GUIDELINES 2025

EUROPEAN RESUSCITATION COUNCIL

[h1] European Resuscitation Council Guidelines 2025: Paediatric Life Support

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[h1] Abstract

This European Resuscitation Council Guideline on Paediatric Life Support (PLS) is based on the Consensus on Science with Treatment Recommendations (CoSTR) of the International Liaison Committee on Resuscitation (ILCOR) and rapid reviews performed by the ERC Writing Group Paediatric Life Support of topics not covered by ILCOR. This chapter provides guidelines on the prevention of cardiac arrest, basic life support, advanced life support, resuscitation in special circumstances, post-resuscitation care, prognostication, and post-discharge care in infants, children and adolescents aged 0-18 years, but does not cover resuscitation of the neonate at birth. The recommendations have been formulated for healthcare providers who take care of children and the general public, and includes recommendations on how to implement the guideline and system factors. Stakeholders from a range of health care settings were involved in the guideline development process and the views of the community advisors representing families of paediatric cardiac arrest survivors and non-survivors were also considered.

[h1] Keywords

paediatric cardiac arrest, paediatric basic life support, paediatric advanced life support, post-resuscitation care, prognostication, post-discharge care, critically ill child, critically injured child

[h1] Key points from the Paediatric Life Support

1) **Early recognition is crucial:** Timely identification of critically ill children is vital for the prevention of cardiac arrest. Use quick-look tools like the BBB-tool (Behaviour, Breathing, Body colour) or the Paediatric Assessment Triangle.

2) **Team approach:** Activate additional resources early and establish a team with clearly defined roles.

3) **ABCDE assessment:** Immediately perform a structured ABCDE assessment on any child who appears critically ill or injured.

4) **ABCDE management:** Open and maintain the airway. Provide adequate oxygenation and ventilation. Aim for adequate organ perfusion. Treat seizures and hypoglycaemia promptly.

5) **Paediatric basic life support:** Check for responsiveness, signs of life and breathing. Call the EMS or resuscitation team. Give 5 initial breaths and start chest compressions. Use a 15:2 compression-to-ventilation ratio.

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6) Untrained rescuers: Follow 3 simple steps to save a child's life: **Check – Call – CPR.** Follow dispatcher's advice.

7) Paediatric advanced life support: Follow the PALS algorithm while considering and treating relevant reversible causes of cardiac arrest.

8) Special circumstances: Remember to modify your approach in some special circumstances, e.g. trauma or intoxications.

9) Post-resuscitation care: Initiate post-resuscitation care immediately after ROSC. Implement individualized goals and bundled care.

10) Prognostication: Use a multimodal approach to prognostication. Withhold prognostication for at least 72 hours in comatose children.

11) Post-discharge care: Discuss and plan post-discharge care for survivors. Follow-up care can help to improve the long-term outcomes.

12) Family-centred approach: Involve parents/caregivers at all stages of care. Communicate with honesty and empathy while considering the needs of the family.

13) Systems: Systems should aim to link all parts of the chain of survival and establish clear protocols for life-threatening conditions in children.

Abbreviations:

ABCDE	Airway, Breathing, Circulation, Disability, Exposure
AED	Automated external defibrillator
AVPU	Alert-Verbal-Pain-Unresponsive
BBB	Behaviour, Breathing, Body colour
BMI	Body mass index
BP	Blood pressure
CoSTR	Consensus on Science with Treatment Recommendations
CPR	Cardiopulmonary resuscitation
ECG	Electrocardiogram
ECMO	Extracorporeal membrane oxygenation
ECPR	Extracorporeal cardiopulmonary resuscitation
EEG	Electroencephalography
EMS	Emergency medical service

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ERC	European Resuscitation Council
$ETCO_2$	End-tidal carbon dioxide
FiO_2	Fraction of inspired oxygen
GCS	Glasgow Coma Scale
HOPE	Hypothermia Outcome Prediction after Extracorporeal life support
HOTT	Hypotension, Oxygenation (hypoxia), Tension pneumothorax and cardiac Tamponade
HR	Heart rate min^{-1}
ICU	Intensive care unit
IHCA	In-hospital cardiac arrest
ILCOR	International Liaison Committee on Resuscitation
IM	Intramuscular
IO	Intraosseous
IV	Intravenous
MAP	Mean arterial pressure
NIBP	Non-invasive blood pressure
NLS	Newborn Life Support
OHCA	Out-of-hospital cardiac arrest
$PaCO_2$	Partial pressure of carbon dioxide in arterial blood
PALS	Paediatric advanced life-support
PaO2	Partial pressure of oxygen in arterial blood
PBLS	Paediatric basic life support
PCR	Polymerase chain reaction
PEA	Pulseless electrical activity
PEEP	Positive end expiratory pressure
PLS	Paediatric Life Support
PLS WG	Paediatric Life Support Writing Group
POCUS	Point of care ultrasound
pVT	Pulseless ventricular tachycardia
ROSC	Return of spontaneous circulation
RR	Respiratory rate min^{-1}

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SBAR	Situation, Background, Assessment, Recommendation
SGA	Supraglottic airway device
SpO_2	Arterial oxygen saturation as measured by pulse oximetry
SvO_2	Mixed venous oxygen saturation
SVT	Supraventricular tachycardia
VF	Ventricular fibrillation
VT	Ventricular tachycardia

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[h1] Introduction

This European Resuscitation Council (ERC) Resuscitation Guideline 2025 on Paediatric Life Support (PLS) is based on evidence from the International Liaison Committee on Resuscitation (ILCOR) and from rapid reviews performed by the ERC Paediatric Life Support Writing Group (PLS WG). These PLS WG rapid reviews addressed topics formulated as questions in PICOST (Population, Intervention, Comparison, Outcomes, Study design, Timeframe) format using a stepwise methodology of identifying and analysing relevant literature similar to that used in the Cochrane rapid reviews. [1] The full methodology of our reviews is available from the authors on request.

Where there was insufficient evidence on a topic either from ILCOR or from our rapid reviews, we reached consensus by iterated discussions within the PLS WG. Where no new evidence was available, we kept our recommendations consistent with previous guidelines. We also considered comments from representatives of the community mentioned in the list of collaborators for this guideline. In our evidence to decision process, we considered the formula for survival (science, education and implementation). We included information on how our recommendations can be implemented in different systems, including access-limited, resource-limited and context-limited healthcare settings. [2] The guideline describes general principles and recommendations but cannot fully describe the detailed care for individual children, especially those with rare or complex chronic conditions or special medical needs. In general, the recommendations described in this chapter are presented as the standard of care when there is no reason to further individualise the approach.

Paediatric patients are defined as persons aged 0-18 years of age. In this guideline, we use the term ‘children’ to encompass all age categories. When distinguishing between age groups, e.g. for specific skills or techniques, we use the word ‘infant’ for neonates and children up to 1 year, the words ‘child’ for children aged 1-12 years and the word ‘adolescents’ for teenagers aged 13-18 years.

The ERC Guidelines 2025 Newborn Life Support (NLS) are primarily intended for newborns at birth (shortly after delivery). The transition phase from foetus to neonate at birth involves major physiological changes. The duration of this phase is variable and there is a lack of scientific data to define when it ends. This makes it difficult to recommend a specific time point at which an infant should be resuscitated according to the NLS or PLS guidelines, and this is particularly true for preterm neonates. The PLS and NLS WGs agree that all neonates discharged from a maternity or neonatal unit to home should be resuscitated using the PLS guideline. We also recommend that hospitals, maternity and neonatal units, and health care teams establish clear protocols specifying

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which algorithm should be applied to which paediatric population. These protocols should be incorporated into local resuscitation training programs. [3] Further details about this topic can be found in the ERC Guidelines 2025 Newborn Life Support of transition of infants at birth. [NLS guidelines ref]

The ERC also acknowledges that distinguishing adolescents from adults can sometimes be challenging. If the rescuer considers a person to be an adult, they should use the adult algorithm, otherwise, they should use the paediatric algorithm. The differences in adult and paediatric resuscitation algorithms are primarily based on the distinct causes of cardiac arrest. However, if an adult person is mistakenly resuscitated using a paediatric algorithm, little or no harm will occur as studies of aetiology have shown that the paediatric causes of arrest continue into young adulthood. [4-6]

Paediatric cardiac arrest is a rare event that can have devastating consequences for patients, their families and society. Despite the fact that cardiac arrest in children comprises a mere fraction of all cardiac arrests, their overall impact on society may be far reaching given the long-term consequences. [7] These consequences may include increased lifelong health care costs and impaired ability to deal with daily life, which can limit participation in society during adulthood, including work force participation. Despite some improvements in overall survival worldwide, survival with good neurological outcome after paediatric out-of-hospital cardiac arrest (OHCA) remains poor with major differences across Europe. [8,9] This highlights the need for novel approaches to science, prevention, resuscitation and training. [10-12] A European registry of all paediatric cardiac arrests would provide insights which would be of help in this process. Children from lower socioeconomic environments and racial or ethnic minorities seem to be disproportionately impacted by cardiac arrest and specific interventions targeting these populations are needed. [13] Half of all paediatric OHCAs have a distinguishable reversible cause with hypoxia being the most prevalent of these. [14,15] In adolescents, trauma, intoxications and suicide attempts are among the leading causes of OHCA. [16] Therefore, preventing traffic accidents, violence, drug abuse, and improving mental health seem to be reasonable society-level strategies to prevent cardiac arrest in this age group. Exercise-related paediatric OHCAs are rare but are associated with higher survival rates. [17] Paediatric in-hospital cardiac arrest (IHCA) has better outcomes compared with paediatric OHCA, particularly in institutions adhering to guidelines and implementing quality-improvement initiatives, in which there has been a steady rise in survival in recent decades. [14,18-20] The main causes of paediatric IHCA are respiratory failure and shock. [10] Common causes of peri-operative paediatric IHCA include hypoxia (e.g. airway management problems), bradycardia and haemorrhage. [21,22] Paediatric IHCA is

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most common in neonates, infants, and children with complex chronic conditions, especially congenital heart disease. [19,22,23]

The ERC guidelines address all aspects of resuscitation as outlined in the Chain of Survival which can be applied to resuscitation of patients of all ages (Figure 1.1): prevent cardiac arrest, early CPR and defibrillation, advanced life support and post-resuscitation care and survival and recovery. In paediatric resuscitation, the initial phase of prevention is most important as cardiac arrest in children can be prevented by quick and effective treatment of a range of life-threatening illnesses. This approach, which is integral and crucial to paediatric resuscitation, is outlined in the sections of the prevention of cardiac arrest and on special circumstances of these guidelines. The phases of paediatric basic life support (PBLS) and paediatric advanced life-support (PALS) are specifically addressed in separate sections and, in line with the chain of survival, this chapter also includes more extensive sections on post-resuscitation and post-discharge care than was included in previous paediatric guidelines.

These ERC recommendations have been formulated for healthcare systems (e.g. hospitals, manufacturers of devices, dispatch centres, emergency medical services and emergency departments), healthcare professionals and the public. The detailed evidence underpinning these pragmatic recommendations is reviewed and discussed in the evidence supporting the guidelines section.

The ERC Guidelines 2025 PLS were drafted and agreed by the ERC PLS Writing Group members and the ERC Guidelines 2025 Steering Committee. This guideline was posted for public comment in May 2025. A total of [INSERT NUMBER] individuals from [INSERT COUNTRIES] submitted [INSERT NUMBER] comments, leading to [INSERT CHANGES] in the final version. Subsequently, the feedback was reviewed by the PLS writing group, and the guideline was thereafter updated where relevant. The ERC Guidelines 2025 PLS were presented to and approved by the ERC Board and the ERC General Assembly on xy June 2025. The methodology used for guideline development is presented in the Executive summary. (REF)

[h1] Summary of key changes or new recommendations

Table 1. Comparison of ERC Paediatric Life Support Guidelines (2021 vs 2025).

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Recommendations for the public and systems	Not included.	Specific recommendations have been added for the public, parents/caregivers and community carers and for guideline implementation at systems level.
Prevention of cardiac arrest	Atropine could be considered as premedication before tracheal intubation. Recommended to avoid multiple attempts at tracheal intubation. Suggested phenytoin/fosphenytoin, valproic acid or levetiracetam as second line medication for seizures. Recommended treating hypoglycaemia with 0,3 ml kg -1 glucose IV bolus.	Atropine is no longer recommended as premedication before intubation. Limit the number of tracheal intubations attempts to two. Recommends a new algorithm for seizures, with levetiracetam as the preferred second line medication. Hypoglycaemia is treated with 2 ml kg-1 10% glucose IV bolus.
Paediatric Basic Life Support	Recommended calling before initiation of chest compressions and that the two-finger technique for infant chest compressions could be considered by a single rescuer.	Call for help as soon as cardiac arrest is recognised. The two-thumbs encircling technique for chest compressions in infants is recommended for all situations
Foreign body airway obstruction	Recommended to perform Chest thrusts in infants using the two-finger technique.	Chest thrusts in infants should be performed using the two-thumbs encircling technique.

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Automatic External Defibrillator / Defibrillation	Recommended using either the anteroposterior or anterolateral pad position in children	The anteroposterior position for defibrillation pads is recommended for all infants and children weighing less than 25 kg. Use the anteroposterior or the anterolateral position in larger children and adolescents. Public access defibrillators should have a uniform pad size for cardiac arrest victims of all ages
Special circumstances	Information on special circumstances was distributed throughout the guidelines. In cardiac arrest caused by hyperkalaemia use calcium, bicarbonate, and insulin with glucose	A specific new subchapter on special circumstances has been included. In cardiac arrest caused by hyperkalaemia use IV insulin with glucose or IV short acting beta2-adrenergic agonists or a combination of these; calcium and bicarbonate should not be used.
Post-resuscitation care and prognostication	A short paragraph on post-resuscitation care and prognostication was included. Recommended targeting the 5th percentile for blood pressure for age.	An extended subchapter on post-resuscitation care, including infographics for the pre-hospital and in-hospital approach to post-resuscitation care and prognostication has been included. Maintain the blood pressure above the 10th

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		percentile for age (MAP and systolic BP).
Post-discharge care	Not included.	A new subchapter on post-discharge care including an infographic.

[h1] Concise guidelines for clinical practice

[h2] Prevention of cardiac arrest

Cardiac arrest in infants, children and adolescents is often secondary to progressive respiratory or circulatory failure or to neurological emergencies. Therefore, the recognition and proper management of critically ill children remains the best way to prevent cardiac arrest.

[h3] Recommendations for caregivers and other untrained rescuers

- All parents and caregivers should be encouraged to learn basic recognition of critical illness and injury and basic first-aid life-saving procedures.
- Simple recognition using triage tools and basic first-aid life-saving procedures should be taught to professional caregivers for children, including child minders, schoolteachers, first responders, lifeguards and coaches/trainers of children and adolescents.
- Immediately call for the help of a physician or call the emergency medical service (EMS) if a child has signs or symptoms that might indicate critical illness such as those described in the BBB-tool namely:
    - **Behaviour**: A child who:
        - is not fully conscious or is difficult to rouse, floppy or rigid,
        - is having a seizure,
        - is confused, agitated, or interacting abnormally with the parents/caregivers,
        - is crying inconsolably,
        - is not able to move one or more limbs, and/or
        - has severe pain or is unable to speak or walk, if previously able to do.

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- **Breathing**: A child who has difficulty breathing, such that they:
  - are unable to take a deep breath,
  - are working hard to take each breath (breathing fast, grunting, flaring of the nostrils, and indrawing between or under the ribs),
  - are making additional noises while breathing,
  - are breathing too fast, too slowly or irregularly, stops breathing, and/or
  - adopt an abnormal posture to aid breathing.
- **Body colour**:
  - The child's skin is cyanosed (blue), mottled, abnormally pale or greyish.

- Parents/caregivers of children with specific chronic conditions (e.g. children who are dependent on medical equipment, who have a tracheostomy, cardiac conditions, malignancy, or who were born with a low birth weight) should have an emergency plan available for any sudden deterioration and caregivers should be familiar with this and trained in initial life-saving procedures.

[h3] Recommendations for health care professionals (Figure 1.2)

- Identify children with an increased risk of sudden cardiac arrest and formulate a care plan for these children.
- Use a dedicated quick-look tool (e.g. the above-mentioned BBB-tool or the paediatric assessment triangle) for the early recognition of a potentially critically ill child.
- Consider your own safety. Use appropriate personal protection equipment when indicated.
- Immediately perform an initial ABCDE assessment in any child who appears to be critically ill or severely injured (Figure 1.2). Initiate life-saving interventions as soon as a problem is identified.
- Activate additional resources (e.g. personnel, equipment) and establish a team with clearly defined individual roles and responsibilities as soon as possible.
- Use cognitive aids such as displayed algorithms and checklists to decrease cognitive load.
- Reassess the child after any intervention or when in doubt.

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- Ask caregivers for an estimate of the child's weight or estimate this using length-based methods, which should ideally be corrected for body-habitus.
- Use an individualised approach or modify interventions for children with chronic medical conditions or specific medical needs. Ask a parent/caregiver for relevant information about the condition if they have this.
- At all times allow parents/caregivers to stay with the child if this does not preclude their safety or the safety of the child or personnel.
- Include parents and those with parental responsibility in discussions and decision-making.
- Assign a dedicated team member to the care of parents or caregivers, and ensure they are fully informed at all stages.

[h4] Recognition of the critically ill or injured child

- **Airway**
    - Check the patency of the airway and the presence of air flow using the look-listen-feel method.
    - Consider stridor or snoring to be a sign of partial airway obstruction.
    - Allow a conscious child to adopt the most comfortable position, do not force them to lie down.
- **Breathing**
    - Check for signs of respiratory insufficiency (Tables 2 and 3). Assess:
        - Work of breathing (respiratory rate, recession, grunting, nasal flaring, tracheal tug, positioning)
        - Effectiveness of breathing (chest expansion, character and strength of crying/speaking, auscultation (reduced air entry, symmetry, wheeze or crepitations), skin colour (cyanosis), arterial oxygen saturation
        - Systemic sign (heart rate, conscious level)
    - Monitor arterial oxygen saturation by pulse oximetry (SpO_2) continuously. Be aware that a pulse oximeter can be less reliable in children with a darker skin.

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    - Monitor capnography (end-tidal carbon dioxide, ($ETCO_2$)) in all patients with an advanced airway (i.e. a tracheal tube or supraglottic airway device (SGA)). Consider capnography in patients with non-invasive ventilation.
    - Consider point of care ultrasound (POCUS) of the lungs and blood gas analysis.
    - Use multiple variables to recognise respiratory failure as no single sign in isolation is indicative of this. Trends are more important than a single value.

- **Circulation**
    - Check for signs of cardiovascular insufficiency (Tables 2 and 3).
        - Cardiovascular signs (heart rate, pulse volume (peripheral and central), blood pressure, preload (jugular veins, liver span, crepitations)
        - Organ perfusion (capillary refill time, skin colour and temperature, urinary output, level of consciousness)
    - Attach an ECG-monitor, to assess the rhythm, and a non-invasive blood pressure (NIBP) monitor/device.
    - Consider serial lactate measurements if signs of shock are present.
    - Consider POCUS which might help to distinguish the cause and type of shock.
    - Consider a 12-lead ECG.
    - Use multiple variables to recognise circulatory failure (shock) and the type of shock; no single sign in isolation is indicative of shock. Trends are more important than a single value.
- **Disability**
    - Check conscious level using the AVPU (Alert-Verbal-Pain-Unresponsive) scale, (paediatric) Glasgow Coma Scale (GCS) total score, or the GCS motor score, pupil size, symmetry, and reactivity to light and the presence of posturing or focal neurological signs.
    - Recognise seizures as a neurological emergency.
    - Check blood glucose.
    - Consider urgent brain imaging if neurological symptoms persist after ABC resuscitation.

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- **Exposure**
  - Check body temperature.
  - Undress the child and look for rashes, injuries and signs of physical child abuse and neglect.
  - Look for signs and symptoms of potentially life-threatening conditions as described further below (e.g. anaphylaxis, sepsis).
  - Try to identify any underlying conditions that might require a specific approach (e.g. intoxication, underlying chronic conditions).
  - Use AMPLE (Allergy-Medication-Past History-Last Meal-Events) to quickly establish a basic medical history.
- Be alert to conditions in which cardiac arrest is imminent such as: airway obstruction, flail chest, silent chest, tension pneumothorax, massive haemorrhage, cardiac tamponade, intracranial hypertension, hypoglycaemia with coma, hypothermia, severe trauma and thrombosis.

Table 2. Approximate normal values for respiratory rate, heart rate and blood pressure. The values change continuously as the child grows. Use intermediate values for children between the specified ages in the table. [24-26]

Age	**1 month**	**1 year**	**2 years**	**5 years**	**10 years**	**18 years**
Upper limit of normal range for RR	60	50	40	30	25	20
Lower limit of normal range for RR	25	20	18	17	14	12
Upper limit of normal range for HR	180	170	160	140	120	100
Lower limit of normal range for HR	110	100	90	70	60	60
p50 for systolic BP	75	95	98	100	110	120
p10 for systolic BP	55	75	77	80	85	105
p5 for systolic BP	50	70	73	75	80	90
p50 for MAP	55	70	73	75	75	75

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p10 for MAP	45	55	58	60	60	65
p5 for MAP	40	50	53	55	55	60

RR = respiratory rate , HR = heart rate, BP = blood pressure, MAP = mean arterial pressure, p50/p10/p5 = 50th /10th /5th percentile of BP for the 50th percentile of child's height at that age

Table 3. Clinical signs of respiratory and circulatory failure. Individual deviations are common especially in children with chronic medical conditions. Be aware that cardiovascular collapse can also occur suddenly without any preceding symptoms or signs. Always use multiple variables to diagnose failure.

