (9, 19, 20). Since no data on the benefits of permissive hypotension with restrictive volume administration for the treatment of severely injured children have yet become, age-specific reference values are sought as treatment targets (1, 9, 14); this applies in particular in patients with traumatic brain injury where it is used to maintain cerebral perfusion pressure.(1). If normalization of blood pressure is not achieved despite volume administration, weight-adapted catecholamine treatment should be initiated. (1). Early transfusion of blood products is recommended for hemodynamically unstable children or children with a blood volume loss of 20–25% or more (19, 21).

#### D (disability) management

Being the most common injury among severely injured children, traumatic brain injury is of great importance in the care of these pediatric patients (5, 7). Besides assessing the level of consciousness, any side difference in motor function as well as pupillary responses must be recorded at the scene of the accident, at handover and in the further course of treatment (1). Since both verbal and motor skills are dependent on age, the Glasgow Coma Scale (GCS) was adapted to account for the special features in children (22); in the prehospital situation, the AVPU scale, a simplified version of the GCS, is commonly used. The AVPU scale distinguishes the child‘s response to its environment (spontaneous, to verbal stimuli, painful stimuli, none) (22).

As in adults, the primary goal of treating severely injured children with TBI early is to prevent secondary conditions (1). If the care targets cannot be achieved while the patient is breathing spontaneously, advanced airway management with mask ventilation, ventilation via laryngeal mask or endotracheal intubation should be considered in patients with a GCS of 8 or less (1). Decreased alertness as the sole indication for endotracheal intubation in a severely injured child does not appear to be an adequate approach (23).

Furthermore, hypocapnia ($etCO_2$ < 30 mm Hg) and hyperventilation must be avoided, as they can lead to vasoconstriction with subsequent cerebral ischemia (1, 24). Efforts should be made to maintain the age-specific blood pressure in order to ensure an adequate cerebral perfusion pressure (24).

#### E (environment) management

The clinical examination for injuries to the extremities is part of the secondary survey; it is performed after treatment/control of life-threatening conditions (1). Treatment of skeletal injuries must not prolong the overall duration of the rescue mission (1). The recommendations

**Figure 3**

**Pediatric transfusion protocol with hybrid approach*1**

| | | | | | |
|---|---|---|---|---|---|
| **Trauma** | **Bleeding** → | | | | |
| **Clinical status** | **Stable** → | **Tachycardia*2** → | | **Hemodynamically unstable** → | |
| **Blood loss** | **0–10 mL/kg** | **10–20 mL/kg** | **20–40 mL/kg** | **1 BV** | **≥ 2 BV** |
| **Crystalloids** | 10 mL/kg | 10–20 mL/kg | | | |
| **TXA** | Possible early (10–15 mg/kg) | | | | |
| **RBCC** | | 10 mL/kg | 20 mL/kg | 20 mL/kg | 20 mL/kg |
| **FFP** | | 10 mL/kg | 20 mL/kg | 20 mL/kg | 20 mL/kg |
| **PC** | | | 10 mL/kg | 10 mL/kg | 10 mL/kg |
| **Fibrinogen** | | | ROTEM/TEG guided | ROTEM/TEG guided | ROTEM/TEG guided |
| **ROTEM/TEG** | X | X | X | X | X |

*1 Adapted from (31, 38)
*2 Low pulse amplitude (blood-pressure amplitude/pulse pressure) as the difference between systole and diastole or other signs of hypovolemia BV, blood volume (loss); RBCC, red blood cell concentrate; FFP, fresh frozen plasma; kg, kilogram; mg, milligram; mL, milliliter; ROTEM, rotational thromboelastometry; TEG, thromboelastometry; PC, platelet concentrate; TXA, tranexamic acid

for prehospital treatment of severely injured children do not differ from those for adults. In children, it is of particular importance to maintain normal body temperature, since they tend to lose heat more quickly due to their larger body surface which in turn can trigger secondary conditions (for example, coagulation disorders as part of the lethal triad, a combination of acidosis, coagulopathy and hypothermia) (25).

### Acute diagnostic evaluation in the shock room

Providing structured care in the shock room helps to shorten the early in-hospital care time and ensures that patients quickly receive definitive treatment (1). It requires a shock room protocol adapted for children with clear regulation of procedures/interdisciplinary collaboration in defined teams with regular training based on child-specific educational concepts, and dedicated logistics (1). According to the S2k clinical practice guideline, the basic shock room team of a supra-regional/regional trauma center, serving as a pediatric trauma reference center, consists of at least three specialists:

1. Surgery (pediatric surgery/traumatology with expertise in pediatric traumatology),
2. Anesthesiology, and
3. Pediatric intensive care medicine.