	Compensated	**Decompensated** **(imminent cardiac arrest)**
Respiratory failure	Tachypnoea Increased work of breathing Normal, increased or slightly decreased tidal volumes. Wheezing Mild to moderate hypoxaemia (e.g. SpO_2 90-93% breathing air) Normocapnia or hypocapnia Agitation	Bradypnoea, irregular breathing Decreasing work of breathing Grunting Diminished chest excursions and/or air entry (silent chest) Severe hypoxaemia (SpO_2 <90% breathing air) Hypercapnia Decreased level of consciousness
Circulatory failure (shock)	Tachycardia Impaired peripheral perfusion Decreased peripheral pulsations Normal blood pressure Agitation	Bradycardia Diminished central pulsations. Hypotension Decreased level of consciousness

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[h4] Principles of the management of the critically ill or injured child

- **Airway**
  - Establish airway patency to enable adequate oxygenation and ventilation.
  - Open the airway and keep it open. Use adequate positioning of the head and body alignment (head tilt and chin lift or jaw thrust), remove secretions and other obstructing materials by careful suctioning if necessary.
  - Consider a nasopharyngeal or oropharyngeal airway of the appropriate size in children with a decreased level of consciousness.
  - Use a supraglottic airway device (laryngeal mask, i-gel), when indicated, only if you are competent in its use.
  - Intubate the trachea of a child, when indicated, only if you are competent and experienced and have the necessary materials and drugs immediately available and use a well-defined operating procedure.
    - Always have a plan for difficulties with the airway (e.g. SGA-insertion, additional expertise).
    - Preoxygenate the child before induction of anaesthesia, avoid distending the stomach.
    - Use sedative and neuromuscular blocking drugs with a rapid onset of action, unless the child is deeply comatose.
    - Do not use atropine as premedication routinely.
    - In an emergency use oral intubation rather than nasal.
    - Video laryngoscopy should be used for tracheal intubation providers should be trained in this technique.
    - Provide oxygen during airway management (apnoeic oxygenation, high-flow nasal oxygen or oral) to avoid hypoxia during the procedure.
    - Do not attempt intubation more than twice and limit each attempt to 30-60 s. Monitor SpO_2, heart rate and blood pressure during intubation and stop the attempt immediately in case of bradycardia or oxygen desaturation.

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        Immediately recommence bag-mask ventilation or insert an SGA to restore oxygenation.

        - Use cuffed tracheal tubes for all children. Monitor and limit cuff inflation pressure according to the manufacturer's recommendations.
        - Provide adequate analgosedation during and after intubation.
        - Confirm tube placement clinically and using $ETCO_2$ monitoring (providers with expertise may use POCUS in addition). Monitor SpO_2 and $ETCO_2$ continuously in all children with an advanced airway. Confirm the tube position with X-ray as soon as practicable.
    - Use a front-of-neck airway only as a last resort option in cannot-ventilate-cannot-oxygenate situations. This should be performed by an individual trained in invasive airway techniques.
    - In children with tracheostomies, who develop difficulty breathing, suspect an obstruction of the tracheostomy tube.
        - Try to relieve the obstruction by suctioning the tracheostomy tube.
        - If a suction catheter cannot be passed, the tracheostomy tube should be removed immediately and replaced.
        - If a clean tube is not available, oxygen and ventilation via bag and mask should be given at the tracheostomy stoma site until the tube is cleaned and replaced (using a laryngeal mask or small face mask).
        - If the child's upper airway is patent, it may be possible to provide oxygen and bag and mask ventilation via the mouth and nose whilst the tracheal stoma site is occluded.
        - In an emergency, tracheal intubation via the tracheostomy or upper airway (if patent) with a tracheal tube may be needed.
- **Breathing**
    - Aim for adequate oxygenation and ventilation.
    - Initially give 100% oxygen for all children with respiratory, circulatory, or neurological failure.

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- Titrate the fraction of inspired oxygen (FiO_2) as soon as the SpO_2 can be monitored and avoid sustained readings of 100% (except in special circumstances, e.g. carbon monoxide intoxication, methaemoglobinaemia, cyanide poisoning or severe anaemia).
- In previously healthy children aim for an SpO_2 of 94-98%. The goal is to achieve an SpO_2 of at least 94% with the lowest possible FiO_2.
- Consider individualised targets for SpO_2 and $ETCO_2$ in children with specific conditions (e.g. cyanotic congenital heart defects, chronic respiratory failure).
- Consider high-flow nasal oxygenation or non-invasive ventilation in children with hypoxaemia not responding adequately to conventional oxygen therapy.
- Support inadequate spontaneous ventilation, using bag-mask ventilation as the first-line method.
    - Ensure correct head positioning, mask size and proper seal between the mask and the face.
    - Use a two-person approach (using both hands to hold the mask and keep the airway open), especially if ventilation is difficult or when there is a risk of disease transmission. Consider airway adjuncts (e.g. oropharyngeal device).
    - Use an appropriately sized bag and sufficiently long inspiratory times to make the chest visibly rise (mild chest rise). Avoid hyperinflation and high peak inspiratory pressure.
    - Aim for a low-normal respiratory rate for the child's age (pragmatically use the following rates per minute: 25 in infants, 20 in children >1 y, 15 in children >8 y, 10 in adolescents).
- Consider the early insertion of an SGA or tracheal tube in cases when bag-mask ventilation does not improve oxygenation or ventilation or when prolonged respiratory support is anticipated.
- Check air leak, signs of aspiration, efficacy of ventilation in patients with SGA or tracheal tube.
- In mechanically ventilated children:

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        - Use tidal volumes of 6 to 8 ml kg^{-1} of ideal body weight and a respiratory rate at a low-normal range for the child's age (Table 2)
        - Start with a positive end expiratory pressure (PEEP) of 5 cm H_2O and adjust PEEP and FiO_2 to improve oxygenation, always titrating these to the minimum support needed to achieve the desired targets.
        - Individualise ventilator setting in specific conditions, seek the advice of a paediatric intensivist early if possible.
        - Minimise apparatus dead space, especially in infants.
        - Avoid both hyperventilation and hypoventilation. Monitor $ETCO_2$ and aim for normocapnia. Check partial pressure of carbon dioxide in arterial blood ($PaCO_2$) as soon as practicable to assess its relationship to $ETCO_2$.
    - Use DOPES to help identify the cause of a sudden rapid deterioration in a ventilated child (bag-mask ventilation or mechanical ventilation):
        - Displacement (mask, SGA, tracheal tube)
        - Obstruction (secretions, tube, circuit, airway – head position)
        - Pneumothorax or other pulmonary pathology
        - Equipment (disconnection, oxygen supply, tubing, valves, ventilator)
        - Stomach/stacking/sedation (abdominal distention, stacked breaths or insufficient sedation).

- **Circulation**
    - Aim for adequate organ perfusion.
    - In the case of circulatory failure (shock), do not spend more than 5 min (or 2 attempts) to establish intravenous (IV) access. Competent providers should use POCUS to guide IV cannulation.
    - Establish intraosseous (IO) access as a rescue alternative if IV access fails or when the chances for a successful IV-cannulation are considered minimal.
        - Use an IO-needle of appropriate size.
        - Provide effective analgesia (e.g. intranasal ketamine) unless the child is deeply comatose.

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        - Use manual infusion or a high-pressure bag for fluid infusion.
        - Monitor for signs of extravasation and displacement.
    - Give one or more fluid boluses of 10 ml kg^{-1} in children in hypovolaemic, obstructive or distributive shock.
        - Use balanced isotonic crystalloids as the first line choice of fluids. If unavailable, use normal saline, which may be the preferred fluid in diabetic ketoacidosis and severe traumatic brain injury.
        - Give repeated 10 ml kg^{-1} boluses, as necessary. A total of 40-60 ml kg^{-1} may be needed during the first hour of treatment of hypovolemic or distributive shock.
        - Reassess the child after each bolus looking for signs of fluid overload or cardiac failure (e.g. lung crepitations, increasing liver edge, raised jugular venous pressure).
        - If the signs of shock recede, continue maintenance fluids and rehydration at a slower pace.
        - Consider vasoactive drugs and respiratory support if repeated fluid boluses are required.
    - Consider the need for fluids in cardiogenic shock on an individual basis. Fluids might still be needed but should be given more cautiously e.g., 5 ml kg^{-1} fluid bolus.
    - Assess the type of shock; hypovolaemic, cardiogenic, obstructive, or distributive (POCUS may be of value for this).
    - Start vasoactive drugs (inotropes and/or vasopressors depending on the type of shock) early, as a continuous infusion via a central or peripheral line, and not later than after three to four fluid boluses (30-40 ml kg^{-1}):
        - Pay attention to the proper composition, dilution, and dosing of fluids.
        - Use a dedicated line for vasoactive drug infusion whenever possible.
        - Titrate the infusion rate according to clinical and other signs (pulse, capillary refill time, urine output), not solely based on blood pressure targets which may differ according to the pathology, age and response. Aim for the 5th percentile as a minimum.

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        - Use noradrenaline as a first line vasopressor and adrenaline as a first line inotrope. Use milrinone as first-line inodilator.
        - Consider the use of POCUS, echocardiography, lactate and mixed venous oxygen saturation (SvO_2) to further guide clinical decision making, if the expertise is available.
    - Treat arrhythmias if present (see below).
    - Initiate other specific treatments according to the type of shock (see below).
    - Seek expert advice on extracorporeal support (e.g. ECMO) in children with refractory shock or specific conditions (e.g. congenital heart disease).
- **Disability**
    - Aim for neuroprotection (see the section on post-resuscitation care).
    - Ensure adequate oxygenation, ventilation, and circulation.
    - Treat clinical and electroencephalographic seizures. Follow a time-critical protocol for the management of status epilepticus such as that suggested in Figure 1.3.
    - Treat hypoglycaemia, orally, if possible, with 0.3 g kg^{-1} glucose as soon as this is detected. If oral intake is not possible, give an IV bolus of 0.2 g kg^{-1} glucose (2ml kg^{-1} 10% glucose) and re-check blood glucose after 5 min and repeat if necessary.
    - When IV glucose is not available, give glucagon as temporary rescue measure: glucagon IM or SC, 0.03 mg kg^{-1} (or 1 mg if >25 kg or 0.5 mg if <25 kg) OR intranasally 3 mg if 4-16 yr.
    - Ensure (preferably continuous) analgosedation in children with discomfort or pain. Anticipate and prevent hypotension.
    - Consider the possibility of paediatric stroke or neuroinfection and quickly seek expert help.
- **Exposure**
    - Avoid hypothermia and hyperthermia and start specific measures if present.
    - Consider antibiotics and/or antiviral medication if a bacterial or viral cause of critical illness is likely (e.g. in sepsis, encephalomeningitis, severe pneumonia).

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- Protect the best interests of the child according to the local ethical and legal policies in case of a suspicion of inflicted injury (child abuse and neglect).

[h4] Additional recommendations for time-critical interventions

- In children with **severe acute asthma** (critical asthma syndrome):
  - Give 100% oxygen.
  - Give (intermittent or continuous) short acting beta2-adrenergic agonists via pressurised metered-dose inhalers with spacer or by nebulisation (e.g. salbutamol 100 microg/dose at 4-10 puffs every 20 min or by nebulisation with 100% oxygen 2.5-5 mg in sterile 0.9% sodium chloride in a volume suitable for the type of nebuliser run until empty)
  - Combine ipratropium with beta2-adrenergic agonists.
  - Give prednisolone 1-2 mg kg^{-1} orally or IV (max. 40 mg) or dexamethasone 0.3-0.6 mg kg^{-1} (max. 16 mg) within the first hour.
  - Consider adding high dose inhaled corticosteroids in a severe crisis.
  - Consider IV magnesium sulphate 40 mg kg^{-1} (max 2 g) over 20 min in children who fail to respond to initial treatment.
  - Consider a loading dose of IV short-acting $beta_2$-adrenergic agonists (e.g. 5-15 microg kg^{-1} salbutamol over 10 min, max. doses of 250-750 microg have been used) which may be followed by an infusion depending on clinical severity (e.g. salbutamol 1-2 microg kg^{-1} min^{-1}). Monitor potassium levels, lactate, blood glucose and ECG.
  - Consider a trial of non-invasive ventilation provided the child still has sufficient respiratory drive.
  - Consider tracheal intubation and invasive ventilation (and anticipate potential serious side effects), or extracorporeal life-support in near fatal asthma (e.g. exhaustion, severe hypoxia despite high flow oxygen and adequate medication).
- In children with **septic shock**:
  - Obtain blood samples for blood culture and PCR if possible and start broad-spectrum antibiotics as soon as possible (within 1 hour) after initial ABCDE management.

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    - Give hydrocortisone 1-2 mg kg^{-1} if the child is not responding to fluids and vasoactive support, and in children with specific pathologies (e.g. adrenal insufficiency) or who are receiving specific medications.
- In children with **cardiogenic shock**:
    - Seek the advice of paediatric cardiologist early. Use echocardiography to guide treatment.
    - Start inotropic support and consider mechanical ventilation. Anticipate possible cardiac arrest during tracheal intubation, use medication with minimal cardiovascular side effects (e.g. ketamine and avoid propofol).
    - Consider IV furosemide only in children without concomitant hypovolaemia.
    - Consider extracorporeal life support in refractory cardiogenic shock.
- In children with **haemorrhagic shock**:
    - Activate local protocols for massive haemorrhage and control bleeding using pressure and tourniquets as indicated.
    - Minimise the use of IV crystalloid boluses (max. 20 ml kg^{-1}). Give blood products or full blood as soon as these are available.
    - Use vasoactive drugs in fluid-refractory shock, especially when there is also a loss of sympathetic drive (e.g. during anaesthesia or analgosedation), or in children with concomitant traumatic brain injury. Target MAP to above the 50th percentile to attain sufficient cerebral perfusion pressure in traumatic brain injury. Support cardiac function if this is necessary to achieve MAP above the threshold.
    - Use a strategy that focuses on improving coagulation in children with severe blood loss.
    - Use tranexamic acid as soon as possible (at least within 3 hours) in all children requiring transfusion after trauma or with life-threatening haemorrhage. Give a loading dose of 15-20 mg kg^{-1} (max. 1 g) IV over 10 min, followed by an infusion of 2 mg kg^{-1} h^{-1} (max. 1 g) for at least 8 hours or until the bleeding stops.
- In children with **circulatory failure due to bradycardia**:
    - Seek the advice of a paediatric cardiologist early.

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- Improve oxygenation, ventilation, and circulation.
- In patients with bradycardia and poor perfusion not responding to oxygenation and ventilation, start chest compressions.
- Consider adrenaline as small IV bolus doses (e.g. 1-2 microg kg^{-1}) or as a continuous infusion.
- Consider transthoracic pacing only in specific cases of bradycardia (e.g. complete heart block, sick sinus syndrome).
- Consider atropine *only* in specific cases of bradycardia (e.g. induced by increased vagal tone or by a cardiac conduction disease); dose IV atropine 20 microg kg^{-1} (max. 0.5 mg).

- In children with **circulatory failure due to tachydysrhythmia**
  - Seek the advice of a paediatric cardiologist early.
  - In patients with decompensated circulatory failure regardless of the origin of tachycardia (supraventricular or ventricular), perform immediate synchronised cardioversion starting with 1 J kg^{-1}, doubling the energy with each subsequent attempt up to a maximum of 4 J kg^{-1}. Have a 12-lead ECG running during the cardioversion attempt. If the child is not comatose, ensure adequate analgosedation according to local protocols. Reassess signs of life and pulse after each attempt. While waiting for anaesthesia and the defibrillator, chemical cardioversion (see below) can be attempted but it should not delay the cardioversion attempt.
  - In patients with narrow complex supraventricular tachycardia (SVT) who are not in decompensated circulatory failure:
    - Consider vagal manoeuvres (e.g. modified Valsalva or ice pack to the face)
    - Consider IV adenosine as a rapid flush of 0.1-0.2 mg kg^{-1} (max. 6 mg) via a large vein. Ensure a 12-lead ECG is running during the administration of adenosine. If the SVT persists, give a second dose of 0.3 mg kg^{-1} (max. 12-18 mg) after at least 1 min.
    - Seek the advice of a paediatric cardiologist. Consider cardioversion or alternative medications (e.g. amiodarone), especially in children with sinus

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node disease, pre-excited atrial arrhythmias, a history of heart transplant or severe asthma.

- In patients with a wide QRS tachycardia who are not in decompensated circulatory failure:
  - Try vagal manoeuvres which might provide diagnostic insight (e.g. into an SVT with abnormal conduction).
  - Seek the advice of paediatric cardiologist. Pharmacological treatment options include amiodarone, lidocaine, esmolol, magnesium sulphate, and procainamide.
  - In torsade-de-pointes VT, give IV magnesium sulphate 50 mg kg^{-1} (max. 2 g).

- In children with generalized **seizures** (Figure 1.3):
  - Monitor the time from the start of the seizures closely. Manage ABC, monitor vital functions and ECG. Consider possible causes for seizures (e.g. infection, intoxication, metabolic disorders, hypoxia, hypoglycaemia, hyperthermia, intracranial hypertension, channelopathies) and treat these appropriately.
  - If seizures do not stop spontaneously within 5 min (status epilepticus), give a 1st dose of a benzodiazepine (first-line medication). Use the IV route if available or an alternative route (e.g. buccal, nasal) if IV/IO access has not yet been established.
  - If the seizures continue, give a second dose of a benzodiazepine IV or IO after 5-10 min and prepare to administer a second-line medication.
  - If the seizures persist after two doses of the first-line medication (< 15-20 min from the start of the seizures) give levetiracetam IV or IO 40-60 mg kg^{-1} (max. 4.5 g) over 5 min (second-line medication). If levetiracetam is not available, give phenytoin, phenobarbital or valproic acid (avoid valproate where possible when there is the potential for pregnancy) IV or IO as a second choice instead.
  - If the seizures continue for ≥30 min (refractory status epilepticus), prepare for intubation and refer the child to the paediatric intensive care team. Consider another drug from second-line medication list if the first drug was given and you are not ready for intubation and anaesthesia.

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- Start anaesthesia (e.g. with midazolam, ketamine, phenobarbital, thiopental, or propofol) within 40 min of the onset of seizures, with intubation and mechanical ventilation. Aim for termination of clinical seizures and burst suppression on electroencephalography (EEG). Monitor for respiratory and haemodynamic instability, metabolic disturbances, renal failure, rhabdomyolysis, and adverse drug effects.
- Seek the advice of paediatric neurologist.
- Consider continuous EEG monitoring and brain imaging.

Other important peri-arrest situations are described below in the dedicated subchapter on Special Circumstances.

[h2] Paediatric basic life support (PBLS) (Figure 2.1)

[h3] Recommendations for untrained rescuers and dispatcher-assisted CPR

- If you encounter a child who appears to be unresponsive and you have no training in PBLS, ensure your own safety and that of the child and follow the **3 steps to save a child's life** (Figure 2.2):
  - **Check** if the child:
    - reacts to non-painful stimulus,
    - is breathing normally,
    - has any other signs of life (coughing, moving, opening the eyes).
  - **Call** the EMS immediately If the child does not react, is not breathing normally and does not show other signs of life.
  - **CPR**: Start CPR immediately following the instructions of the dispatcher.
- Dispatchers should encourage bystanders to perform both rescue breaths and chest compressions in children of all ages. They should actively ask about signs confirming that the rescue breaths are effective (e.g. whether the chest rises and falls).
- Dispatchers should use a 30:2 ratio for CPR instructions with 5 initial rescue breaths for untrained bystanders or bystanders trained only in adult BLS.

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- If the bystanders are not willing or able to perform rescue breathing, dispatchers should encourage compression-only CPR in all children.
- Dispatchers should instruct bystanders to use age-specific techniques for chest compressions and breathing in infants, children and adolescents (see below).

[h3] Recommendations for those trained in PBLS (Figure 2.1)

- Ensure safety for you and the child.
- Use verbal and tactile stimulation to assess responsiveness. Do not use painful stimuli.
- Use the head tilt chin lift manoeuvre to open the airway and assess breathing for no longer than 10 s. (Figure 2.3a and b) – or video.
- Call the EMS immediately upon recognition of a cardiac arrest (unresponsive, not breathing normally, with no other signs of life), using your mobile phone's speaker function with video when possible.
- Give five initial rescue breaths. (Figure 2.4a and b) – or video
- Immediately proceed with 15 chest compressions. (Figure 2.5a and b) – or video
- Continue CPR in a 15:2 compression-to-ventilation ratio.
- Focus on consistently high-quality compressions and effective ventilations. Minimise chest compression pauses.
- If another rescuer is available, they should call the EMS and then bring and attach an automated external defibrillator (AED) as soon as possible in children of all ages and follow the instructions of the AED.
- If there is only a single rescuer, calling the EMS and starting CPR should be prioritised over fetching and attaching an AED.
- Do not interrupt CPR unless there are clear signs of life, or you are instructed to do so by the AED.
- If there are clear signs of life, but the child remains unconscious and is not breathing normally, continue ventilation aiming for mild chest rise with each breath.
- In an unresponsive child who is clearly breathing effectively, keep the airway open by continued head tilt chin lift or positioning the child in a recovery position, especially if there is a risk of vomiting, but not in trauma.

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- Check the breathing continuously or at least every minute if the child is placed in a recovery position. If in doubt about the stability of the position or the quality of the breathing, turn the child onto their back and open the airway with the head tilt chin lift manoeuvre.
- **Airway** and assessment of breathing:
  - Keep the head in the neutral position in infants by slightly tilting the head and lifting the chin with two fingers on the chin bone without pressing on the soft tissues (head tilt chin lift manoeuvre) (Figure 2.3a). In older children, more head tilt will be needed (Figure 2.3b). In adolescents, full extension of the head is needed as in adults.
  - Look for chest movement, listen and feel for the flow of air from the nose and/or mouth. If the chest is moving but there is no air flow, the airway is not open. Immediately try to improve the airway opening manoeuvre.
  - If you have any doubt whether breathing is normal, act as if it were not normal.
- **Rescue breaths** without equipment**:**
  - Ensure the airway is open and blow steadily into the child's mouth (or infant's mouth and nose) for about 1 second, sufficient to make the chest visibly rise and then allow the chest to fall back passively while you take your next breath (Figure 2.4a and b).
  - If the chest does not rise, the airway may be obstructed:
    - Remove any visible obstruction in the mouth if it is easy to do so. Do not perform a blind finger sweep.
    - Reposition the head or adjust the airway opening method by further lifting the chin or tilting the head.
- **Chest compressions**:
  - Perform chest compressions on a firm surface if immediately available. Remove clothes only if they hinder chest compressions.
  - Perform chest compressions over the lower half of the sternum (breastbone) in all age-groups.
  - Use the two-thumb encircling method for chest compressions in infants (Figure 2.5a or video).

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- Use the one-hand or two-hand technique in children older than 1 year, or when unable to give high-quality chest compressions with the two-thumb-encircling technique. (Figure 2.5b or video).
- Deliver high quality chest compressions as defined by:
  - Rate of 100-120 /min.
  - Depress the chest by *at least* one third of the anteroposterior dimension. Use the adult depth recommendation of 5-6 cm in adolescents and do not exceed a depth of 6 cm at any age.
  - Avoid leaning by releasing all pressure between compressions and allow the chest to rise again completely (chest recoil).
  - Do not interrupt chest compressions except when giving ventilations, or if you are instructed to do so by the AED.

- **Using an Automated External Defibrillator**:
  - Follow the instructions of the AED.
  - Apply the pads with minimal interruptions in CPR (one person applying the pads, a second performing CPR).
  - Activate the paediatric mode, if available, in all infants and children weighing less than 25 kg (i.e. approximately 8 years of age). In larger children and adolescents, use the AED in standard adult mode. If the AED does not have instruction for children, use it in standard adult mode.
  - Place adult size pads as follows (Figure 2.6a and 2.6b):
    - Use the anteroposterior position in infants and children weighing less than 25 kg: the anterior pad is placed mid-chest immediately left of the sternum and the posterior on the back placing the centre of the pad between the scapulae (shoulder blades).
    - Use either the anterolateral or the anteroposterior position in children weighing more than 25 kg and adolescents. In the anterolateral position one pad is placed bellow the right clavicle and the other in the left axilla. If the anteroposterior position is used in adolescents, avoid placing the pads over breast tissue.

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    - Do not touch the patient while the AED is analysing the rhythm.
    - Restart chest compressions immediately after shock delivery.

[h3] Additional considerations for PBLS

- Healthcare professionals should call for help as soon as deterioration is detected and not wait for cardiac arrest.
- Competent providers should use bag-mask ventilation with oxygen.
- If starting ventilations is not immediately possible (e.g. bag-mask ventilation is not immediately available and there is a contraindication to mouth-to-mouth ventilation), start chest compressions immediately and add ventilations as soon as possible.
- Competent providers can also use a pocket mask for rescue breaths to ventilate larger children when a bag and mask is not available.
- Activate the CPR mode on the bed to increase stiffness of the mattress (if the bed is equipped with this function).
- Over-the-head chest compressions can be used in certain specific situations such as limited space or limited personnel.
- The anterolateral pad position can be used by competent providers in children ≤25 kg when using paediatric pads provided these do not touch each other.
- A single rescuer without a mobile phone, should perform CPR for 1 min before going to seek help.

[h3] Foreign body airway obstruction (Figure 2.7)

- Suspect choking due to a foreign body if the victim is unable to speak (children and adolescents) or cry aloud (infants or smaller children), especially during feeding, eating, or playing unsupervised.
- Call or have someone call the EMS as soon as possible.
- Encourage an older child or adolescent to cough.
- Give up to 5 back blows if coughing is not possible or becoming ineffective:
    - Turn the infant face-down on your forearm with your forearm resting on your leg. Support the head of the infant with your hand. Try to hold the head below the level

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of the (use gravity). Give a sharp blow between the shoulder blades (Figure 2.8a or video). Repeat 5 times or until the obstruction is relieved.

   - Lean children and adolescents forward and give blows between the shoulder blades (Figure 2.8b or video). Repeat up to 5 times.

- Give up to 5 chest/abdominal thrusts if back blows are not effective:
   - In infants (Figure 2.9b or video):
      - Turn the infant onto their back and lay them on your knees.
      - Use the two-thumbs encircling technique to perform chest thrusts as advised for chest compressions but compressing the sternum more sharply. Repeat 5 times or until the obstruction is relieved.
   - In children and adolescents (Figure 2.9b or video):
      - Stand behind the victim and put your arms around the upper part of their abdomen.
      - Lean them forward.
      - Clench your fist and place it between the navel (umbilicus) and the end of the breastbone (xiphoid).
      - Grasp your fist with the other hand and pull sharply inwards and upwards.
      - Repeat 5 times or until the obstruction is relieved.
   - If the child is still conscious, repeat up to 5 back blows alternating these with up to 5 chest/abdominal thrusts.
   - Stop back blows or chest/abdominal thrusts immediately if at any time there are signs of relief of the obstruction (coughing, loud breathing or crying).
- Do not use blind sweeps to clear the obstruction from the mouth but use a single sweep to remove a clearly visible obstruction.
- Call for help and the EMS as soon as practical (if not already done so), at the latest when the child loses consciousness.
- Start CPR immediately with 5 rescue breaths as soon as the child becomes unconscious.

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- Do not use suction, including suction-based devices advertised and marketed for clearing a foreign body airway obstruction, as this will waste valuable time which is better used for delivering established treatments.
- As no high-certainty scientific evidence exists, the ERC cannot make a recommendation for or against these devices.

[h2] Paediatric advanced life support (PALS) (Figure 3.1)

- Use a team approach, define clear roles for each team member, consider and practice the choreography (i.e. the best way for your own team to resuscitate a child including roles and sequences of action). A possible team composition is illustrated in Figure 3.2.
- Commence or continue with high quality chest compressions and ventilations.
- Recognise cardiac arrest on clinical grounds (e.g. no signs of life) or based on monitored vital signs (e.g. ECG, loss of SpO_2 and/or $ETCO_2$, loss of intra-arterial blood pressure trace).
- Importantly, chest compressions should also be started in children who become bradycardic (<60 per min) with signs of poor perfusion despite adequate respiratory support, even if there is still a detectable pulse.
- Apply cardiac monitoring as soon as possible, if not already in place, using self-adhesive defibrillator pads as the first choice as this allows for a shorter time to defibrillation in children who require it.
- Differentiate between shockable and non-shockable cardiac rhythms.
- **Non-shockable rhythms** are bradycardia (with poor perfusion), pulseless electrical activity (PEA) and asystole.
    - Obtain vascular access and give adrenaline IV/IO (10 microg/ kg, max 1 mg) *as soon as possible* followed by a flush to facilitate drug delivery. Immediately attempt IO access if IV access is likely to be difficult.
    - Repeat adrenaline IV/IO every 4 min (i.e. *every other* 2 min cycle) unless being guided by intra-arterial blood pressure monitoring and the haemodynamic response.
    - Reassess the cardiac rhythm every 2 min (< 5 s).
    - Change the person doing chest compressions at least every 2 min. Watch for fatigue and/or suboptimal chest compressions and switch rescuers earlier if necessary.

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    - If the rhythm changes, to an organised rhythm which could produce cardiac output, check for signs of life and feel for a central pulse (max. 5 sec).

- **Shockable rhythms** are pulseless ventricular tachycardia (pVT) and ventricular fibrillation (VF).
    - As soon as identified, give one defibrillation shock (regardless of the ECG amplitude). If in doubt, consider the rhythm to be shockable.
    - If using self-adhesive pads, continue chest compressions while the defibrillator is charging.
    - If the child is being ventilated with a bag and mask with oxygen this should be removed at least 1 metre from the pads before charging the defibrillator. If the child has a tracheal tube and is being hand ventilated disconnect the tracheal tube from the oxygen source prior to charging. Do not disconnect the tracheal tube if a closed circuit is being used e.g. during mechanical ventilation.
    - Once charged, pause chest compressions, briefly check that the rhythm is still shockable (<5 s) and ensure *all* persons are clear of the child before giving a single shock.
    - Minimise pauses between stopping chest compressions, delivery of the shock and restarting chest compressions (<5 s).
    - Give one shock (4 J kg^{-1}, max. 120-200 J) and *immediately* resume CPR for 2 min.
    - Reassess the cardiac rhythm:
        - If the rhythm changes to an organised rhythm which could produce cardiac output, check signs of life and feel for a central pulse (<5 s)

        OR

        - If a shockable rhythm persists, give a 2nd shock (4 J kg^{-1}) and immediately resume CPR for 2 min, then reassess and continue to repeat this cycle.
    - Give adrenaline (10 microg kg^{-1}, max. 1 mg) and amiodarone (5 mg kg^{-1}, max. 300 mg) IV/IO immediately after the 3rd shock. Flush after each drug. Lidocaine IV (1 mg/ kg) might be used as an alternative to amiodarone.
    - Give a second dose of adrenaline (10 microg/ kg, max 1 mg) and amiodarone (5 mg kg^{-1}, max 150 mg) IV/IO immediately after the 5th shock.

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  - Unless there are clear signs of life adrenaline IV/IO should be repeated every 4 min (i.e., *every other* 2 min cycle) unless being guided by intra-arterial blood pressure monitoring and the haemodynamic response.
  - Change the person doing compressions at least every 2 min. Watch for fatigue and/or suboptimal compressions and switch rescuers earlier if necessary.
- CPR should be continued unless:
  - An organised rhythm is recognised at a rhythm check and is accompanied by signs of return of spontaneous circulation (ROSC), identified clinically (e.g. eye opening, movement, normal breathing) and/or by monitoring (e.g. ETCO2, SpO2, blood pressure, echocardiogram) and/or presence of a palpable central pulse.
  - Perfusion is restored by extracorporeal cardiopulmonary resuscitation.
  - Criteria for withdrawing resuscitation are met (see the ERC Guideline 2025 Ethics in Resuscitation. (INSERT REF)

[h3] Defibrillation during PALS (video)

- Manual defibrillation is the recommended method for PALS. If this is not immediately available an AED can be used.
- Proper planning before each defibrillation will minimise hands-off time.
- Pads should be positioned either in the anterolateral or the anteroposterior position. (Figure 2.6)
  - Avoid contact between pads as this can cause charge arcing.
  - In the anterolateral position, one pad is placed below the right clavicle and the other in the left axilla.
  - In the anteroposterior position the anterior pad is placed mid-chest immediately left of the sternum and the posterior in the middle of the back between the scapulae.
  - Use the anteroposterior position in infants and children who can easily be turned onto their side for pad placement and in whom the anterolateral position is more difficult to achieve without contact between the pads.

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    - Use the anterolateral position in larger children as this leads to less interruption of chest compressions than the anteroposterior position. Avoid breast tissue in adolescents.
    - If you use CPR feedback devices place pads anteroposterior to allow accurate device function.
- Defibrillation with self-adhesive pads is standard, use it if available, if not, use paddles with preformed gel pads (this demands specific choreography of defibrillation).
- Use 4 J kg^{-1} as the standard energy dose for the initial shocks. It seems reasonable not to use doses above those suggested for adults (120 -200 J, depending on the type of defibrillator).
- Increase the energy dose - stepwise increasing up to 8 J kg^{-1} (max. 360 J) for refractory VF/pVT (i.e. more than 5 shocks are needed).
- Charge the defibrillator with the pads or paddles on the chest. Continue chest compressions while the defibrillator is charging when using pads.
- If any period of ROSC is achieved and the child goes back into a shockable rhythm, use the defibrillation energy dose that was previously successful.

[h3] Oxygenation and ventilation during PALS

- Effective oxygenation and ventilation combined with high quality chest compressions are essential during CPR to generate sufficient coronary perfusion to restart the heart.
- Oxygenate and ventilate with a bag and mask, using 100% oxygen. Do not titrate FiO_2 during CPR.
- Intubate the child only if you are experienced and competent and have all the necessary equipment. If not, continue to ventilate using a bag and mask or insert an SGA. Ensure the chest rises during ventilation. If not, adjust the airway or ventilation technique.
- Use a tracheal tube or SGA if CPR is required during transport; when prolonged resuscitation is anticipated or when it is impossible to ventilate with a bag-mask. Call for expert help if this is not already present.
- Do not interrupt chest compressions during airway management. Use $ETCO_2$ monitoring to ensure correct ventilation when a tracheal tube or SGA is in place.
- Avoid hypo- or hyperventilation.

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- Give continuous chest compressions when the airway is secured with a tracheal tube or SGA and ventilate without pausing chest compressions. Pausing only briefly for each rhythm check.
- Ventilate at the lower limit of the normal rate for age e.g. pragmatically use breaths/min: 25 (infants), 20 (>1 yr), 15 (>8 yr), 10 (>12 yr).
- If there is doubt about the effectiveness of ventilation (e.g. high air leak, diminished air entry into lungs) during continuous chest compressions return to a chest compression to ventilation ratio of 15:2.
- For children who go into cardiac arrest on a mechanical ventilator, either disconnect the ventilator and ventilate with a self-inflating bag/ anaesthetic bag (depending on expertise) or continue to ventilate with the mechanical ventilator (ensuring the child is adequately ventilated). In the latter case, ensure that the ventilator is in a volume-controlled mode, that triggers and limits are disabled, and that the ventilation rate, tidal volume and FiO2 are appropriate for CPR. There is no evidence to support any specific level of PEEP during CPR. Always consider ventilator dysfunction as a possible cause of cardiac arrest
- Titrate FiO2 to an SpO_2 of 94-98% after ROSC.

[h3] Measurable factors during PALS

- **Capnography:** Use $ETCO_2$ monitoring once a tracheal tube or an SGA is in place to assess the quality of chest compressions and help verify ROSC.
- **Invasive blood pressure:** If an intra-arterial line in situ during CPR, monitor the diastolic blood pressure values in response to chest compressions and drugs (adrenaline). Aim for an intra-arrest diastolic blood pressure of at least 25 mmHg for infants and at least 30 mmHg for children and adolescents.
- **Point of care ultrasound:** Use POCUS only if you are competent in its use during CPR and it does not compromise the quality of chest compressions.
- **Point of care blood analysis:** Check at least glucose, potassium, haemoglobin, lactate and treat as appropriate.

[h3] Extracorporeal CPR

- Consider extracorporeal CPR (ECPR) as an *early* intervention for selected infants and children with IHCA (e.g. children with cardiac conditions in the paediatric intensive care

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unit, perioperative children) and OHCA (e.g. a refractory shockable rhythm) in settings where resources allow ECPR.

[h3] Reversible causes of paediatric cardiac arrest (Figure 3.3)

- Seek and identify any reversible cause for cardiac arrest early and treat appropriately.
- Use the mnemonic '4H4T' (Table 4)

Table 4: Reversible causes of cardiac arrest

Consider	Identification	Treatment in cardiac arrest
Hypoxia	History/clinical exam/ SpO_2 and/or PaO_2 pre-arrest or intra-arrest.	Ventilate with 100% oxygen. Insert an advanced airway if bag-mask ventilation is inadequate. Ensure adequate chest rise. Check for leaks, air entry, abdominal distention, or stacked breaths if an advanced airway is in situ.
Hypovolaemia	History (sepsis, haemorrhage, diarrhoea, anaphylaxis) POCUS.	Fluid bolus 10 ml kg^{-1} isotonic crystalloid or blood products for major haemorrhage.
Hyper-/ hypo-kalaemia, calcaemia, magnesaemia and hypoglycaemia (metabolic derangements)	***Hyperkalaemia***	
	History (massive haemolysis, tumour lysis syndrome, crush syndrome, acute or chronic renal failure, malignant hyperthermia, specific intoxications). Blood gas analysis with electrolytes.	In cardiac arrest with severe hyperkalaemia (> 7 mmol/L), start an IV/IO 20% glucose infusion at 2.5 ml kg^{-1} $hour^{-1}$ with an IV/IO insulin infusion (0.1 unit kg^{-1} $hour^{-1}$, max 10 unit $hour^{-1}$) and/or IV/IO infusion of a short acting beta2-adrenergic agonist (e.g. salbutamol 5 microcg kg^{-1}).

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		Consider extracorporeal potassium removal.
	Hypokalaemia	
	History (diarrhoea, vomiting, diabetes insipidus, specific medications, hyperaldosteronism). Blood gas analysis with electrolytes.	In cardiac arrest associated with severe hypokalaemia (< 2.5 mmol/L), give 1 mmol kg^{-1} (max 30 mmol) potassium at 2 mmol/min for 10 min followed by the rest of the dose (if necessary) in 5-10 min. Repeat, if necessary, until the serum potassium is > 2.5 mmol/L. Consider magnesium for concomitant hypomagnesaemia.
	Hypoglycaemia	
	History and blood analysis.	Give an IV bolus of 0.2 g kg^{-1} glucose (e.g. 2 ml kg^{-1} 10% glucose) and re-check blood glucose after 5 min. Repeat if necessary.
	Other metabolic derangements	
	History and blood analysis.	Correct calcium, magnesium and other metabolic derangements.
	Hypothermia	

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Hypo-or hyperthermia	History/situation and core temperature.	Modify the PALS algorithm: ● < 30 °C: no drugs. Give a maximum of three shocks if a shockable rhythm is present; if this is ineffective, delay further attempts until core temperature > 30 °C. ● 30-35 °C: adrenaline IV/IO every 8 min (6-10 min), second dose amiodarone IV/IO after 8 min, normal interval of defibrillation (every 2 min). ● > 35 °C: normal algorithm. ● Consider transport to a centre for extracorporeal life support. ● >32°C: warm using external rewarming methods (hypothermia is unlikely to be the primary cause of cardiac arrest). < 32°C: use active external and internal rewarming methods including extracorporeal techniques.
	Hyperthermia	
	History and core temperature.	External cooling. If drug mediated, consider antidotes or other treatments.
Thromboembolism	History (children with indwelling central lines,	Consider IV thrombolysis.

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	cardiac conditions, cancer, recent trauma, recent surgery) and POCUS.	
Tension pneumothorax	History (trauma, positive pressure ventilation, acute severe asthma exacerbation) Examine for symmetrical air entry and POCUS.	Needle thoracocentesis /thoracostomy (trauma).
Tamponade	History (cardiac surgery, penetrating chest trauma, acute viral pericarditis) and POCUS.	Pericardiocentesis/ thoracotomy (trauma).
Toxins	History. Pre-arrest ECG, blood gas analysis electrolytes.	Specific measures (safety, antidotes, decontamination, enhanced elimination). Consider ECPR.

[h2] Cardiac arrest and its prevention in special circumstances

The recommendations in this section are primarily aimed at healthcare professionals.

[h3] Anaphylaxis

- Identify and treat anaphylaxis as soon as possible to prevent cardiac arrest - typically an acute onset of cutaneous, respiratory, circulatory and/or severe gastrointestinal symptoms.
- Discontinue/remove the suspected allergen, if known.
- Immediately administer 0.01 mg kg^{-1} = 10 microg kg^{-1} (max. 0.5 mg) adrenaline (1mg/ml) *intramuscularly* (IM) into the anterolateral mid-thigh.
- Pragmatically one can use the following doses of adrenaline according to the child's age:
  - 0.15 mg at 1 to 5 years,
  - 0.3 mg at 6 to 12 years and
  - 0.5 mg if older than 12 years.

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An age-appropriate autoinjector can also be used.

- Repeat this dose of IM adrenaline every 5 min if symptoms persist.
- Assess ABCDE and position the child according to the presenting features (supine for shock, but the sitting position may optimise respiratory effort). Reassess ABCDE frequently.
- Give 100% oxygen to children with respiratory distress and those receiving more than one dose of adrenaline.
- Consider early tracheal intubation in case of respiratory compromise and in anticipation of airway oedema. Airway management can be difficult, and the early involvement of a competent practitioner is mandatory.
- Establish vascular access and give crystalloid fluids 10 ml kg^{-1} as required to treat shock.
- Give inhaled short-acting beta-2 agonists for bronchospasm *in addition* to intramuscular adrenaline.
- After treatment, observe the child for at least 6-12 hours.
- Consider second-line medications, such as antihistamines (for cutaneous symptoms) and steroids (only if there is concurrent asthma), when the initial reaction is under control.
- Seek expert advice (e.g. of a paediatric intensivist) if the child requires more than two doses of adrenaline with ongoing symptoms.
- Try to identify the allergen and take blood for serum tryptase analysis.

[h3] Traumatic cardiac arrest

- Identify and treat reversible causes to prevent cardiac arrest.
- Ensure proper team collaboration.
- *Additional recommendations for PBLS in traumatic cardiac arrest*
    - Follow standard CPR, start opening the airway and ventilate.
    - Competent providers open the upper airway with a jaw thrust and minimise spinal movement without hampering CPR.
    - Stop significant external bleeding immediately with manual pressure, haemostatic dressing or tourniquet.

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  - Use an AED only if there is a high likelihood of a shockable rhythm (e.g. following electrocution).

- *PALS in trauma*
  - professional rescuers should look for and treat reversible causes.
  - Use the acronym 'HOTT' to identify reversible causes: **H**ypotension, **O**xygenation (hypoxia), **T**ension pneumothorax and cardiac **T**amponade). In cardiac arrest, treating these has priority, or should run concurrently with, chest compressions and the administration of adrenaline IV/IO.
  - Use POCUS where available to diagnose reversible causes.
  - The optimal sequence of action will depend upon the setting and the number of rescuers, but consider:
    - Correct hypoxia. Open the airway using a jaw thrust manoeuvre and minimise spinal movement, without hampering CPR. Ensure adequate ventilation and intubate the child as soon as the expertise and equipment are available. Intubate the child's trachea if the expertise and equipment are available. Use an SGA if intubation is not possible.
    - Correct hypovolemia with intravascular fluid replacement, including early use of blood products in haemorrhagic shock.
    - Relieve a suspected tension pneumothorax with a bilateral finger thoracostomy prior to chest drain placement.
    - Perform a resuscitative thoracotomy, if competent, for a cardiac tamponade. Otherwise perform pericardiocentesis via a mini-thoracotomy or insert a wide-bore drain, preferrable guided by POCUS.
  - Attach an AED directly if there is a high likelihood of a shockable underlying rhythm such as following electrocution or in cardiac contusion. Otherwise, HOTT has priority over the AED.
  - Consider a resuscitative thoracotomy (e.g. for penetrating chest injuries) provided the expertise, equipment and systems are in place.