The availability of a pediatric radiologists or a radiologist with expertise in pediatric radiology and a neurosurgeon with pediatric experience or a pediatric surgeon with experience in neurosurgery should be ensured (1).

### Imaging

As part of the primary survey, an ultrasound (FAST/eFAST) is performed to detect free intra-abdominal fluid, a pericardial/pleural effusion, or a hemothorax/pneumothorax. In children younger than 1 year of age, a transfontanellar/transtemporal cranial ultrasound scan may be performed to detect intracranial hemorrhage, provided the diagnostic evaluation is not delayed by this examination (1). Diagnostic assessment by means of ultrasound imaging is dependent on the examiner and not all regions of the body are assessed with reliable sensitivity/specificity; since unremarkable findings do not rule out life-threatening injuries, all patients must be closely monitored (1). Computed tomography (CT) should be carried out in children in accordance with defined criteria *(Box 1)*, as a team decision and with the use of age-specific low-dose CT protocols (ALARA principle, as low as reasonably achievable [1, 27]). According to retrospective data analysis, CT findings rarely resulted in an immediate indication for surgery (26–28); the high rate of negative results, even with strict indications, also needs to be taken into account (28). On the other hand, the diagnostic sensitivity/specificity of CT imaging is known so that diagnostic processes can be accelerated and decisions can be made more quickly. Larger studies, some based on the TR-DGU, have now shown that an initial full-body CT scan does not result in a survival benefit in children; for this reason, selective imaging is required (28, e21–e23). With regard to magnetic resonance imaging (MRI), the logistical aspects and the time involved must be taken into account; cranial/spinal MRI is used primarily to monitor the clinical course/answer specific questions in the post-shock room phase..

### Coagulation monitoring and management

Retrospective registry studies have reported prevalence rates for injury-associated hemorrhage with coagulopathy of 13% to 38% (29). This diagnosis has always been associated with increased morbidity and mortality among the injured children; with 18%, this increase was most evident in small children (30). It seems that hyperfibrinolysis in particular, regardless of injury pattern/region, occurs more frequently in children compared to adults (24%–53% [31, 32]). Fatal hemorrhage and/or

**Box 2**

## Conclusion for clinical practice

- With an annual share of 4% of all polytrauma cases, pediatric polytrauma is a rare emergency; however, it is challenging to diagnose and treat due to age-specific features of physiology/anatomy in children.
- Acute care follows the ABCDE algorithm with attention to special features in children and age-specific reference values.
- Treatment in a pediatric trauma reference center of the trauma network is recommended.
- Computed tomography (CT) should be performed in children in accordance with defined criteria (PECARN), as a team decision and with the use of age-specific low-dose CT protocols (ALARA principle) and specific algorithms.
- Functional point-of-care viscoelasticity-based tests, taking into account age-specific reference values, are available for goal-directed care for the bleeding pediatric polytrauma patient.

uncontrollable/uncontrolled coagulation disorders usually occur within the first 24 hours (9, 29, 30). Unlike in adult care, there are no protocols/guidelines for children in place that address the management of early post-traumatic coagulation disorders, although children are likely to also benefit from early interventions to control the bleeding and/or stabilize coagulation (19, 33).

Current recommendations/guidelines on the transfusion strategy for critically ill children have recently been summarized (e24). The updated 2022 guideline of the European Society of Anesthesiology and Intensive Care (ESAIC) recommends the transfusion of red blood cell concentrates (RBCCs) in hemodynamically unstable children, guided by laboratory parameters (hemoglobin [Hb] <7 g/dL), clinical condition and risk-benefit assessment (21). The German cross-sectional guideline (QLL) reduced the age limit above which transfusions can be given even more restrictively to four weeks (e24, e25). In patients with active bleeding and coagulopathy/massive transfusion, the administration of therapeutic plasma is an integral part of acute management (e26–e28). For patients with hemorrhagic shock, the empiric/ratio-based transfusion of RBCCs, plasma and platelets in the ratios 2 : 1 : 1 to 1 : 1 : 1 is recommended and should be continued until the bleeding is no longer life-threatening (e29).

Current research on massive transfusion both in adults (e30–e32) and children (34) increasingly casts doubt on empirical, rigid/ratio-based strategies and is in support of a targeted approach (34, 35, e29). Early injury-associated disorders of coagulation can be diagnosed in children in a timely manner, using functional point-of-care viscoelasticity-based testing (for example, thromboelastometry [ROTEM]/thromboelastography [TEG]), and be treated using a targeted approach (35); the use of blood products/coagulation-stabilizing substances (for example, fibrinogen concentrate) is optimized, the risk of overtransfusion reduced (19, 31, 33–35, e29).Age-specific reference values and therapeutic trigger values have now been defined and clinical reviewed (31, 33, 36–38). A retrospective study on 332 pediatric patients aged <15 years found that coagulation disorders were more rapidly detected, treated and corrected by means of goal-directed ROTEM testing/treatment, and that this was achieved with less plasma products (33). *Figure 3* shows a child-specific transfusion protocol with hybrid approach (38).