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- High-quality resuscitation is the standard in cardiac arrest due to a medical cause coincidental to the trauma or to a non-hypovolemic, non-obstructive aetiology (e.g. isolated traumatic brain injury, cardiac contusion, or asphyxia) or due to electrocution.

[h3] Drowning

- Reverse hypoxia and treat respiratory failure early to prevent cardiac arrest following drowning.
- Manage cardiac arrest following drowning with standard PALS with additional attention to reversing hypoxia and hypothermia.
- Remove the child as quickly and safely as possible from the water.
- Do not enter the water unless you are trained to rescue a victim from the water.
- Try to reach the child from the land and provide a flotation device such as a lifebuoy or other rescue equipment.
- Start ventilation in the water if you are trained to do so and have a floatation device and the child is unconscious and not breathing.
- Start standard PBLS with 5 rescue breaths as soon as it is safe to do so (e.g. on land or on a boat).
- Give 100% oxygen as soon as it is available. Intubate the child if the expertise and equipment are available.
- Attach an AED after drying the chest. Uninterrupted CPR and oxygenation take priority over the AED.
- Assess ABCDE and stabilise the child if not in cardiac arrest Prevent cardiac arrest by identifying and treating respiratory insufficiency and hypothermia.
- Rewarm a hypothermic child immediately and simultaneously with the stabilisation. Treat hypothermia in a child with an intact circulation as follows:
    - Monitor the core temperature with a thermometer suitable for low temperatures.
    - Handle the child gently in a horizontal position to reduce the risk of cardiac arrest (especially VF).
    - Start rewarming if < 35 °C and rewarm at > 1-2 °C hour^{-1}. Aim for normothermia but stop active rewarming at 35 °C to avoid overshoot hyperthermia.

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  - Use active external rewarming applied to the trunk (chest, abdomen, back and axillae - not the extremities) with e.g. a hot-air blanket, radiant warmer, warmed blankets or hot packs, applied according to the manufacturers' instructions.
  - Do not place warm devices directly on the skin to prevent burns. Avoid rubbing and massaging of the extremities.
  - Do not use a warm shower or warm water immersion for rewarming a child with a decreased level of consciousness.
  - Give warmed and humidified 100% oxygen and warmed IV/IO fluids (39-42°C) to prevent further heat loss and to compensate for the vasodilatation during rewarming but avoid fluid overload by careful haemodynamic monitoring.
- Look for and treat a possible underlying cause of drowning (e.g. arrhythmia, epilepsy, intoxication, or trauma).
- Check blood glucose and electrolytes.
- Follow the PALS guideline modified for hypothermic arrest if cardiac arrest occurs (see below).
- Consider ECPR if conventional CPR is failing.

[h3] Hypothermic cardiac arrest

- Individualise approaches depending on the cause of cardiac arrest: accidental hypothermia, or other possible causes such as drowning, suffocation, intoxication.
- Start standard CPR in every case of hypothermic cardiac arrest as soon as possible (e.g. before full extrication from an avalanche or in the water).
- If standard CPR is not possible and the child is deeply hypothermic (<28 °C) consider delayed or intermittent CPR.
- Modify the standard PALS-algorithm according to the core temperature. The revised Swiss Staging for Hypothermia can be used when the core temperature cannot be measured.
- Start rewarming the child as rapidly as possible while monitoring the core-temperature as soon as this is practicable.
- Do not give adrenaline or amiodarone until the core temperature is above 30 °C. Prolong the administration intervals while the core temperature remains between 30-35 °C (i.e. adrenaline every 8 min, second dose of amiodarone after 8 min).

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- Attempt defibrillation a maximum of 3 times if a shockable rhythm is present under 30 °C. If this is ineffective, delay further attempts until the core temperature exceeds 30 °C. Then use the standard sequence of defibrillation (every two minutes).
- Transport a child considered to have a chance of a favourable outcome from hypothermic cardiac arrest as soon as possible to an appropriate centre for extracorporeal life support.
- Extracorporeal life support is potentially indicated in all children with hypothermic cardiac arrest who do not achieve ROSC in the field.
- Hypothermic patients with risks factors for imminent cardiac arrest (e.g. P or U on the AVPU scale, associated trauma, ventricular arrhythmia, or hypotension) should be also transported to an extracorporeal life support centre.
- Stop resuscitation if ROSC is not achieved within 30 min when cardiac arrest is due to trauma or asphyxia (i.e. avalanche burial for >60 min, core temperature ≥30 °C and an obstructed airway).

[h3] Hyperthermia

- Identify patients with hyperthermia or heat stroke (core temperature above 40 °C) as soon as possible. Look for an elevated body temperature associated with confusion, agitation or disorientation which can progress to coma and/or seizures.
- Remove the child from the heat source and/or stop exercise and loosen or remove clothing.
- If the temperature is above 39°C, start cooling aggressively preferably using immersion in cold water.
- Activate the EMS at the same time as initiating cooling.
- Monitor the core temperature to prevent overcooling. Aim to reduce this by about 0.1-0.2°C/min. If the core temperature cannot be measured, cool for 15 min or until neurological symptoms subside.
- Hydrate orally if possible, or intravenously. Give room-temperature intravenous fluids as an adjunct to cooling and avoid fluid overload.
- Monitor symptoms and vital signs including mental status.
- Start resuscitation if circulatory collapse supervenes (often around 41°C) and follow the standard PALS guidelines while continuing cooling.

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- Stop aggressive cooling (e.g. cold-water immersion) when core temperature reaches 39°C. Stop all active cooling at 38°C but continue to monitor core temperature.
- Stabilise the child according to the ABCDE-method.
- All children with heat stroke should be admitted to a paediatric intensive care unit for continued monitoring in anticipation of sequalae and complications.

In the case of malignant hyperthermia (MH) stop all potential triggering agents immediately (e.g. anaesthetics), cool the child actively, ensure adequate oxygenation and ventilation, correct severe acidosis and hyperkalaemia, and administer dantrolene.

[h3] Tension pneumothorax

- Suspect tension pneumothorax especially in trauma, following central venous cannulation and during positive pressure ventilation.
- Use clinical signs to diagnose a tension pneumothorax. POCUS is helpful but is not necessary to make the diagnosis.
- Perform a needle thoracocentesis in the 4th or 5th intercostal space in the anterior axillary line or 2nd intercostal space in mid clavicular line; followed by chest drain insertion usually in the axilla.
- In trauma perform a finger thoracostomy in the 4th or 5th intercostal space in the anterior axillary line, followed by emergency chest drain insertion.
- Perform bilateral thoracostomies in traumatic cardiac arrest with or without signs of a tension pneumothorax.

[h3] Cardiac tamponade

- Suspect cardiac tamponade especially after cardiac surgery, in penetrating chest trauma and pericarditis.
- Use clinical signs and POCUS to recognise cardiac tamponade which is most common post cardiac surgery and in penetrating chest trauma and some viral illnesses.
- Perform urgent pericardiocentesis, mini-thoracotomy, resuscitative thoracotomy or re-sternotomy depending on the setting and available expertise.

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[h3] Pulmonary thromboembolism

- Suspect PE in case of tachycardia, tachypnoea and hypoxia, especially in children with central lines, cardiac conditions, cancer, unilateral limb swelling, recent trauma/surgery, prior thromboembolism, anaemia and/or leucocytosis.
- Use echocardiography to help with the diagnosis.
- For thrombolytic therapy refer to local protocols and call for expert help. Consider systemic or catheter-directed administration of thrombolysis which is more effective than systemic anticoagulation.
- Consider extracorporeal life support and surgical embolectomy when thrombolysis fails, or the child progresses towards cardiac arrest.
- Consider thrombolysis, e.g. IV alteplase 0.1 mg kg^{-1}, max. 100 mg over 5-10 min in cardiac arrest.

[h3] Toxins

Prevention of Cardiac Arrest

- Provide supportive care based on the ABCDE approach to prevent cardiorespiratory arrest whilst awaiting toxin elimination. Look for evidence of non-accidental injury.
- Provide early advanced airway management if decreased conscious level.
- Administer IV boluses of 10 ml kg^{-1} isotonic crystalloids for hypotension. Noradrenaline may be required if hypotension persists.
- Perform a 12-lead ECG in certain poisonings (e.g. antipsychotics, 3,4-methylenedioxymethamphetamine (MDMA) and other amphetamines) or in children with altered consciousness, abnormal heart rate or blood pressure. Cardiovert life-threatening tachyarrhythmias
- Take blood for electrolytes, blood glucose and blood gas analysis and correct any abnormalities. Take blood and urine for toxicological analysis.
- Check for and correct hyperthermia (ecstasy, cocaine, salicylates) and hypothermia (ethanol, barbiturates).

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- Take a thorough history (relatives, friends, EMS crew) and perform a complete physical examination to identify diagnostic clues (e.g. odours, needle puncture marks, pupils, tablet residues).
- Administer antidotes, where available.
- Consult a regional or national poisons centre for information on treatment.

Cardiac Arrest

- Suspect toxins as an infrequent cause of cardiac arrest after more common causes have been excluded.
- Provide standard PBLS and PALS.
- Do not use mouth-to-mouth ventilation in the presence of chemicals such as cyanide, hydrogen sulphide, corrosives and organophosphates.
- Exclude all reversible causes of cardiac arrest, including electrolyte abnormalities which can be indirectly caused by a toxic agent.
- Be prepared to continue resuscitation for a prolonged period while the toxin concentration falls.
- Consult regional or national poison centres for information on treatment.
- Consider ECPR for selected patients when conventional CPR is failing.

[h3] Hyperkalaemia

- Suspect hyperkalaemia in children with massive haemolysis (neonates), cellular lysis (tumour lysis syndrome, crush syndrome), in acute or chronic renal failure, malignant hyperthermia, or specific intoxications.
- Stop all exogenous sources of potassium including fluids containing potassium when hyperkalaemia is detected. Use normal saline if fluids are needed.
- If severe hyperkalaemia is confirmed (> 6.5 mmol/L or > 7.0 mmol/L in neonates younger than 96 h):
    - Treat the underlying cause if possible.
    - Administer rapidly acting insulin with glucose (0.1 U kg^{-1} $hour^{-1}$, max. 10 U $hour^{-1}$+ 20% glucose at 2.5 ml kg^{-1} $hour^{-1}$). Check potassium and glucose frequently and adjust the infusion rates when necessary.

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- Administer short acting beta$_2$-adrenergic agonists preferably as inhalation/nebulisation (e.g. salbutamol 2.5-5 mg, repeat up to 5 times).
- If inhalation is not possible, give short-acting beta2-adrenergic agonists IV (e.g. salbutamol 5 microg kg^{-1} over 5 min). Repeat if insufficient effect is seen within 15 min, up to a maximum total dose of 15 microg kg^{-1}.
- In patients with conduction abnormalities on the ECG consider 10% calcium gluconate, 0.5 ml kg^{-1}, max. 20 ml.
- Prepare a potassium removal strategy (e.g. binding agents, furosemide in well hydrated children with preserved kidney functions, dialysis).

- For cardiac arrest caused by severe hyperkalaemia (usually > 7 mmol/L):
  - Start an IV infusion of 20% glucose at 2.5 ml kg^{-1} hour^{-1} with an IV insulin infusion (0.1 unit kg^{-1} hour^{-1}, max 10 units hour^{-1}).
  - Do not use calcium in children in cardiac arrest.
  - Continue high quality PALS and consider ECPR.

[h3] Other metabolic derangements

- Hypokalaemia: give 1 mmol kg^{-1} (max 30 mmol) potassium at 2 mmol/min for 10 min followed by the rest of the dose (if necessary) in 5-10 min in children with severe hypokalaemia (< 2.5 mmol/L) with life-threatening symptoms or in cardiac arrest. Repeat, if necessary, until the serum potassium is > 2.5 mmol/L. Follow this with an IV infusion (e.g. 0.5 to 1 mmol kg^{-1} hour^{-1}, maximum 20 mmol hour^{-1}, depending on the potassium level for 1-2 hours). Consider magnesium sulphate 30-50 mg kg^{-1} IV for concurrent hypomagnesaemia.
- Hypoglycaemia: Treat hypoglycaemia < 3.9 mmol/L with symptoms, or < 3.0 mmol/L if asymptomatic. Give a bolus of 0.2 g kg^{-1} glucose (e.g. 2 ml kg^{-1} 10% glucose) and re-check the glucose after 5 min. Repeat as needed.
- In other metabolic derangements (hypocalcaemia, hypercalcaemia, hypomagnesaemia, hypermagnesaemia): Correct the metabolic derangement during cardiac arrest, while continuing high-quality CPR. Consider extracorporeal life support.

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[h3] Cardiac arrest in children with congenital heart disease

- Follow the standard PALS algorithm with additional considerations for pulmonary hypertension, obstructed cardiac shunt or if the child is attached to a defibrillator and has a witnessed shockable rhythm.

[h3] Pulmonary hypertension

- Suspect pulmonary hypertension in children with congenital heart disease or chronic lung disease but also as a primary disease.
- Anticipate and prevent pulmonary hypertensive crises by avoiding triggers such as pain, anxiety, excessive tracheal tube suctioning, hypoxia, hypercapnia, and metabolic acidosis.
- Treat pulmonary hypertensive crises with a high concentration of oxygen, adequate ventilation, analgesia and sedation and with muscle relaxation as necessary.
- Search for and treat other possible reversible causes of increased pulmonary vascular resistance: inadvertent interruption of pulmonary hypertensive therapy, arrhythmia, cardiac tamponade, or drug toxicity.
- Consider inotropic and or vasopressor therapy to avoid or treat right ventricle ischaemia caused by systemic hypotension.
- Additional therapies, which are indicated if the crisis does not rapidly resolve or in the case of cardiac arrest, are inhaled nitric oxide (iNO) and/or intravenous prostacyclin.
- Consider extracorporeal life support if medical management is ineffective.

[h3] Cardiac arrest due to obstruction of a cardiac shunt

- Suspect acute obstruction due to thrombosis or mechanical kinking of connections between the systemic and pulmonary circulation in children with aortopulmonary shunts or patent ductus arteriosus stents as a cause of cardiac arrest.
- Give 100% oxygen to maximise alveolar oxygenation.
- Consider hypovolemia and treat this with intravascular fluids if necessary.
- Ensure an adequate systemic blood pressure to optimise shunt and coronary perfusion pressure with vasoactive agents and inotropes.
- Ensure adequate anticoagulation e.g. with a bolus of heparin 50–100 U kg^{-1} followed by a titrated continuous infusion.

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- Call for immediate expert help and consider interventional catheterisation or surgery. In the direct post-operative period immediate re-sternotomy may improve shunt perfusion.

[h3] Cardiac arrest in an ECG-monitored child attached to a defibrillator with a witnessed shockable rhythm

- As soon as a shockable rhythm is detected, give up to three quickly successive (stacked) shocks using the standard energy doses for the child's weight.
- Recharge the defibrillator and rapidly check for a rhythm change and signs of life after each defibrillation attempt and, if necessary, immediately give a further shock.
- Start chest compressions after the third defibrillation attempt and continue CPR for 2 min.
- Give amiodarone after starting CPR if the third shock is unsuccessful. Give adrenaline after 4 min.
- The subsequent resuscitation follows the standard sequence of actions, i.e. giving a single shock every 2 min, adrenaline every 4 min and a second dose of amiodarone after the 5th shock.

[h3] Cardiac arrest in the operating room

- Clarify roles and procedures during the team briefing before high-risk cases to enable co-ordinated actions should cardiac arrest occur.
- Treat pre-arrest states such as hypoxia and hypotension aggressively. Ventilate with 100% oxygen and give intravascular fluid and vasoactive agents.
- Recognise cardiac arrest early by continuous monitoring and a high index of suspicion, particularly during difficult airway management and massive bleeding.
- Start chest compressions if extreme bradycardia or hypotension (< 5th percentile for age) occurs suddenly despite interventions, or the waveform capnography suddenly decreases.
- Inform the whole OR-team of the cardiac arrest.
- Call for help and for the defibrillator.
- Optimise the child's position and the height of the operating table to facilitate high-quality chest compressions.
- Ensure the airway is secure, review the ETCO2 tracing, and deliver effective ventilation with 100% oxygen.

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- Follow the general PALS algorithm and focus initially on the most likely reversible causes: hypovolaemia (haemorrhage, anaphylaxis), hypoxia, tension pneumothorax, thrombosis (pulmonary embolism) and toxins (medication).
- Use POCUS to identify the cause and guide resuscitation.
- Also consider causes specific to the operating room such as: gas embolism, bradycardia from axial nerve blocks, malignant hyperthermia, local anaesthetic overdose, and other drug errors.
- For hypotensive and/or bradycardic children in a pre-arrest state, give smaller incremental bolus doses of IV adrenaline initially (e.g. 1-2 microg / kg intravenously). If the child progresses to cardiac arrest give adrenaline according to the standard PALS-algorithm.
- If the facilities and expertise are available and conventional CPR is failing, consider early ECPR or open chest cardiac compressions as an alternative if ECPR is unavailable.

[h2] Post-resuscitation care

Post-resuscitation care starts immediately after return of spontaneous circulation (ROSC) is achieved.

[h3] Recommendations for health care providers in the pre-hospital setting and limited-resource healthcare (Figure 5.1)

- The general ABCDE principles described in the section on the prevention of cardiac arrest also apply to post-resuscitation care.
- Ensure adequate oxygenation and ventilation.
- Intubate the trachea only if you are competent and equipped to do so safely.
- Always use analgosedation and muscle relaxants for intubation unless the child is deeply comatose (GCS 3). Provide 100% oxygen during intubation.
- Monitor $ETCO_2$ continuously if an advanced airway is in place.
- Titrate FiO2 to achieve a peripheral oxygen saturation of 94-98% as soon as reliable measurement is available. When ABG-analysis is available aim for normoxaemia.
- In the absence of ABG-analysis, aim for a low normal respiratory frequency for the child's age and mild chest rise.

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- Monitor capnography and aim for normocapnia. When ABG-analysis is available confirm normocapnia.
- Use tidal volumes of 6-8 ml kg^{-1} of ideal body weight, and PEEP of 5 cm of H2O for mechanical ventilation in previously healthy children.
- Use the minimum airway pressures needed to achieve oxygenation and ventilation goals, adjusting these in special circumstances (e.g. chronic lung disease).
- Check for signs of shock and treat it immediately if present. Treat shock with fluids, vasoactive drugs or inotropes or combinations of these.
- Aim for a systolic and mean arterial blood pressure above 10th percentile for child's age.
- Treat seizures immediately if they emerge.
- Check blood glucose after cardiac arrest and treat hypoglycaemia.
- Use analgesia and sedation to treat pain and discomfort after cardiac arrest in children of all ages. Avoid bolus medications which can cause sudden drops or rises in blood pressure.
- Always treat hyperthermia with active cooling.
- Try to establish the cause of cardiac arrest and treat it to avoid re-arrest.
- Enable parental or caregiver presence during the pre-hospital care or transport whenever this can be done safely.

[h3] Recommendations for health care providers in a hospital (Figure 5.2)

- Use individualised goals and bundles of care rather than specific single targets during post-resuscitation care. Treat underlying disease(s) as well as post-cardiac arrest syndrome.
- Establish invasive arterial blood pressure monitoring and central venous access with SvO2 measurement as a minimum in all sedated or comatose children.
- If no individualisation is needed, continue targeting normoxaemia, normocapnia, and maintain systolic and mean arterial blood pressure above 10th percentile for at least 24 hours after cardiac arrest.
- Use available non-invasive or invasive techniques to diagnose the probable cause of cardiac arrest as well as to make individualised decisions in the management of post-cardiac arrest syndrome.
- Diagnose, monitor, and treat pain, discomfort and delirium.

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- Keep targeted temperature management as an integral part of post-resuscitation care for at least 24 hours after cardiac arrest. Avoid fever for at least 72 hours.
- Prevent, diagnose, and treat acute kidney injury or renal failure.
- Optimise nutrition.
- Start rehabilitation early.
- Allow unrestricted access of primary caregivers to the child as a part of family-centred care. Be sensitive to cultural and religious issues.
- Communicate clearly and honestly with parents/caregivers while also paying attention to their understanding and needs; decision making should be shared. Involve concerned stakeholders (e.g. extended family, religious support) in the communication.
- Seek the assistance of specialised multidisciplinary teams early (paediatric neurologists, psychologists, paediatric palliative care team, social workers etc.) to address the needs and concerns of the child, parents, family and other caregivers.
- In case of Sudden Cardiac Arrest (SCA), whether fatal or not, use a standardised diagnostic protocol to identify the cause. If the SCA might have been due to an inherited condition, such as certain arrhythmias and cardiomyopathies, ensure appropriate screening of family members to prevent SCA in future patients.

[h2] Prognostication after cardiac arrest

- Avoid both false optimism and false pessimism, and prevent individual suffering, increased healthcare costs, impaired daily skills and reduced ability to participate in society (education, labour).

[h3] Recommendations for health care providers (Figure 5.3)

- Delay prognostication in children with a decreased level of consciousness or who are sedated for at least 72 hours following cardiac arrest.
- Use a multimodal approach to prognostication. Accurate prognostication for both good and poor outcomes involves:
    - Pre-arrest: knowledge of the child's baseline health and neurological status
    - The context of the CA: e.g. location of CA, bystander BLS, first rhythm, cause of cardiac arrest and duration of CA.

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    - Post-cardiac arrest care: a comprehensive assessment supplemented with repeated evaluations.

- Combinations and timing of investigations and signs predicting good outcomes differ from those predicting poor outcomes (see Figure 5.4). No single modality can be used in isolation for prognostication with high accuracy.
- Use the suggested standardised minimal set of diagnostic modalities for better comparability and research (see Figure 5.3).
- Visual aids and presentations might help parents/caregivers to understand certain specifics of prognostication enabling them to participate better in the decision making.

[h2] Post-discharge care (Figure 5.5)

- Assess outcomes with standardised measurements using validated instruments and involve paediatric psychologists, neurologists, rehabilitation physicians and/or intensivists in post-discharge care.
- Plan and discuss the post-discharge care with caregivers before hospital discharge.
- Organise multidisciplinary post-discharge care to minimise the number of hospital visits for the child and family.
- Consider a virtual consultation when an on-site visit to an outpatient clinic is challenging due to financial, travel or work limitations.
- Screen patients, parents/caregivers, and family members for symptoms of post-intensive care syndrome regularly and refer to a professional (e.g. psychologist) as soon as any physical or mental health issues arise.
- Seek and signpost supportive structures for patients and parents/caregivers, such as parent groups, cardiac arrest survivors' groups and bereavement groups.

[h2] System-level recommendations and recommendations for implementation

[h3] Recommendations for general public

- All parents and caregivers should be encouraged to learn the basic recognition of signs and symptoms of critical illness and injury, basic first-aid life-saving procedures and PBLS.
- PBLS, simple recognition triage tools and basic first-aid life-saving procedures for paediatric emergencies should be part of training for professional caregivers of children (e.g. child

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minders, schoolteachers, first responders, lifeguards, and coaches/trainers of children and adolescents). Priority should be given to the training of those who take care of children with an increased risk of an acute life-threatening event.

- Facilities should be in place to manage acute life-threatening events in children, including trauma, in settings in which there is an increased risk of these events, such as sporting events, swimming pools and other areas of open water. These facilities must include equipment, protocols, systems, and trained personnel.
- Children who live near water should be taught to swim before they are allowed to play unsupervised.
- In settings where heat stroke might occur, e.g. sports events in a warm climate, facilities for the management of hyperthermia, including a method for rapid cooling should be available.
- Every child who has had an anaphylactic reaction should carry an adrenaline auto-injector of the appropriate dose which the caregivers and the child, if old enough, should be able to use.

[h3] Recommendations for all healthcare systems

- All systems caring for children should aim to link all parts of the chain of survival (prevention of CA, early call for help, PBLS, PALS, post-resuscitation care and post-discharge care).
- As well as individual technical and non-technical skills, the safe and effective management of an acute life-threatening event or cardiac arrest requires an institutional safety culture embedded in everyday practice through continuous education, training, and multidisciplinary cooperation.
- All systems should promote the use of protocols and bundles of care for life-threatening conditions (e.g. for cardiac arrest, sepsis, anaphylaxis, status epilepticus) and should evaluate protocol adherence aiming for improvements in care.
- All systems caring for children should adopt standardised drug calculations and provide cognitive aids (algorithms, tapes, posters, applications) and standardised drug and equipment labelling and handling to avoid medical errors. All personnel should be trained accordingly. Cognitive aids used should be easily accessible.
- All systems should aim to identify children who may be at increased risk of cardiac arrest such as very small and preterm infants, children with a sudden unexplained death in family, siblings of children who died from sudden infant death syndrome (SIDS) and children with specific congenital abnormalities, primary arrhythmia syndromes, cardiomyopathies, channelopathies

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and coronary artery abnormalities. Systems should ensure that a plan is in place to care for these children.

[h3] Recommendations for emergency medical systems and dispatch systems

- Dispatch systems should implement instructions for dispatcher-assisted CPR specific for children.
- Ensure clear and effective communication so that emergency personnel are dispatched promptly to a critically ill or injured child or a child in cardiac arrest.
- Pre-hospital emergency medical systems should train all professionals in the recognition and initial management of critically ill and injured children to prevent cardiac arrest, including field triage.
- Pre-hospital emergency medical systems should train all professionals in PBLS.
- Emergency healthcare responders should be available at all times and must be trained in PALS and suitably equipped to respond to a paediatric cardiac arrest.
- Emergency responders' PALS skills should include bag-mask ventilation, IV/IO access, administration of adrenaline, rhythm recognition, use of a defibrillator/AED and knowledge and understanding of the PBLS and PALS algorithms including choking. Training should also include communication with parents/caregivers.
- Emergency medical systems should have set training schemes to improve skill retention and teamwork. They should develop clear protocols and communication plans to facilitate the transportation of children with a cardiac arrest.
- There should be systems, including protocols, to guide communication between pre-hospital teams and hospital teams to prepare them to receive the child.
- There should be systems, including protocols, to guide the transport of parents/caregivers when possible.
- Children sustaining a cardiac arrest should be transported to a hospital with a paediatric intensive care unit.
- Certain specific subgroups of patients should be transported directly to specialised paediatric intensive care units with facilities for extracorporeal life support.
- Consultation with specialists (e.g. via telemedicine) should be encouraged when there are uncertainties regarding the management or transport of a child.

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[h3] Recommendations for hospital departments and resuscitation teams

- Emergency departments treating children should implement triage systems specific for, or adapted to children and should train personnel in their use. They should monitor and evaluate the effectiveness of their triage protocols.
- Hospitals should train all healthcare professionals who are involved in the care of children (including those who only occasionally treat them) in the recognition and initial management of critically ill or injured children.
- All health care professionals involved in the care of children should be able to perform PBLS.
- Systems should exist to activate personnel skilled to establish IO access in less than 5 min.
- Use paediatric early warning systems as part of an overall in-hospital response system, not as a stand-alone measure.
- Each hospital caring for children should have a resuscitation team (and/or clinical emergency team) trained in PALS. Its members should have pre-designated roles. These individual roles should cover all the required interventions and competencies to resuscitate a child effectively and efficiently. Shared leadership should be considered.
- Each hospital should set training requirements for members of the resuscitation team to improve skill retention and teamwork.
- Each hospital should have a designated method of summoning the resuscitation team which can be audited.
- Ideally, members of the resuscitation team should meet once or twice a day at the beginning of each shift (team huddle) to get to know each other, discuss role allocation and any patients of concern in the hospital.
- Members of the resuscitation team should be given time to debrief after critical events both to support staff and to enhance performance.
- Standardise resuscitation trolleys across the hospital and train staff in their contents and use of equipment. Trolleys should be checked frequently.
- Provide easy bedside access to cardiac arrest algorithms both electronically and on paper, and display these on the resuscitation trolley and in all areas where cardiac arrest might occur. Provide handheld cards and/or electronic tools for staff.

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- Every child who has a reduced level of consciousness after cardiac arrest should be admitted to a paediatric intensive care unit, if possible, for post-resuscitation care.
- Hospitals offering extracorporeal life support, should establish institution-specific protocols for cardiac arrest in children during or after cardiothoracic surgery, and other children with cardiac arrest or peri-arrest conditions.
- There should be a clear protocol, based on these guidelines, for the management of perioperative cardiac arrest in every operation room.
- Hospitals, department and paediatric intensive care units should investigate and employ ethical, guideline-based and reliable prognostication methods.
- Allow sufficient dedicated time for physicians to talk with parents/caregivers about care and prognostication.
- Family-centred care and a shared approach to decision making should be considered the standard of care in the best interest for the child.
- Include all cardiac arrest survivors and their families in post-discharge care. Offer specific care to families of non-survivors, including bereavement care and psychological support.
- Aim for well-coordinated family-centred post-discharge care, using e.g. family liaison staff to limit the burden for cardiac arrest survivors and their families.

[h3] Recommendations for manufacturers of medical devices

- Manufacturers of AEDs and defibrillation pads should standardise pictograms for pad-positioning for infants and children so that they are in line with current resuscitation guidelines.
- Manufacturers of public access defibrillators should aim for the simplest and quickest possible ways to attenuate energy levels in case the AED is used in younger children (preferably a paediatric button with only one size of pad).

[h2] Recommendations for low resource settings

- Aim for the highest possible level of care within the specific context.
- Prioritise implementation of recommendations according to the expected benefit for the overall outcomes (e.g. training many in simple procedures rather than buying expensive advanced equipment).
- Modify recommendations taking the availability of personnel and equipment into account.

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- Adjust recommendations to the typical patient-population and specific setting.
- Where possible, critically ill and injured children should receive specific *paediatric* care, as recommended in these guidelines. Where this is not possible, arrange for the most appropriate care, considering the child's age, condition and circumstances.

[h1] Evidence informing the PLS guidelines

For these evidence-informed guidelines, our recommendations are grounded in a comprehensive analysis of the available evidence. In instances where no modifications were made to the guidelines or no new relevant evidence was identified, no additional commentary has been provided.

[h2] Prevention of cardiac arrest

Cardiac arrest in infants, children and adolescents is often secondary to progressive respiratory, circulatory, or neurological failure caused by critical illness or injury, while a primary cardiac aetiology is less common. [10,15,22,27,28] Cardiac arrest might therefore be prevented in some children by earlier recognition, preventative measures and improved management of critical illness and injury. [9,16,18,19,29] There has been no recent ILCOR CoSTR on cardiac arrest prevention in children, therefore the ERC Writing Group Paediatric Life Support compiled their own reviews of the evidence.

[h3] Recommendations for caregivers and other untrained rescuers

The identification of children with critical illness at risk of cardiac arrest is not easy, especially for untrained rescuers. The recommendations for caregivers and untrained rescuers are based on quick-look clinical triage protocols which need to be reworded for non-professionals. The ERC recognises that the use of some of these protocols might lead to over-triage but consider this to be a reasonable approach as under-triage at this level probably carries a higher risk for children. The suggested signs in these protocols include symptoms of respiratory and circulatory failure and neurological emergencies. Children with chronic medical conditions, chronic illnesses, and those dependent on medical technology are at increased risk of unexpected deterioration. [23] The ERC recommends that the parents/caregivers of these children should be trained in basic life-saving procedures according to the specific needs of their child, including PBLS. They should also have an emergency plan for a sudden deterioration of their child.

[h3] Recommendations for healthcare professionals

The sequence of actions in the recognition of a critically ill or injured child should include a dedicated quick-look tool for the rapid detection of a child at risk of cardiac arrest. [30] Rescuers

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should always consider their own safety and use appropriate personal protective equipment before approaching a critically ill or injured child. The ABCDE system is a widely recognised priority-based method for assessing critically ill patients and is designed to identify and manage life-threatening conditions quickly and improve quality of care by breaking down the response to a complex clinical situation into manageable steps. [31] Whenever resources allow, a dedicated team should be summoned in response to the recognition of a critically ill child. Effective teamwork and the use of structured and standardised communication (e.g., SBAR, Situation-Background-Assessment-Recommendation) should establish a shared mental model within the team. [32] Both leadership and followership are important parts of effective teamwork. Two small studies show improved patient outcomes (fewer non-ICU cardiac arrests and unplanned ICU admissions) after the implementation of a rapid response team. [33,34] Dedicated cognitive aids appear to improve outcomes and decrease cognitive load for healthcare providers in time-critical situations and help establish a shared mental model. [35,36]

It is important to know the weight of the child when delivering care, especially when giving medications, but weighing the child can be problematic in an emergency. Ideally, the child's weight as reported by the parents/caregivers is often the most accurate and we recommend using this when available. When this is not available, other methods can be considered. Generally, a length-based method, corrected for body habitus, is more accurate than a formula. Due to increasing obesity among children and adolescents worldwide, age-based formulas tend to underperform in estimations of actual body weight, compared with emergency tapes with or without correction for body habitus. [37-47] Overall performance of the Broselow tape remains high, with most studies reporting a PW20 (the percentage of all estimates within 20% of the measured weight) above 80% in healthy children aged 0-12 years, in all countries studied. In chronically ill, severely underweight, and severely obese children, accuracy is below 80%. [38,45] The PAWPER, PAWPER XL and PAWPER XL-MAC are length-based methods corrected for body habitus, developed and validated in South Africa. They outperformed all other length-based methods in children from 1-18 years old, with PW20 ranging from 84% to 100%, regardless of body type. [45,48-52]

In most resuscitation situations ideal body weight is the preferred weight utilised because volume of distribution is deemed the most important pharmacokinetic factor affecting the therapeutic effect of a given dose of a drug. Drugs used in resuscitation are largely hydrophilic (adrenaline, calcium, potassium, salbutamol, magnesium, adenosine) with fewer being lipophilic (amiodarone). A hydrophilic drug should be dosed according to ideal (not actual) body weight. Children with a high body mass index (BMI) have a similar volume of distribution for hydrophilic drugs as children with a

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BMI in the normal range. These drugs are not distributed in the excess tissue which is usually extra fat tissue. Therefore, if hydrophilic drug doses are calculated for actual body weight (e.g. using a length-based method corrected for body habitus) then there is a chance the dose will be too high exposing the child to potential toxicity.

Parental/caregiver presence is important for the care of a critically ill child. This should be considered standard care unless the safety of the child, caregiver or personnel cannot be guaranteed. [53-55]

[h4] Recognition of critically ill or injured child

Signs of respiratory and circulatory failure are long established although the threshold values of measured vital signs are still under discussion because of increasing amounts of data being gathered from children measured in different settings. [24-26] No new evidence was found to change the previous recommendations regarding threshold values for children of different ages. We added (rounded) values for the 10th percentile of blood pressure as we recommend aiming for this during post-resuscitation care. These values offer reasonable sensitivity and specificity for use in emergency settings.

Although the most accurate way to determine normal values is through detailed percentile charts, these are impractical in emergencies. Mobile applications and other cognitive aids—such as resuscitation tapes displaying estimated values—can be helpful, but they have not been validated and may be based on older, less accurate data derived from relatively small paediatric samples.

The most typical signs of respiratory failure in children, as well as the most common conditions associated with imminent cardiac arrest, can be identified through a thorough ABCDE assessment. It is important to emphasise that no single value or sign is sufficiently sensitive; assessment must always include multiple signs. Distinguishing compensated from decompensated respiratory and circulatory failure is not easy as deterioration takes place on a continuum. Progression to cardiac arrest can occur very quickly even from the compensated phase, especially in infants.

The ERC recommends monitoring pulse oximetry continuously in all critically ill and injured children. Hypoxia is common in critically ill children and is strongly associated with death, especially in lower resource settings. [56,57] Pulse oximetry together with clinical examination can help detect the most severely ill children and improve outcomes. [58,59] One study found that children with severe hypoxaemia (SpO_2 <90%) and children with mild/moderate hypoxaemia (SpO_2 90-93%) had an increased risk of death. [60] Professionals should be aware that SpO_2 values might be overestimated in children with a darker skin tone. [61]

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Use ETCO2 to continuously monitor the position of a tracheal tube or supraglottic airway; this will enable immediate detection of a dislodgement or obstruction and provides some indication of quality of ventilation. In patients with traumatic brain injury, using ETCO2 to prevent hyperventilation or hypoventilation decreased mortality. [62]

Although the evidence for the use of $ETCO_2$ monitoring in non-invasive ventilation is limited, it is widely used during periprocedural sedation to detect respiratory adverse events in non-intubated patients. [63-66] Various factors influence the difference between $PaCO_2$ and $ETCO_2$ such as ventilation-perfusion mismatch. Therefore, blood gas analysis (arterial or capillary) should be performed to identify the difference. [67,68].

Many providers underestimate face mask leaks and miss partial or complete airway obstruction resulting in low delivered volumes. [69] Respiratory function monitoring (devices that calculate or display mask leak, inspired and expired tidal volume, flow rate, respiratory rate, peak inflation pressure etc.) can replace imprecise visual estimation of tidal volumes (i.e. by observing chest rise), however, there is insufficient data to recommend its use in clinical practice. [69] Point-of-care lung ultrasound performed by trained individuals can be useful in distinguishing different causes of respiratory failure (e.g. pneumothorax, atelectasis) in the emergency setting and guiding therapy. [70-73]

The proper assessment of the circulatory status includes recognising shock and determining its type, because time-critical interventions differ according to the type. [74] Hypovolaemic (including haemorrhagic) and distributive shock are the most common types in children, while cardiogenic shock is present in 5-10%, and obstructive and dissociative shock are rare, although the latter can be more prevalent in limited resource settings (e.g. malaria). [75] Non-invasive blood pressure (NIBP) monitoring remains important, although hypotension is a very late sign of circulatory failure in children. Accurate measurement in children requires use of the correct cuff size and is most accurately measured in the upper arm. [76,77] Lower accuracy was noted in neonates with a mean arterial pressure below 30 mmHg. [76] Specific point-of-care tests (lactate, POCUS/echocardiography, troponin I) can help guide time-critical interventions in shock and potentially improve outcomes. [78,79]

Recognition of a neurological emergency remains unchanged because no new relevant evidence to change our recommendations was found. Brain imaging in children with severe neurological symptoms has been given more emphasis to reduce delays in the identification of time-critical emergencies (e.g. meningitis, encephalitis, seizures, stroke and hypoglycaemia).

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Examination of the whole body (the "E" of the ABCDE-assessment) can reveal indications of underlying disorders and specific conditions which require modifications of the initial approach (e.g. signs of sepsis, thrombosis, or intoxication). Child abuse and neglect is underdiagnosed in emergency settings and action is needed to improve recognition and outcomes. [80] Unfortunately, during ABCDE-assessment there are few signs or symptoms indicating child abuse and clinicians need to be alert to the possibility of child abuse to help identify children at risk. [81,82]

[h4] Management of the critically ill or injured child

Airway

No new evidence was found to change the airway recommendations. The main goal of airway management is oxygenation and ventilation. Where prolonged ventilation is anticipated, competent providers should place a supraglottic airway (SGA) or tracheal tube. However, bag-mask ventilation remains the first-line method for ventilation because early placement of an advanced airway have either shown no benefit, or harm, in the pre-hospital setting. [83] Pre-hospital use of SGAs is recommended over tracheal intubation if an advanced airway is required, as SGAs have been shown to be at least non-inferior to intubation. [84] The ERC recommends laryngeal masks or i-Gels rather than laryngeal tubes as their insertion has a higher failure-rate.[85]

Tracheal intubation remains the preferred method for the definitive management of the airway in critically ill or injured children. [86] Intubation-related adverse events are more common with multiple attempts and are commonest in neonates and infants. [87-90] Prolonged intubation attempts are common in stressful situations and the time spent during attempts is often underestimated. [91] In line with anaesthesiology guidelines, we recommend having a 'plan B' for difficult airway situations. Use pre-oxygenation, continue oxygen insufflation during intubation, use rapidly acting sedative and neuromuscular blocking agents and limit the number and duration of attempts. [92] Most anaesthetic drugs are associated with vasodilation which might induce bradycardia and cardiovascular collapse, especially in hypovolaemia or sepsis. [93] Recent studies failed to show any benefit of atropine premedication before intubation, and this is not recommended. [94,95] The use of video-laryngoscopy by trained providers reduces the incidence of failed intubation and complications, especially in infants. [96] Cuffed tracheal tubes are safe for use in infants and children and reduce leaks. Monitor the cuff pressure to reduce damage to the tracheal mucosa. [97,98] The formula for the internal diameter of cuffed tubes (age/4 + 3.5 mm) in children up to 8 years remains valid. [99,100] Broselow tapes should not be used in isolation to estimate tracheal tube size in children weighing > 18 kg. [101,102] POCUS seems able to predict the size of the tracheal tube reliably but requires expertise

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and equipment. POCUS will estimate the internal diameter of the trachea, which determines the maximum safe external diameter of the tracheal tube, not its internal diameter. Malposition of the tracheal tube is common and checking the correct position using a combination of techniques is mandatory (clinical examination, chest X-ray, POCUS, ETCO2). [103]

The safe emergency management of a difficult airway consists of a planned stepwise approach focused on ensuring oxygenation and starting with non-invasive techniques. [104] Where bag-mask ventilation fails or following unsuccessful intubation, an SGA can often be used to secure the airway quickly and simply.

A cannot-ventilate-cannot-oxygenate situation occurs when bag-mask ventilation, SGA and intubation are unsuccessful in achieving oxygenation. This can quickly cause cardiac arrest. An invasive airway technique (front-of-neck airway) may be required. This is difficulty in children, particularly infants, and the best technique is unknown. International guidelines vary and various techniques have been suggested. [105,106] A recent narrative review highlighted the extreme difficulty of needle cricothyroidotomy in young children and concluded that the scalpel-bougie tracheostomy should be preferred in children under 8 years of age and a surgical cricothyroidotomy considered in older children. [92] In the absence of conclusive evidence expert providers should perform the technique in which they are trained, have the most experience with, have the appropriate equipment for and feel confident in.

Tracheostomy emergencies are largely preventable, but if they do occur, they must be managed quickly. [107,108]

Breathing

Oxygen saturation targets for critically ill children are not clearly defined and may need to be adjusted for specific conditions (e.g. chronic lung disease). A recent systematic review compared SpO_2 targets of 80-92% with 92-94% in children with respiratory distress. The lower targets were equivalent to the higher targets in terms of mortality, neurocognitive outcome and readmission or re-attendance. Using the lower targets admission rates were 40% lower and hospitalisation duration was 10–18 hours shorter. [109] A large randomised controlled trial (Oxy-PICU trial) in children ventilated in the paediatric intensive care unit found that conservative oxygen saturation targets (SpO_2 88-92%) led to a slightly better outcome (duration of organ support or death) compared to liberal targets (SpO_2 >94%). However, the study excluded some important groups (brain pathology or injury, post cardiac arrest, pulmonary hypertension, sickle cell disease, uncorrected congenital heart disease and on long term ventilation). [110] Whilst these studies are promising, further evidence

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is required to guide SpO_2 targets in critically ill children in different populations and settings. There is no evidence to guide pre-hospital SpO_2 targets, where measurement may be unreliable. Therefore, the ERC recommends a lower limit SpO_2 target of 94% after initial resuscitation, which may be adjusted in specific situations (e.g. congenital heart disease). No studies of the optimal FiO_2 were identified, but to avoid hyperoxia, the lowest possible FiO_2 to achieve the required SpO_2 should be used.