Despite the increased prevalence of hyperfibrinolysis (31, 32), the early empirical use of tranexamic acid (TXA) in children is still viewed as controversial (1, 39). In a meta-analysis, the use of TXA was not associated with a survival benefit, even after adjustment for severity (39). A higher survival rate was only found in children with war injuries; TXA treatment did not result in differences in the occurrence of thromboembolic events (39). A recent observational study, using propensity score matching, evaluated the prehospital use of TXA in severely injured children. It again found no advantage with TXA use (40). Early administration of TXA is recommended (e29), but without supporting evidence; pediatric dosing also remains unclear.

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**Conflict of interest statement**
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MC declares that no conflict of interest exists.

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**Supplementary material**
**eReferences:**
**www.aerzteblatt-international.de/m2024.0036**

**Supplementary material** to accompany the article

# Polytrauma in Children

## Epidemiology, Acute Diagnostic Evaluation, and Treatment

by Monica Christine Ciorba and Marc Maegele

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**Questions** on the article in issue 9/2024:

# Polytrauma in Children—Epidemiology, Acute Diagnostic Evaluation, and Treatment

The submission deadline is 2 May 2025. Only one answer is possible per question. Please select the answer that is most appropriate.

### Question 1

**What percentage of children and adolescents suffer an accidental injury requiring treatment annually, according to the German Child and Adolescent Health Survey?**

a) 1.6%
b) 6%
c) 16%
d) 36%
e) 60%

### Question 2

**Which score can be used for prognostication in severely injured children?**

a) SMALL score
b) BIG score
c) INFANT score
d) BABY score
e) MINOR score

### Question 3

**This article describes the ABCDE approach to patient management. What does this acronym stand for?**

a) “Airway”, “Breathing”, “Circulation”, “Disability”, “Environment”
b) “Airway“, “Blood“, “Cold“, “Disability“, “Emergency“
c) “Ambulance”, “Blood”, “Circulation”, “Diversity”, “Environment”
d) “Ambulance”, “Bystanders”, “Cardiac”, “Disease”, “Emergency”
e) “Accident”, “Blood”, “Circulation”, “Disease”, “Emergency”

### Question 4

**According to the age-specific reference ranges cited in the article, what heart rate range would be considered normal for a 1-month-old infant?**

a) 50–70/min
b) 70–90/min
c) 80–100/min
d) 110–180/min
e) 170–210/min

### Question 5

**According to the article, at what level of blood loss/volume loss does the blood pressure start to drop in children?**

a) From a blood loss/volume loss of 5%
b) From a blood loss/volume loss of 10%
c) From a blood loss/volume loss of 15%
d) From a blood loss/volume loss of 30%
e) From a blood loss/volume loss of 45%

### Question 6

**What is the respiratory rate range for a two-year-old child according to the article?**

a) 14–20/min
b) 18–40/min
c) 40–60/min
d) 50–75/min
e) 60–80/min

### Question 7

**Which bones are mentioned as the puncture sites of first and second choice for intraosseous access in infants and small children?**

a) Proximal tibia and distal tibia
b) Humerus and fibula
c) Femur and fibula
d) Humerus and femur
e) Ulna and humerus

### Question 8

**What are the components of the lethal triad?**

a) Cardiomyopathy, hypertension and asphyxia
b) Coagulopathy, hypothermia and acidosis
c) Coagulopathy, hyperthermia and alkalosis
d) Cardiomyopathy, hyperthermia and acidosis
e) Coagulopathy, hypertension, alkalosis

### Question 9

**Which imaging procedure for the detection of free intra-abdominal fluid, hemathorax/pneumothorax, pericardial effusion or pleural effusion in children is a standard part of the diagnostic evaluation of trauma during the primary survey?**

a) Magnetic resonance imaging
b) High-dose computed tomography
c) X-ray
d) Positron emission tomography
e) Ultrasound

### Question 10

**With the help of certain point-of-care tests, early trauma-associated coagulation disorders can be diagnosed promptly. Which test is mentioned in the article as an example of such point-of-care tests?**

a) Thromboelastometry
b) Prothrombin time
c) Partial thromboplastin time
d) D-dimers
e) Thrombin time