Non-invasive ventilation can be delivered by bag-mask ventilation (preferably using two-hands on the mask). High-flow nasal oxygenation, continuous positive airway pressure or non-invasive ventilation are reasonable options when conventional oxygen therapy is insufficient or additional ventilatory support is required. [111-114]

Circulation

Adequate organ perfusion is the main aim of circulatory support. Providers should not spend more than 5 min (or 2 attempts) on attempts to establish IV access. POCUS can be used to guide cannulation. [115] If the chances of IV access are considered minimal (shock, severe hypovolaemia, previously difficult cannulation), use a rescue alternative early. Intraosseous (IO) access is underutilised yet is appropriate for patients of all ages in resuscitation and other critical care situations. [116,117] Providers should be trained in this technique. Signs of extravasation should be actively sought, and the cannulation site continuously monitored. Special attention must be given to infants, who experience more complications, particularly dislodgements. [117,118]

The previous ERC recommendation on fluid boluses remains unchanged as stated in the sequence of actions. Further evidence supports frequent re-evaluation of the circulatory status to avoid fluid overload as well as the use of balanced solutions. [119-121] Cautious fluid administration is needed in cardiogenic or obstructive shock, although some extra fluid might be needed, especially in infants who have had feeding problems or if another type of shock is concurrent. Vasoactive and inotropic support might be needed in fluid non-responsive and cardiogenic shock. The optimal time to start vasoactive support is not clearly defined, but possibly lies after 20-40 ml kg^{-1} has been given and evidence supports the use of vasoactive support. [122,123] A recent systematic review comparing different first-line vasoactive strategies on mortality supports this recommendation. [124] Combined regimens using more than one agent are increasingly used successfully. [125] A peripheral IV line can be used for short-term administration of vasoactive or inotropic drugs. [126-130] Milrinon remains the most used inodilators with levosimendan is a promising alternative. [131-133] Extracorporeal life

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support should always be considered early as a rescue strategy for children with shock not responding to initial resuscitation.

Disability and exposure

Neuroprotection (as described in post-resuscitation care) is an important part of the initial management of neurological emergencies. Attention needs to be given to sedation and pain management as pain management is often poor. [134] The ERC emphasises the importance of recognising seizures as a neurological emergency and acting quickly as delays in treatment are common and earlier treatment improves outcomes. [135]

[h4] Additional recommendations for time-critical interventions

Severe acute asthma (critical asthma syndrome)

Critical asthma syndrome is an umbrella term for all forms of asthma with a high probability of mortality. [136] As asthma still causes significant morbidity and mortality timely aggressive treatment is needed.

The PLS WG have based their recommendations on the recent overview of Cochrane reviews and the updated Global Initiative for Asthma recommendations. [137,138] Recognition of severe asthma is primarily based on clinical signs, brief history, and oxygen saturation. Hypoxaemia is a sign of decompensated respiratory failure, which might induce agitation, irritability and decreased consciousness. The differential diagnosis includes pneumonia, pneumothorax, cardiac failure, laryngeal obstruction, pulmonary embolism, foreign body aspiration and anaphylaxis.

High-dose inhaled short-acting beta$_2$-adrenergic agonists (e.g. salbutamol) are safe, but can cause side effects (electrolyte disorders, hyperlactatemia, hypotension, arrhythmia, transient hypoxia). Ipratropium bromide when given with short-acting beta2-adrenergic agonists for moderate-severe exacerbations is associated with fewer hospitalisations and greater improvement compared with short-acting beta2-adrenergic agonists alone.

Systemic steroids are indicated within the first hour. Oral steroids are as effective as intravenous. High dose inhaled steroids may be added in a severe crisis. IV magnesium may result in reduced hospital admission in children who fail to respond to initial treatment and have persistent hypoxaemia; isotonic magnesium sulphate might be used as a nebulised solution. There is no evidence for an added benefit of IV short-acting beta2-adrenergic agonists, but in children with near fatal asthma this may be the only way to administer bronchodilation. Side effects of IV administration include electrolyte disorders, dysrhythmias and cardiovascular failure in pre-existing

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cardiac disorders, so expert advice and continuous monitoring are required. A loading dose of 15 microg kg^{-1} IV salbutamol can be considered, but there is no consensus on the maximum recommended loading which varies from 250 microg to 750 microg. [139] Severe exhaustion, deteriorating consciousness, poor air entry (silent chest), severe hypoxaemia not responding to treatment, and cardiopulmonary arrest are indications for tracheal intubation. Mechanical ventilation of a child with severe asthma is extremely challenging and requires expert advice.

Septic shock

Early identification and treatment (including antibiotics) of sepsis and septic shock are essential parts of care bundles and are associated with improved outcomes. [140] An early stress-dose of hydrocortisone is recommended. [141,142] For more details, we recommend specific guidelines for management of sepsis that will be published in 2025.

Cardiogenic shock

Cardiogenic shock is infrequently present in children but with can have devastating impact. Causes are heterogeneous, ranging from myocarditis, systemic inflammatory syndromes to cardiomyopathies, arrhythmias and congenital heart diseases, including acute decompensation of the underlying disease. Signs and symptoms can be non-specific especially in the infant (difficulty with feeding, irritability, crepitations and enlarged liver edge) and a high level of suspicion is necessary.

Treatment needs expertise and will depend on the underlying cause and needs to be individualized, however in critically ill children, starting inotropic medication is usually necessary. Furosemide IV should only be considered in children with adequate hydration. Fluids might be also cautiously given, but their administration needs to be cautious. Mechanical support and extra corporeal life support (e.g. ECMO) might be needed in a subgroup of these patients. [143]

Haemorrhagic shock

The PLS WG did not find any evidence to change the recommendation to limit the administration of crystalloid fluids and start the transfusion of blood products as early as possible. Vasoactive agents play a role in achieving blood pressure targets where fluids or blood alone are not sufficient, particularly in severe traumatic brain injuries when maintaining the blood pressure above the 50^{th} percentile is recommended. [144] Addressing coagulation is a critical component of trauma care and must be started early. The specific strategy depends on factors beyond the scope of these

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guidelines. We did not find evidence to change our current recommendation regarding tranexamic acid, and recent studies confirm its safety. [145,146]

Circulatory failure due to bradycardia

Atropine use across all paediatric ages declined following the ERC 2010 guidelines. [147] Bradycardia is rare in out-of-hospital cardiac arrest and adherence to the recommended management is poor. [148] The ERC recommends that rescuers primarily focus on treating respiratory and circulatory failure before treating bradycardia directly. Administration of atropine in these situations is likely to be ineffective and may be harmful as the temporary increase in heart rate may increase oxygen consumption, thereby accelerating the depletion of already highly limited oxygen reserves in decompensated cardiac failure. Furthermore, reducing parasympathetic drive may exacerbate pathologies involving catecholamine-mediated mechanisms (e.g. Takotsubo cardiomyopathy).

Nonetheless, atropine (20 microg kg^{-1}, max. 500 microg) probably has a role in managing bradycardia caused by increased vagal tone. In line with the updated ILCOR CoSTR, the ERC recommends starting CPR in children with bradycardia and poor perfusion who do not respond to oxygenation and ventilation. [149] The role of adrenaline and transthoracic pacing was found to be unclear in the ILCOR CoSTR. In the non-randomised retrospective studies of patients receiving CPR for bradycardia with poor perfusion, adrenaline either had no effect on survival or was associated with a worse outcome. The ERC recommends considering adrenaline (10 microg kg^{-1}) in children with bradycardia and poor perfusion based on expert opinion. Similarly, the ERC recommends considering transthoracic pacing in selected cases where bradycardia is caused by complete heart block or sinus node dysfunction.

Circulatory failure due to tachycardia

There is limited evidence for the treatment of unstable tachycardia. For in-depth information about subtypes, diagnosis and preventive treatment option, consult the European Society of Cardiology guidelines. [150,151] In haemodynamically unstable children with either a narrow QRS tachycardia or any persistent wide QRS tachycardia, the first choice for treatment is immediate synchronised cardioversion at a starting energy of 1–2 J kg^{-1} body weight and doubling the energy with each attempt up to 4 J kg^{-1}. A systematic review in neonates confirmed that doses between 0.25 and 3 J kg^{-1} are efficient with the highest first dose being 1 J kg^{-1} and a failure rate of 20.3%. [152] In children with haemodynamically stable supraventricular tachycardia, the first-line treatment is a vagal manoeuvre (success rate 27- 53%) followed by IV adenosine (first dose 0.1-0.2 mg kg^{-1}, maximum 6 mg, followed by 0.3 mg kg^{-1}, maximum 12-18 mg), which had a success rate of 96%. [153] Most children

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will require further treatment with a medication with a longer half-life either because of failure of the first-line manoeuvres or because of recurrence of the arrhythmia. [154,155] Repeated doses of adenosine may increase catecholamine levels, making termination more difficult. In such cases, the child may need additional antiarrhythmic medication before repeating adenosine administration. [155] Alternative medications include calcium channel blockers, beta-blockers, flecainide, procainamide, amiodarone, dexmedetomidine, ivabradine and digoxin. Each of these medications has specific side effects and contraindications and should only be used as guided by a paediatric cardiologist. [154-159]

Seizures

There is no clear evidence of superiority of one benzodiazepine over another in the first line treatment of status epilepticus.[160] If a child already has IV access in place when seizures are continuing at 5 min then IV benzodiazepines should be given. If the child has no IV access priority is given to stopping the seizures so alternatives routes for benzodiazepine administration are advocated rather than spending time trying to gain IV access. Intranasal and buccal routes are recommended (e.g. intranasal or buccal midazolam). [161]

For second-line treatment of benzodiazepine-refractory status epilepticus, levetiracetam offers comparable efficacy to phenytoin and fosphenytoin, with superior safety outcomes. [162-164]. Studies suggest that high-dose levetiracetam (e.g. 60 mg kg^{-1} IV) is more likely to stop seizures than standard doses. [165] In settings where seizures persist beyond 40 min, the use of anaesthetic drugs like midazolam, ketamine or propofol is indicated.

[h2] Paediatric basic life support (PBLS)

Paediatric basic life support (PBLS) differs slightly from adult BLS in terms of aetiology, epidemiology and physiology.

[h3] Public recommendations and dispatcher-assisted CPR

The ERC considered alterations of the standard PBLS algorithm which might improve the performance of untrained rescuers and how to communicate this to the public using the simplest possible message. [11,166] Recommending three simple steps (Check – Call – CPR) for this group, emphasises simplicity while remaining consistent with the recommendations for adult resuscitation. The three steps are also the first part of the chain of survival (early recognition, calling for help, early CPR).

Chest compressions with rescue breathing are considered standard CPR and is associated with improved neurological outcomes in children of all ages when compared with compression-only CPR

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and is recommended by ILCOR and the ERC. [167-169] ILCOR also recognised that bystanders are frequently willing to provide CPR in children, often including rescue breathing, as they are often the child's primary caregivers. [170] Therefore, the ERC recommends that bystanders perform chest compressions and ventilations in all children. If a bystander is not willing or able to provide rescue breathing, the ERC recommends that dispatchers encourage bystanders to perform chest-compression only CPR as this is superior to no CPR.[11,169]

Use of dispatcher-assisted CPR for children was strongly recommended by ILCOR, despite limited evidence in children. [171] Paediatric specific instructions should be tailored to specific age groups. [172] The ERC recommends that dispatchers use a simplified protocol with a compression:ventilation ratio of 30:2, starting with 5 rescue breaths, as this decreases the number of switches between compressions and ventilations and simplifies the guidance given to bystanders by using the same ratio as in adults. [173] Untrained bystanders are generally able to deliver effective ventilations when guided by dispatchers, although ventilation in infants seems more challenging. [174] Checking for the effectiveness of rescue breaths might improve bystanders' quality of ventilations during dispatcher-assisted CPR. As hypoxia is a frequent cause of cardiac arrest in infants and children, efforts to improve ventilation quality seems justified.

The effect of video-assisted CPR for untrained rescuers is not clear in paediatric cardiac arrest. [175,176] Therefore, the ERC cannot make recommendations on this until more paediatric data is available.

[h3] Recommendations for those trained in PBLS

In line with the ILCOR CoSTR on the recognition of cardiac arrest, the ERC recommends that pulse check alone is inaccurate for the diagnosis of cardiac arrest. [177] Therefore, the recognition of cardiac arrest should be based on the recognition that the victim is unresponsive, not breathing normally and shows no other signs of life.

The ILCOR CoSTR on starting CPR in adults and children found no evidence that either the ABC or CAB approach is superior to the other in terms of improving clinical outcomes in children. [178] The ERC recommends starting CPR with 5 rescue breaths. Manikin studies found that only 50–72% of rescuers with limited experience succeed in delivering two correct ventilations out of five. [174,179] The recommendation for five attempts aims to increase alveolar ventilation before initiation of chest compressions, acknowledges this finding. Manikin studies suggest comparable or superior outcomes for mouth-to-mouth (or mouth-to-mouth-and-nose in infants) ventilation compared to bag-mask ventilation in healthcare professionals and first responders. [180-182] Consequently, the ERC

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recommends mouth-to-mouth ventilations when bag-mask ventilation is unavailable, or rescuers are not competent in its use.

The ILCOR CoSTR on compression to ventilation ratios addressed adult resuscitation and did not make any recommendation for children. [183] The ERC identified indirect evidence from one manikin study which found no difference in compression depths and rates between a ratio of 30:2 or 15:2. [184] In the absence of any evidence on outcomes, the ERC sees no reason to change the recommended compression:ventilation of 15:2 for children. Minimisation of chest compressions pauses is recognised as important for outcomes. [185] Therefore, the ERC recommends not to interrupt CPR unless there are clear signs of life and to minimise pauses in chest compressions (<5 s) during resuscitation.

For single rescuers, the ERC considers CPR to be more important than fetching an AED as non-shockable rhythms are more common in all paediatric age groups and retrieval of the AED would further increase no-flow time. [186] If more than one rescuer is present, CPR should be started while a second person calls the EMS and fetches and attaches the AED as soon as possible. Based on expert opinion and in line with ILCOR, the ERC recommends the inclusion of children over 1 year of age into public access defibrillation programs. [168,187] AEDs are rarely used in infants in whom the overall incidence of shockable rhythms is low. [188] However, survival is greater in cardiac arrest with a shockable rhythm when bystanders use an AED. [169,189] Based on expert opinion and in line with ILCOR, the ERC recommends the inclusion of children over 1 year of age into public access defibrillation programs, both to simplify the recommendations and to increase AED use in this age group, especially in systems with first responders.[168,187] When using an AED without energy attenuation in small children, the energy delivered will be higher than that recommended for manual defibrillation, but we consider the potential benefit of an early defibrillation attempt to be greater than the risk of harm through defibrillation using a higher energy. [190,191]

In case of respiratory arrest with signs of life, the ERC recommends ventilating at a low normal respiratory rate for the child's age to avoid hypoventilation and hyperventilation. The recommendation to use either continued head tilt chin lift or a recovery position for unconscious, spontaneously breathing children is in line with the recent ILCOR CoSTR. [168,192] When a recovery position is used, the breathing should be checked at least every minute to recognise deterioration (e.g. airway obstruction, inadequate or agonal breathing). The detection of cardiac arrest and breathing difficulties is more quickly achieved in the supine position using continued head tilt chin lift. [193] A recovery position is not ideal in traumatic injuries to the spine, hip or pelvis or if the child's breathing is not normal. [192]

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[h3] Skills for PBLS

Airway positioning for specific age groups was not reviewed by ILCOR but the ERC considered the long-established standards and continues to recommend the neutral position of the head for infants and slight extension for older children with optimal angles ranging from -1° to 13° in pre-school children to 16° in school children [figure 2.3a and b]. [194] Adolescents usually need more extension, like adults. To achieve the neutral position in infants the head usually needs to be tilted back a little because the head adopts a natural flexed position in unconscious supine infants. Adding chin lift further decreases the possibility of airway obstruction by preventing occlusion caused by the soft tissues and relaxed muscles in unconscious patients.

Look-listen-feel is an established technique for detecting breathing in all age groups.

The technique for rescue breathing in children, as described earlier in this guideline, was not reviewed by ILCOR and we have not changed our recommendation. Ventilation during resuscitation, especially in infants, is not an easy skill to master and rescuers often use excessive peak pressures. [181] Training in ventilation techniques improves the ability to deliver the correct volume. [174]

In line with the ILCOR CoSTR, the ERC recommends that chest compressions be performed on a firm surface when this is practical, provided this does not delay starting CPR. [195,196] The quality of chest compressions depends on the technique, compression point, rate, depth and recoil and the duration of pauses. An ILCOR CoSTR on hand position during chest compressions only made recommendations for adults. [197] The optimal compression point (hand, finger or thumb position for compressions) is unknown and might differ between individual patients. In the absence of data, the ERC continues to recommend the lower half of the sternum as the location for chest compressions in children. In line with, a neonatal ILCOR CoSTR and other systematic reviews, the ERC recommends the two-thumb encircling technique for chest compressions in infants [Figure 2.5a]. [198-201] The two-thumb-encircling technique results in consistently greater chest compression depth, less fatigue and higher proportion of correct hand placement compared to the two-finger technique. [198-201] A manikin study found a slightly decreased minute ventilation when using two-thumbs compared to two-fingers but the effect on patient outcome is unclear. [202] The two-thumb-encircling technique can be used for dispatcher-assisted CPR, including advice for untrained single rescuers, as it appears to be easier to explain to bystanders than the two-finger technique. [203] Modifications of the two-thumb technique have not been shown to be superior to method. [204,205] Another manikin study showed that the two-hand technique in children 1-8 years of age leads to more efficient compressions and less fatigue that the one-hand technique. [206] The ERC therefore continues to

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recommend using either one hand or two hands to perform chest compressions in children aged 1-8 years. In adolescents, using two hands is necessary and the technique of chest compressions is the same as for adult patients.

The 2021 recommendation on compression depth was partially based on a scoping review suggesting improved ROSC and survival with better chest compressions depth compliance. [207] The ERC recognises that the ILCOR CoSTR recommended age-related absolute compression depths of 4 cm and 5 cm can only be approximations, as the anteroposterior diameter of the thorax increases continuously during growth. Studies have indicated that at most ages these depths exceed the measured one-third of the anteroposterior diameter of the thorax and for infants in particular they may exceed one half of the anteroposterior diameter. [208-210] Also, aiming for one third of the diameter in children older than 12 years can generate a depth of more than the recommended adult limit of 6 cm. [209] Recent evidence suggests that targeting "*at least* one third of the anteroposterior diameter" leads to deeper and more adequate chest compressions in manikin studies than targeting absolute values of 5 or 4 cm respectively. [211,212] Chest compression depth is commonly too shallow in children. [213,214] Therefore, the ERC recommends depressing the lower half of the sternum by *at least* one third of the anteroposterior diameter of the chest. In adolescents the compression depth should be the same as for adults, i.e. 5-6 cm. No evidence was found to change the recommendation to fully release pressure after each compression. The velocity of release was not associated with ROSC. [215,216] Recent studies support the current advice to keep pauses in chest compressions as short as possible (< 5 s). [217,218]

There is no evidence to change the recommended anatomical position of defibrillation electrodes as described in these guidelines (Figure 2.6a and 2.6b). [219] The use of larger pads and the anteroposterior position enables more current to flow through the chest but the significance of this for outcomes remains unknown. [220] Based on expert opinion and conformity the ERC recommends that pads be placed in the anteroposterior position when the paediatric mode of an AED is activated (i.e. up to 25 kg). In larger children, the pads can also be used in the anterolateral position as in adults provided they can be placed without touching each other. Turning larger children for the application of the posterior pad is likely to be more difficult, possibly causing a longer pause in chest compressions and inaccurate placement of the posterior pad.

Children at high risk of sudden cardiac arrest (cardiomyopathies, myocarditis, channelopathies, congenital heart disease, autonomic nervous system dysfunctions) might benefit from AED placement in the home whilst awaiting defibrillator implantation where these resources are available. [221]

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[h3] Considerations for algorithm deviations

Based on ILCOR evidence, the ERC recommends that if a person is unwilling or unable to give rescue breaths immediately (i.e. unwilling to give mouth-to-mouth and/or no bag and mask is available), they should start chest compressions immediately and rescue breaths should be added as soon as practicable. This reduces the delay in starting chest compressions. [178]

The jaw thrust manoeuvre can be a better method of opening the airway than the head tilt chin lift in trained rescuers, especially in trauma patients. The jaw thrust also seems to be the most effective method of keeping the airway patent during bag-mask ventilation.

Healthcare providers can use bag-mask ventilation with oxygen for PBLS if they are trained. Most rescuers require both hands to hold the airway open when using the face mask with jaw thrust. [222] They can also use a pocket mask in older children and adolescents.

In line with the updated ILCOR CoSTR, the ERC recommends activating the CPR mode to increase mattress stiffness if available for in-hospital cardiac arrest. [196] For healthcare systems that are already using backboards routinely during CPR, there is insufficient evidence to suggest against their continued use. Conversely, there is insufficient evidence, and some concerns about harm, to justify their introduction in systems which do not already use them.

A simulation study suggests that effective chest compressions can be given using the two-thumb encircling technique ‘over the head’ of the infant, which might be applied by trained professionals in a limited space environment. [223] Chest compressions in infants while walking are not recommended, except in exceptional circumstances, as the quality of the compressions is limited. [224]

Only a lone rescuer without a readily available phone, should perform CPR for one minute before going to seek help. There is no new evidence to justify changing this historical recommendation and this situation is becoming much less common.

[h3] Foreign body airway obstruction

Foreign body airway obstruction is a relatively frequent emergency, especially in young children. Early removal of the foreign body by bystanders is associated with improved survival with good neurological outcome. [225,226] Most events occur during eating and are often witnessed. [225] Simple bystander interventions are effective in more than 75% of cases and improve survival when performed prior to the cardiac arrest. [226,227] Abdominal and chest thrusts or compressions are less effective as a first intervention than back blows and are associated with both a lower chance of success and more intervention-associated injuries. [226] However, abdominal thrusts might be more effective in children than in adults. [228] Therefore, the ERC continues to recommend starting with

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back blows and alternating these with abdominal thrusts (in older children) or chest thrusts/compressions (in infants). We recommend using the two-thumb encircling technique for chest thrusts in infants rather than the previously recommended two-finger technique. This recommendation is made because the two-thumb-encircling technique leads to deeper compressions and generates a higher pressure than the two-finger technique, is easier for the dispatcher to explain to bystander, and its use simplifies teaching as only one skill is required for both CPR and choking.

The ERC reviewed the evidence regarding suction-based devices marketed and advertised as airway clearance devices. Until more data from industry-independent studies are available, the ERC like ILCOR, cannot issue a recommendation for or against the use of these devices due to insufficient scientific evidence. [225,229]

[h2] Paediatric advanced life support

[h3] Recognition of cardiac arrest

The public should identify the need for resuscitation by the combination of unresponsiveness and absent or abnormal breathing. For healthcare professionals' recognition of cardiac arrest should be based on clinical assessment (absence of signs of life) or monitored vital signs such as ECG changes, loss of SpO_2 and/or end-tidal CO_2 ($ETCO_2$), or a sudden drop in blood pressure. Importantly, CPR should also be initiated in children who develop severe bradycardia with signs of very poor perfusion despite adequate respiratory support, as this can quickly deteriorate into cardiac arrest. If there is a change to an organised rhythm which could produce cardiac output during PALS, healthcare professionals may use signs of life with ancillary observations including a pulse check, blood pressure, SpO2, waveform and POCUS during PALS to determine ROSC. If a manual pulse-check is used this should be kept as short as possible, and certainly not longer than 5 s. [217]

The usefulness of a manual pulse check as an indication for starting CPR and to detect cardiac output during pauses in CPR was reviewed in the 2025 ERC guideline process. An ILCOR CoSTR concluded that palpation of a pulse is unreliable as the sole determinant of cardiac arrest and the need for chest compressions. [177] The authors recommended that clinicians should begin or continue CPR unless they can palpate a pulse within 10 s. An ILCOR CoSTR found one case series which showed good accuracy of POCUS by trained providers to detect pulses during paediatric cardiac arrest but considered this insufficient evidence for a treatment recommendation. [177] In adults, pulse assessment with POCUS might be superior to manual assessment for the prediction of ROSC and during cardiac arrest.[230,231] However, this does not imply a clinical advantage nor is there evidence

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from paediatric studies. It is conceivable that patients with pulses that are only detectable with POCUS have insufficient circulation to justify stopping or not starting resuscitation. In summary, the ERC does not recommend changing the status of the pulse check in paediatric resuscitation.

Previous guidelines recommended that bradycardia with signs of poor perfusion, even with a palpable pulse, should be treated by immediate CPR. [65] ILCOR recently carried out a scoping review for studies of the treatment of children with bradycardia and poor perfusion. [232] In almost all studies, on univariate analysis, survival to hospital discharge rates were higher when cardiac arrest was due to a first documented rhythm of bradycardia with poor perfusion (43-77%) compared with PEA or asystole. Patients who receive CPR for bradycardia with poor perfusion and maintained that rhythm had higher survival rates than those who progressed to pulselessness. ILCOR found no data to support any recommendation for atropine, adrenaline or transcutaneous pacing. The ERC considers that the potential benefits of early CPR outweigh the low risk of harm from inadvertent CPR. The ERC recommends starting CPR for children with bradycardia and poor perfusion who do not respond to oxygen and ventilation. There are currently no studies on the impact of chest compressions on survival in children with very low-flow shock states without bradycardia (e.g. supraventricular tachycardia).

[h3] Defibrillation

No new paediatric evidence on the use of defibrillation electrodes was identified. We based our recommendation on an ILCOR CoSTR on paddle/pad position and size in adults and children. [219] No new paediatric evidence was found.[216] No new paediatric evidence was found. Therefore, all recommendations are based on indirect evidence from adults, all of which was of low certainty.

Paddles are still in use in some limited resource settings. Some feedback devices for chest compression metrics, an AED and pre-emptive placement of a defibrillator require the use of pads. The anteroposterior position and charging of the defibrillator during chest compressions are more difficult to achieve with paddles. If firmly applied there is little difference in transthoracic impedance between paddles and pads. [220] The ERC therefore recommends that pads be preferred over paddles; paddles may be used only if pads are unavailable.

Currently the anteroposterior position is recommended for small children and the anterolateral position for older children. It seems that the anteroposterior position is at least non-inferior to the anterolateral position. [233,234] On the other hand, turning the child to apply pads in the anteroposterior position could be more difficult with larger children and adolescents particularly if there is a limited number of rescuers. Although paediatric data are lacking, evidence from adults

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suggests that changing the vector of defibrillation may improve outcome and defibrillation success in refractory VF. [235,236] In older children this would involve replacing the pads (i.e. moving them from the anterolateral to the anteroposterior position).

[h4] Shockable rhythms

Data on paediatric defibrillation is limited and challenging to interpret. [237] The ERC recommends 4J kg^{-1} for the first and subsequent shocks and considering higher energy levels for a refractory shockable rhythm (up to 8 J kg^{-1} after 5 attempts).

An ILCOR CoSTR and a registry study found greater survival to hospital discharge in children with VF who received an initial energy dose of 1.7-2.5 J kg^{-1}, compared with those receiving >2.5 J kg^{-1}. [238,239] However, this study was comparing standard practice for their setting (i.e. 2 J kg^{-1} in North America) with non-standard care, which might be a confounder. The ERC does not consider that the evidence is sufficient to justify a change in the current recommendation of 4 J kg^{-1} as the standard energy dose for shocks. It seems reasonable not to use doses above those suggested for adults. Consider escalating doses, increasing stepwise up to 8 J kg^{-1} if more than 5 shocks are needed.

No studies were identified which specifically addressed the timing of shocks and of rhythm checks in children. One registry study found that increasing chest-compression pause duration was associated with a lower chance of ROSC and survival. [217] This confirms the current advice to keep pauses for rhythm checks to a minimum. No new evidence was found concerning the effect of CPR before defibrillation.

[h4] Oxygenation and ventilation during PALS

A recent ILCOR CoSTR did not identify further evidence on oxygen titration. [198] Therefore, the ERC continues to recommend using 100% oxygen.

The ERC recommends the two-hand technique for bag-mask ventilation to enhance effectiveness. If only two rescuers are available, this means that the person responsible for chest compressions also assists with ventilations, which might increase chest compression pauses. If more rescuers are present, assign the roles of airway management and chest compressions to separate persons, minimising pauses in compressions and ensuring continuous, high-quality CPR.

ILCOR recently published a CoSTR on advanced airway management during ALS. [240] The ERC follows that recommendation for the use of bag-mask ventilation by professionals during cardiac arrest paediatric OHCA. There is currently a lack of high-quality evidence to recommend or discourage the use of bag-mask ventilation over tracheal intubation or supraglottic airway devices (SGA) during

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paediatric IHCA. The ERC emphasises that effective ventilation and oxygenation and high-quality chest compressions are essential in order to achieve ROSC. The ERC therefore recommends that healthcare providers transition to advanced airway management (SGA or tracheal tube) when the necessary resources and expertise are available for placement without disrupting chest compressions.

ILCOR has also reviewed ventilation rates during paediatric cardiac arrest, without identifying any relevant literature. [35,241] Based on expert opinion, ventilation rates should be close to age-appropriate respiratory rates, and hypoventilation and hyperventilation should be avoided, in paediatric resuscitation with an advanced airway. Positive pressure ventilation with an advanced airway in place can be asynchronous (at the lower limit of normal as stated in the sequence of actions) and chest compressions continuous (pausing only every 2 min for rhythm check). However, the ERC recommends that rescuers should stop continuous chest compressions and return to a compression:ventilation ratio of 15:2, when there is doubt about the effectiveness of ventilation.

[h4] Drugs during PALS

Vasoactive medication

Evidence remains very weak for the optimal dosing interval of adrenaline during CPR in children. [35,198,242] The ERC continues to recommend adrenaline as soon as possible in paediatric cardiac arrest with a non-shockable rhythm, ideally within the first three minutes. The dosing interval remains 3 to 5 min during PALS. In patients already receiving a vasoactive drug infusion at the start of CPR, a shorter interval (less than 3 min) seems to be associated with higher ROSC and improved survival to hospital discharge with favourable neurological outcome. [242] Pragmatically, the ERC recommends adrenaline administration every 4 min (or every other cycle) – which still falls into the 3-5 min interval – and giving the first dose of adrenaline after 4 min in shockable rhythms. Other vasoactive drugs (vasopressin, terlipressin, milrinone, noradrenaline) have been used, but the evidence for their use remains very weak and we currently advise using them only in controlled research settings. [35]

Antiarrhythmic drugs

We did not find any new evidence that would justify changes in the current recommendations on amiodarone and lidocaine as described in the sequence of actions.

Sodium bicarbonate

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The ERC considered a meta-analysis and a secondary analysis of a prospective nonrandomised controlled trial when recommending not routinely using sodium bicarbonate in cardiac arrest. [243,244] Both studies reported decreased survival to hospital discharge with the use of sodium bicarbonate during paediatric resuscitation.

Magnesium

No new high-quality evidence on this topic was found other than a single inconclusive registry study. [245] The ERC recommends not routinely using magnesium during paediatric cardiac arrest. Magnesium is indicated in documented hypomagnesaemia or torsade de pointes VT regardless of the cause.

Calcium

As no new evidence was identified, the ERC continuous to recommend not routinely using calcium for infants and children with cardiac arrest in the absence of hypocalcaemia, calcium channel blocker overdose or hypermagnesaemia.

[h4] Measurable factors during paediatric PALS

Blood pressure

Previous ERC guidelines did not recommend for or against the use of diastolic blood pressure to guide resuscitation efforts in children in cardiac arrest due to lack of evidence.[65] A recent ILCOR CoSTR on intra-arrest blood pressure found only five observational trials. [246] While intra-arterial blood pressure monitoring is generally available only in high-resource settings, children with invasive blood pressure monitoring are at higher risk of suffering cardiac arrest, thus making a recommendation valuable. [247,248] The ERC recommends targeting an intra-arrest diastolic blood pressure of ≥25 mmHg for infants <1 year and ≥30 mmHg for children 1 to 18 years with intra-arterial blood pressure monitoring in place at the time of cardiac arrest.

End-tidal CO_2 monitoring

Existing paediatric data indicate that capnography may enhance the quality of CPR, improve adherence to resuscitation guidelines and help to detect ROSC. [249-252] However, no specified values have been established to guide intra-arrest therapies or to indicate whether to stop or continue CPR. [250] Data from a large multicentre study suggests targeting an intra-arrest $ETCO_2$ >20 mmHg is associated with higher blood pressure and survival to hospital discharge. [250]

Near-infrared spectroscopy

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Although an ILCOR evidence update and a multicentred study suggest an association between higher intra-arrest cerebral oxygenation and improved resuscitation outcomes, the evidence was insufficient to make a recommendation for or against routine use of cerebral near-infrared spectroscopy during paediatric cardiac arrest. [198,253]

Point of care ultrasound

An ILCOR evidence update identified two small studies on point of care ultrasound (POCUS) which included paediatric cardiac arrests one of which was a small case series describing the feasibility of POCUS during cardiac arrest to assess ventricular contractility and pericardial effusion. [254] The ERC recommends that POCUS (as defined by in the evidence update) may be considered to identify reversible causes of cardiac arrest when appropriately skilled personnel are available, but the benefits must be carefully weighed against the known deleterious consequences of interrupting chest compressions.

Point of care blood analysis

No new evidence was identified on this topic. The ERC recommends not using specific values as indicators of when to initiate or stop resuscitation efforts. When treatable metabolic derangements are discovered, these should be corrected.

[h4] Extracorporeal cardiopulmonary resuscitation (ECPR)

Little new high-quality evidence concerning the use of ECPR in paediatric cardiac arrest was identified in a recent ILCOR CoSTR and a systematic review of paediatric OHCA. [198,255] The primary outcome in these publications was survival to hospital discharge, and neurological outcomes were rarely reported.

ECPR is a resource intensive therapy and success relies on hospital-level factors such as experience in extracorporeal life support implementation and availability of a 24/7 multidisciplinary response team. In line with the recent ILCOR CoSTR, the ERC recommends considering ECPR as an early intervention (e.g. within 5-10 min. of the start of CPR) for selected infants and children (e.g. those with cardiac conditions) with IHCA refractory to conventional CPR in settings where ECPR programmes have been implemented and perform well. [198] There is insufficient evidence in paediatric OHCA to make a treatment recommendation. However, the successful use of ECPR in OHCA in cases of shockable rhythms, drowning or severe hypothermia has been reported recently. The ERC acknowledges recent developments and agrees that in specific cases and when resources are available, ECPR is an option to improve survival.

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[h2] Cardiac arrest in special circumstances

[h3] Anaphylaxis

The most common triggers for anaphylaxis in children in Europe are food (including cow's milk, egg, nuts and fish - 65%), insect venom (20%) and drugs (5%). No obvious trigger can be found in up 30% of cases.

An ILCOR CoSTR found no new studies relating to the recognition of anaphylaxis. [168] Important symptoms are an acute onset (minutes to hours) of breathing difficulties, wheezing or coughing, swelling of the face and other body parts, shock, confusion or floppiness in young children, diarrhoea, nausea, vomiting and abdominal pain. Anaphylaxis can present in a single organ-system and cutaneous signs are absent in 10-20% of cases. [256] First responders can be trained to recognise anaphylaxis.

If anaphylaxis is suspected the EMS should be activated. All children who have had an anaphylactic reaction should be evaluated by a physician (e.g. a paediatrician or emergency physician). If symptoms resolve completely in the pre-hospital setting after a single dose of adrenaline, then admission to hospital is not always needed. [256] Elevation of the lower extremities can increase venous return and cardiac output, but can also compromise ventilation. [257]

The ERC recommends intramuscular adrenaline into the vastus lateralis of the quadriceps which is effective and rapidly absorbed and preferred to subcutaneous or intravenous administration. [258] There is little evidence on outcomes using other routes of adrenaline administration in children including adrenaline nasal spray. [259] Prompt administration of adrenaline is critical. A second dose of adrenaline is required in 7-18% of cases and should be given after 5 min if symptoms of severe anaphylaxis persist.[260] Delayed administration of adrenaline is associated with protracted reactions, hypotension, and fatal outcomes. Refractory anaphylaxis, requiring more than two doses of adrenaline with ongoing symptoms, occurs in 1% of cases and requires specialist in-hospital treatment often with an adrenaline infusion.

The ERC recommends not giving steroids in anaphylaxis except when this is associated with asthma, as there is no good evidence that they are helpful. [258,261,262] Intravenous glucagon may have a role when there is an inadequate response to adrenaline, particularly in patients on beta-blockers. [256]

As half of the patients who have a biphasic reaction will do so within 6-12 hours, prolonged observation (12-24 h) is advised in children with a history of a biphasic or protracted anaphylactic

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reaction or asthma, those who needed more than one dose of IM adrenaline, or when adrenaline was first administered more than 60 min after the onset of symptoms. [65]

Identification of the allergen is important in avoiding future reactions. Appropriately timed serum tryptase analysis can confirm the diagnosis of anaphylaxis. The serum concentration peaks at 1-2 hours after the reaction and often normalises within 6-8 hours. All children should be referred to an allergist for ongoing management of their allergy and be prescribed two adrenaline auto-injectors and instructed in their use. [256,263-266]

[h3] Traumatic cardiac arrest

Cardiac arrest is rare in paediatric trauma but may be the cause of 10-40% of all paediatric OHCAs. Survival is very poor at 2-5%, but good or moderate outcomes have been reported in survivors. [267-271] Chest compressions are less effective in hypovolaemia and cardiac tamponade, and their effect on outcome of traumatic cardiac arrest is unclear. [267,272-277] Therefore, professional rescuers should prioritise the detection and treatment of potentially reversible causes. Use the acronym HOTT: **H**ypotension, hypoxia (**O**xygenation), **T**ension pneumothorax and cardiac **T**amponade). [278] This should take priority over or run concurrently with CPR. There is insufficient evidence to support a trauma-specific resuscitation protocol for ambulance personnel. [272,279]

Stopping significant external bleeding can be lifesaving and has priority over starting chest compressions in an unresponsive child. Direct manual pressure, haemostatic or pressure dressings, a pelvic binder and tourniquet can all be effective. [280,281] In the case of a tourniquet, preferably use a manufactured windlass device and apply this above the injury, but not over a joint. Tighten the tourniquet until the bleeding stops and note the time of its application. Only a trained healthcare professional should remove the tourniquet. Manual pressure to the brachial or femoral artery might not be effective. [282] Intravascular fluid replacement to correct haemorrhagic shock should include blood products as soon as these are available.

Minimise spinal movement provided this does not hamper resuscitation efforts (e.g. by compromising the airway). Cervical collars are not advised and investing time in immobilisation may be detrimental in the case of penetrating trauma, particularly if a resuscitative thoracotomy is indicated. [282,283]

The place of adrenaline in traumatic cardiac arrest is controversial. A systematic review and meta-analysis of studies, mainly in adults, found that adrenaline did not improve ROSC benefit or short-term survival. [284] Adrenaline might be more beneficial in specific cases, like vasoplegia from spinal injuries. [273] In the absence of clear outcome data the ERC continues to recommend adrenaline IV/IO

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in traumatic cardiac arrest in children but emphasises the priority of stopping significant bleeding and treatment of reversible causes (HOTT) over the administration of adrenaline.

Shockable rhythms are rare, occurring in 2-7% of paediatric traumatic cardiac arrest and may be associated with a better outcome. [273,276] A shockable rhythm may be secondary to hypoxia or hypovolemia which needs to be treated first to improve the chance of successful defibrillation. Therefore, priority should be given to HOTT over attaching an AED except in electrocution or cardiac contusion.

In a traumatic tension pneumothorax finger thoracostomy seems more effective than needle thoracocentesis and has a low risk of major complications. [285]

A resuscitative thoracotomy is time sensitive and has a better outcome in penetrating injuries compared with blunt trauma. [286] Resuscitative thoracotomy requires that specific expertise, equipment and systems are in place, but is probably the best option for a traumatic cardiac tamponade. If not available, cardiac tamponade should be treated by a pericardiocentesis either via a subxiphoid mini-thoracotomy or by inserting a wide-bore drain. If available, POCUS should be used to guide percutaneous pericardiocentesis.

There is insufficient experience with extracorporeal life support in paediatric traumatic cardiac arrest to make recommendations for or against indications and techniques.

[h3] Drowning

Drowning is the process of experiencing respiratory impairment from submersion/immersion in a liquid, usually water and is a major cause of paediatric morbidity and morbidity worldwide. [287] The prevention of cardiac arrest is focused on reversing hypoxia, treating respiratory failure with potentially non-compliant lungs and dealing with hypothermia. The management of cardiac arrest involves reversing hypoxia and hypothermia. Attention should be given to a possible underlying cause of drowning such as arrhythmia, epilepsy, intoxication or trauma.

The following considerations are taken from the recent ILCOR CoSTR on drowning. [198]

Hypoxia is the primary mechanism leading to cardiac arrest in children following drowning and needs to be treated as soon as possible. Ventilation of the child’s lungs while they are still in the water is feasible for those specifically trained in this technique but should not delay other interventions. [288,289] Drowning in infants mostly occurs in the home or in small bodies of water where rescue times are short, so rapid removal from the water might be the best option. [290]

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The ventilation-first strategy (ABC) is the standard in paediatric CPR and emphasises the importance of reversing hypoxia. There is no evidence that another approach is superior. [289,291] Those trained should give mouth-to-mouth, pocket mask or bag-mask ventilation. Ventilation via a tracheal tube optimises oxygenation and might overcome increased airway resistance and decreased lung compliance. Early tracheal intubation by those competent in the technique is recommended. [292]

Starting high-quality CPR to correct hypoxia takes priority over attaching an AED. The incidence of a shockable rhythm following drowning has been estimated at 2-14% and it is uncertain whether this is associated with a better outcome. [278,291-296]

Drowning is often associated with hypothermia which can be defined as a core temperature below 35°C. Severe hypothermia (< 28°C) may cause cardiac arrest. There is no recent ILCOR CoSTR on accidental hypothermia in children not in cardiac arrest. The ERC recommendations are based on previous guidelines and expert consensus.

Remove wet clothing. Active external rewarming is usually sufficient when the core body temperature is above 30 °C. Active internal rewarming is indicated when core body temperature is less than 30 °C. During rewarming, vasodilation occurs, with possible hypotension, requiring infusion of warmed intravenous fluids but avoiding fluid overload. Rapid rewarming with a warm shower or warm water immersion of a child with circulation is potentially harmful because of hypotension and core temperature after-drop. There is no evidence for a specific rewarming rate for hypothermic children with circulation, but one study suggests increased mortality (at all ages with an initial temperature 30.5 °C) with slower rewarming at < 1°C $hour^{-1}$. [297-300] In children with severe hypothermia and intact circulation warm saline lavage of the left pleural space, bladder, stomach or peritoneum has been reported, but no comparative studies are available in children.

There is increasing experience with extracorporeal life support for hypothermic cardiac arrest or severe respiratory failure following drowning but there are insufficient data to guide recommendations on selection criteria or the timing for initiating these techniques. [301]

Although lower core temperatures are generally associated with longer immersion times and a worse prognosis, hypothermia may in rare cases have a neuroprotective effect after drowning, especially when hypothermia occurs early and rapidly and precedes hypoxia. [290,302-304]

[h3] Hypothermia

It is difficult to measure core body temperature correctly in the pre-hospital environment. Therefore, the simplified revised Swiss Staging system is recommended to estimate the core body

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temperature in case of accidental hypothermia. [305] The risk of cardiac arrest increases with decreasing core temperature. Risk factors associated with cardiac arrest are decreased level of consciousness (P or U in the AVPU scale) and cardiovascular instability (usually defined as ventricular arrhythmia or systolic hypotension). A combination of passive and active rewarming techniques should be started in the pre-hospital environment in all cases of hypothermia. [304]

Successful outcomes have been described in children with hypothermic cardiac arrest receiving very prolonged CPR with a core temperature as low as 10 °C.[302,303] Centralisation of the circulation in hypothermia may be neuroprotective. Recent guidelines and reviews support the use of prolonged resuscitation when necessary. [65,297,306-309] Consequently, the ERC recommends starting CPR as soon as possible in all children in hypothermic cardiac arrest and not to use a cut-off temperature for the decision to start resuscitation. [297]

There are no observational or randomised studies on defibrillation or the administration of drugs in severe hypothermia in children. Therefore, the recommendations of the ERC are based on recent guidelines. [307,309] These recommend that adrenaline should be withheld until the core temperature is above 30 °C. Defibrillation may be ineffective at low temperatures but shockable rhythms can be defibrillated once the core-temperature is above 30 °C. [310]. The ERC recommends that a maximum of three attempts should be made while the core temperature < 30 °C. As in previous ERC guidelines we continue to recommend that any child who has a chance of a favourable outcome in hypothermic cardiac arrest should be quickly transported to a specialised centre where rewarming should be performed with extracorporeal life support. [65,309] At that time prognostication using the Hypothermia Outcome Prediction after Extracorporeal life support (HOPE) score was only recommended for adults. [311] Since then, the HOPE-score has also been tested in a subgroup of children but the evidence supporting its use in children remains limited. [312,313]

A recent rapid review on rewarming young children after drowning-associated hypothermic cardiac arrest suggests that extracorporeal life support should be used to resuscitate children who do not achieve ROSC in the field and to use external rewarming for children with ROSC.[314] A strategy for extracorporeal life support based on slow, prolonged, high-flow rewarming at an experienced centre may prevent end-organ failure, preserve heart function and improve survival even after prolonged resuscitation. The optimal rate of rewarming is unknown. [299] Where the facilities and expertise are available, ECPR might also be initiated in the pre-hospital setting.

It has been suggested, based on a case-report analysis that, if ALS with rewarming does not result in ROSC, therapy might be withdrawn when the core temperature has reached 34°C. [299] A recent

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evidence-based guideline suggests stopping resuscitation if ROSC is not achieved within 30 min in hypothermic cardiac arrest associated with trauma or asphyxia (e.g. avalanche burial >60 min, core temperature ≥30°C and a non-patent airway); thus, in such circumstances ECPR is contraindicated. [297] In all other circumstances, and in the light of the increasingly successful use of ECPR, the ERC is currently unable to make a recommendation on criteria for the withdrawal of resuscitation in hypothermic cardiac arrest in children.

[h3] Cardiac arrest associated with septicaemia

Sepsis is a common cause of shock in children which may lead to cardiac arrest from which there is generally a poor outcome. There is currently no evidence to recommend a deviation from the standard PALS algorithm for cardiac arrest caused by sepsis. Early source control and antibiotic therapy is important. Cardiac arrest occurring shortly before or during cannulation for extracorporeal life support should not preclude its initiation. High flows on extracorporeal life support (greater than 150 mL kg^{-1}/min) might improve outcomes in children with sepsis.

[h3] Tension pneumothorax

Tension pneumothorax is less common in children than in adults and is mainly seen in ventilated children, in trauma and following central venous cannulation. [315]A tension pneumothorax should be diagnosed clinical and rapidly (respiratory distress, chest pain, unilateral absent lung sounds, tachycardia, and a rapid haemodynamic collapse). Point of care ultrasound helps diagnosis but should never delay treatment. [309,316] Needle thoracocentesis remains the first choice in non-traumatic tension pneumothorax as a temporary measure to buy time for chest drain placement. In traumatic tension pneumothorax, especially pre-hospital, finger thoracostomy is more efficient than needle thoracocentesis, with fewer reinterventions and a low complication rate. [285,317] Needle thoracocentesis must not delay finger thoracostomy. [318] In traumatic cardiac arrest, treatment of tension pneumothorax has priority, as untreated it will prevent successful resuscitation.

[h3] Cardiac tamponade

Cardiac tamponade is uncommon in children but occurs in penetrating chest trauma, post cardiac surgery and acute pericarditis. Point of care ultrasound in competent hands is helpful in the diagnosis. [254] Pericardiocentesis is relatively safe and highly effective procedure in experienced hands. [319] Depending on the cause (e.g. traumatic/non-traumatic/post-cardiac surgery) and the available expertise, alternative therapies include mini-thoracotomy, emergency or resuscitative thoracotomy or re-sternotomy.

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[h3] Pulmonary embolism

ILCOR recently reviewed the evidence on pulmonary embolus in paediatric cardiac arrest. [320] Pulmonary embolism is being increasingly reported in children either because there has been a true increase in incidence or because of increased awareness following the covid pandemic. [321-323] The clinical diagnosis is challenging, and POCUS/echocardiography might be of value. [324] Pulmonary embolus presents in children with tachycardia, tachypnoea, hypoxia, unilateral limb swelling, recent trauma or surgery, prior thromboembolism, cancer, anaemia and leucocytosis. [325]

Thrombolysis is generally more effective than systemic anticoagulation alone but there is insufficient paediatric evidence to make recommendations on indications, drugs, timing, dose or strategy in children. [326,327] Catheter-directed thrombolysis is associated with lower mortality and fewer complications in adults and is preferable to systemic therapy for those on extracorporeal life support. [328,329]

Surgical embolectomy is an established treatment option in adults.[330] Extracorporeal life support has been used successfully in children. [331] There are no comparative trials of surgical embolectomy or extracorporeal life support with thrombolysis in children.

[h3] Toxins

Intoxication is an uncommon cause of cardiac arrest in children but the incidence of intoxication generally is increasing worldwide. [332] In younger children intoxication is mostly caused by accidental ingestion of substances in the home (cleaning agents, parent's medication or drugs, batteries). In adolescents self-poisoning with therapeutic or recreational drugs is more common (alcohol, amphetamines, analgesics including opioids). [333] Carbon monoxide poisoning can occur at any age. In healthcare settings accidental overdosing or drug interactions are not infrequent. Life-threatening cardiovascular events associated with intoxication are rare but more common in adolescents and are associated with metabolic acidosis and a prolonged QT-interval. Intoxication with opioids and sympathomimetics have the highest mortality. [332]

The cornerstone of therapy is supportive using the ABCDE approach in a critical care setting, with correction of hypoxia, hypotension, and acid/base and electrolyte disorders. Manage seizures promptly with benzodiazepines (avoid phenytoin in intoxication). [334] Early advanced airway management is required when there is airway obstruction (e.g. due to depressed consciousness) or inadequate breathing, and to prevent aspiration of gastric contents. Drug-induced hypotension usually responds to fluid therapy. Occasionally vasopressors (e.g. noradrenaline) or inotropes may

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be required (e.g. in beta-blocker and calcium channel blocker overdose). Transcutaneous pacing may be effective for severe bradycardia caused by intoxication.

There are few specific therapies that are useful immediately, but consider the following for specific intoxications:

- Haemodialysis (methanol, ethylene glycol, salicylates, lithium).
- Charcoal haemoperfusion (carbamazepine, phenobarbital, phenytoin, theophylline).
- Lipid emulsion, e.g. Intralipid, (local anaesthetics).
- Naloxone (opioids).
- Alkalinisation to an arterial pH of 7.45 -7.55 with sodium bicarbonate (tricyclic antidepressants with ventricular conduction abnormalities).
- Acetylcysteine (paracetamol).
- High-dose atropine (organophosphates and nerve gases)

A thorough history is important to determine the toxic agent(s) and how much was ingested. Consider non-accidental injury particularly when the history is inconsistent. Consider child neglect if there have been repeated accidental ingestions.

In the event of cardiac arrest, resuscitation may be required over a prolonged period, as the poison may be metabolised or excreted during extended life support measures. Extracorporeal removal (e.g. dialysis) or extracorporeal life support should be considered in refractory shock and cardiac arrest when conventional CPR is failing.[335-337]

[h3] Hyperthermia

Heat stroke can result from exertion in a warm environment (most often in older children and adolescents), or from environmental heat exposure in children who are unable to escape the hot environment or who have a disorder of thermoregulation. Cardiovascular collapse commonly occurs at around 41°C, so active cooling should be initiated earlier to prevent this. [282]

No recent paediatric evidence was found for major changes to the management of hyperthermia. Recent ERC, ILCOR and American Heart Association guidelines recommend immediate cooling by removing the child from the heat-source, stopping excessive heat generation (e.g. through exercise), loosening or removing clothing, external cooling and hydration. [168,282,300,338] Standard resuscitation should be started where necessary. These measures should be initiated concurrently with activation of the EMS. Active cooling is associated with a lower mortality in severe

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hyperthermia compared with no active cooling.[339] Protocols describe the pre-hospital management of hyperthermia and the duration of cold-water immersion.[340-343] Key is early identification, rapid cooling with standard resuscitation when indicated and early transport for more advanced support.

Core temperature monitoring is required to guide cooling and prevent hypothermia. The rectal site is ideal for this in the prehospital setting. In hospital, the oesophageal, bladder or intravascular temperature can be used depending on the setting. The aim is to reduce the core temperature by 0.1-0.2 °C/min and the goal is 38°C when cooling measures should be stopped and monitoring continued.

Cooling methods were reviewed by ILCOR in 2020.[344] Aggressive cooling by immersion in cold or ice-water is the best technique for decreasing body temperature and should be initiated as soon as possible, ideally within the first 30 min.[344-346] Immerse the child from the neck down in a tub of cold water (1-26°C). Ice water is ideal, but even lukewarm water is helpful. Immersion is uncomfortable and leads to shivering, agitation and combativeness. Meticulous care if needed, benzodiazepines might be used (e.g., midazolam 0.05 to 0.1 mg kg^{-1} IV) to provide sedation and reduce shivering.

Hypothermia is a real risk when cooling aggressively, especially in infants and small children. Gentle handling and careful monitoring (which can be challenging) are needed to prevent overcooling.[347,348] In hospital, once core temperature starts decreasing, evaporative cooling may be preferrable to immersive cooling as it facilitates monitoring and reduces the risk of overcooling. Suitable methods are misting with water and fanning with cool air, wrapping the child in a wet sheet or using ice packs applied to the neck, axillae and groin, avoiding direct skin contact. If cold water immersion is not feasible or too risky (e.g. in infants), initiate an alternative cooling method such as evaporative cooling. Gentle oscillation in cold water on a tarpaulin might also be a feasible and effective alternative to immersive cooling in the prehospital setting or emergency department.[349,350]

Rehydration is often necessary. Cool intravascular fluids are not superior to cold water immersion for cooling.[351] Transpulmonary cooling by cold air inhalation is inferior to ice water immersion.[352] Antipyretic medication is ineffective in heat stroke. Various other cooling methods have been described, there is too little evidence to advocate one over the other.[353-363]

All children with heat stroke should be admitted to a paediatric intensive care unit for continued monitoring. Complications include seizures, multiorgan failure with rhabdomyolysis, hyperkalaemia, hypocalcaemia, hyperphosphataemia and other electrolyte imbalances, renal and hepatic injury, disseminated intravascular coagulation, cerebral and pulmonary oedema, and cardiogenic shock.

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Malignant hyperthermia is a special case of life-threatening hyperthermia associated with anaesthesia. Treatment involves immediate cessation of the triggering agent(s), active cooling, adequate oxygenation and ventilation, correction of severe acidosis and hyperkalaemia and immediate administration of dantrolene according to local protocols. (e.g. an initial dose of 2.5 mg kg^{-1}).

[h3] Hyperkalaemia

Treatment of hyperkalaemia should be directed at prompt recognition and appropriate treatment of the underlying cause. An ILCOR CoSTR on the treatment of hyperkalaemia found evidence that treatment with IV insulin and glucose or inhaled or IV beta2-adrenergic agonists causes an acute reduction in potassium values (in the range of 0.7 to 1.2 mmol/l). [364,365] It was not clear whether this resulted in improved clinical outcomes. Only a few studies have compared different treatment strategies. One meta-analysis, in adults, compared IV salbutamol to the combination of IV salbutamol and 10 units of insulin and found the combination therapy was more effective in lowering potassium values. [364] This suggests prioritising treatment with IV salbutamol either alone or in combination with insulin and glucose. The rationale for giving calcium during cardiac arrest caused by hyperkalaemia is based on the presumed ability to prevent arrhythmias. Although calcium is widely recognised and used for this indication, the ILCOR CoSTR did not find any clinical evidence to support this. One adult study found a lower unadjusted rate of ROSC with the administration of calcium and one paediatric study which included children in cardiac arrest with hyperkalaemia found those treated with calcium had worse outcomes. [366,367]

The ILCOR CoSTR did not find any evidence for a potassium lowering effect of bicarbonate in non-hyperkalaemic cardiac arrest but no studies in children were identified. The role of bicarbonate for non-toxicological metabolic acidosis is questionable. [364,368]

The ERC considers treatment with IV insulin and glucose and beta2-adrenergic agonists to be a reasonable approach to lowering potassium in children with and without cardiac arrest. In cardiac arrest high quality resuscitation is mandatory and may be prolonged considering the time that may be needed to lower the potassium. Extracorporeal life support can be considered.

[h3] Other metabolic derangements

In **severe hypokalaemia** (<2.5 mmol/L), or hypokalaemia with arrhythmias, an intravenous potassium infusion of 1 mmol kg^{-1} $hour^{-1}$ over 1 to 2 hours is safe and effective in young children. [369] In cardiac arrest with hypokalaemia the ERC recommends rapid administration of IV potassium 1 mmol kg^{-1} at a rate of 2 mmol/min for 10 min (maximum 20 mmol). When required, continue the

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dose for another 5-10 min (maximum total 30 mmol) until the serum potassium value is above 2.5 mmol. Repeat if necessary. [309,370] Co-existing depletion of magnesium is common and it must be replaced to enable the successful treatment of hypokalaemia (30-50 mg kg^{-1}). [371]

Treat **hypoglycaemia (**blood glucose < 3 mmol/L or < 3.9 mmol/L with symptoms) immediately via the oral route, if possible, with 0.3 g kg^{-1} glucose. [372,373] If oral intake is not possible, give an IV bolus of 0.2 g kg^{-1} glucose (e.g. 2ml kg^{-1} 10% glucose) and re-check blood glucose after 5 min repeating the dose if necessary and starting a maintenance infusion containing glucose. When IV/IO glucose is not available, and oral administration is not possible, providers may administer glucagon intramuscularly, intranasally or subcutaneously. [373,374]

The ERC did not review other rarer metabolic derangements but recommends correcting those that might potentially cause critical illness or cardiac arrest (e.g. hypocalcaemia, hypercalcaemia, hypermagnesaemia).

[h3] Cardiac arrest in children with congenital heart disease

Children with congenital heart disease are prone to acute cardiac events including an obstructed cardiac shunt, pulmonary hypertension and a shockable rhythm occurring in a monitored child attached to a defibrillator. The latter two situations can also occur in children without primary cardiac disease in other settings, and the approach to those is similar to that described in these guidelines.

The standard PALS guidelines should be followed in infants and children with a single ventricle anatomy with special consideration of possible pulmonary hypertension and an obstructed shunt. [198]There is increasing experience with extracorporeal life support, but no studies comparing it with standard CPR in children with single ventricle physiology. The ERC recommends considering extracorporeal life support if resuscitation is failing. In some cases, extracorporeal life support may be a bridge to a ventricular assist device and heart transplantation.

[h3] Pulmonary hypertension

The treatment of acute pulmonary hypertension in these guidelines is based on a recent ILCOR CoSTR. [375] Pulmonary hypertension occurs in congenital heart disease, chronic lung disease and as a primary disease. These children are at risk of pulmonary hypertensive crises which can rapidly lead to acute right ventricular failure, acute left ventricular preload reduction and cardiac arrest. Standard CPR may be less effective in pulmonary hypertension as increased pulmonary vascular resistance impedes left heart filling and limits coronary perfusion during chest compressions. [376]

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[h3] Cardiac arrest caused by a suspected obstruction of a cardiac shunt

The creation of artificial connections between the systemic and pulmonary circulation (e.g. aortopulmonary shunts and patent ductus arteriosus stents) are important procedures in congenital heart disease. The management of a life-threatening obstruction (due to thrombosis or mechanical kinking) of a shunt is based on a recent ILCOR CoSTR. [377]

[h3] Cardiac arrest in an ECG-monitored child attached to a defibrillator with a witnessed shockable rhythm

Self-adhesive defibrillation pads may be attached to a child in the intensive care unit, operating room or catheterisation laboratory or elsewhere, such that the child can be defibrillated as soon as a shockable rhythm is detected. In this setting it is potentially beneficial to attempt defibrillation up to three times immediately, before starting CPR (the 'stacked-shock strategy'). The ERC acknowledges that there are no paediatric data on this strategy in this specific situation and emphasises that the 'stacked shock' strategy in other circumstances is no longer recommended. Our recommendation is based on expert opinion. However, it is considered unlikely that chest compressions will improve the already very high chance of ROSC as the heart is believed to be more readily defibrillated in the first moments of a shockable rhythm. This is supported by the survival rate of > 95% of potentially lethal arrhythmias in patients with an implantable defibrillator. Using this stacked-shock strategy, IV amiodarone is given according to the number of defibrillation attempts (i.e. after the third attempt) and IV adrenaline according to the time since the arrest (i.e. the first dose after four minutes).

[h3] Cardiac arrest in the operating room

In case of paediatric cardiac arrest in the operating room follow the standard PALS algorithm, with particular emphasis on the common reversible causes in this setting (hypoxia, hypovolemia from bleeding or anaphylaxis, tension-pneumothorax and thrombosis) as well as causes specific to the operating room.

No recent systematic review specifically addressed perioperative paediatric cardiac arrest. The recommendations are therefore based on the ERC guidelines 2025 for adults. [CROSSREFERENCE]

Cardiac arrest occurs in 3-12 children per 10.000 procedures under anaesthesia and is more common in children < 1 year and those with severe underlying disease and/or undergoing emergency surgery. [378-382] Respiratory and circulatory problems are the main causes e.g. laryngospasm, difficult airway, blood loss and arrythmias. Rarer causes are hyperkalaemia from

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transfusion of stored blood and medication- and equipment related issues.[378,379,383] Cardiac arrest directly related to anaesthesia is rare (0.1-3.4 per 10.000 anaesthetics). Anaesthesia-related cardiac arrest has a lower mortality than other peri-operative cardiac arrests. The limited data on neurocognitive outcome in survivors of perioperative cardiac arrest suggests an incidence of 24% for temporary, and 6% for permanent harm.[380]

Standard operation room monitoring allows shockable rhythms and asystole to be quickly recognised, but it can be difficult to differentiate between severe shock and PEA. Recently it has been suggested to start chest compression in adults if the patient remains hypotensive despite intervention.[384] Pragmatically, the PLS WG recommends starting chest compressions in children if the blood pressure or the heart rate remains below the 5th percentile of the normal range for age.

In pre-arrest states in adults, initial incremental boluses of 50-100 microg IV adrenaline have been proposed rather than the standard 1 mg bolus which in this situation might induce severe hypertension or tachyarrhythmias.[22] Similarly lower doses of IV adrenaline might be tried in children, for example 1-2 microgram kg^{-1}. If a low-dose adrenaline bolus fails, the standard doses of intravenous adrenaline should be given.[385,386]

When the likelihood of cardiac arrest is high, the child should be attached to a defibrillator in standby mode using self-adhesive pads before induction of anaesthesia. Defibrillation should then be performed immediately if a shockable rhythm occurs, before starting CPR, as described above.

Ensure high quality PALS. Current data suggests that mechanical ventilation yields a similar PaO_2 to manual ventilation with a self-inflating bag.[387-390]

Chest compressions are optimally performed in the supine position, but in case of a cardiac arrest in the prone position with a tracheal tube in place, CPR can be initiated before turning the child if immediate supination is not possible.[391,392] Consider simultaneous left lateral decubitus and Trendelenburg positioning in cases of massive gas embolism, provided this does not impede adequate chest compressions.[393-395] Open cardiac compressions should be performed only by those appropriately trained.

Prioritise the identification and treatment of reversible causes. If available, consider the use of ultrasound (transthoracic/ transoesophageal) to help determine the cause.[396] If arrest is due to significant blood loss, chest compressions are effective only if the circulating volume is replaced simultaneously, and haemorrhage control (e.g. surgery, endoscopy, endovascular techniques) is initiated immediately.[396]

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Stop the surgery unless it addresses a reversible cause of the cardiac arrest. It may be necessary to cover the surgical field to facilitate access to the patient and adequate resuscitation.

If cardiac arrest occurs during laparoscopic or robotic surgery, release the pneumoperitoneum and deflate the abdomen to enhance venous return during CPR, unless the pneumoperitoneum is essential to the treatment of the surgical cause of the cardiac arrest (e.g. bleeding), in which case use the minimum necessary intra-abdominal pressure. If cardiac arrest occurs during thoracoscopy, stop CO_2 insufflation and rule out contralateral pneumothorax. In both cases consider gas embolism as a possible cause of the cardiac arrest.

Extracorporeal life support should be considered in cases where conventional CPR is failing or when prolonged resuscitation is required.

Successful management of intraoperative cardiac arrest requires not only individual technical and non-technical skills but also an orchestrated team approach, an institutional safety culture embedded in everyday practice through continuous education, training and multidisciplinary cooperation. [35,36,397,398] Institutional protocols for responding to potential cardiac arrest situations (e.g. massive transfusion protocols) and checklists will help to optimise the response to cardiac arrest in the operating room. [35,36]

[h2] Post-resuscitation care

The ERC considered the ILCOR CoSTRs on paediatric post-resuscitation care and ILCOR recommendations for a paediatric cardiac arrest core outcome set as well as recent literature in areas which ILCOR did not address. [7,35,168,399-404] Possible differences in the organisation of healthcare systems were considered as were the needs of patients, caregivers and families of survivors and non-survivors. Comments from representatives of the community advisors were also included. [405]

[h3] Recommendations for health care providers in the pre-hospital setting

The general recommendations about ABCDE principles in the section on cardiac arrest prevention also apply to post-resuscitation care.

Healthcare providers can consider inserting an advanced airway after ROSC if the child's level of consciousness and respiratory effort do not quickly improve. Early tracheal intubation is not always necessary as evidence shows that early tracheal intubation in the field is not better than delayed tracheal intubation. [83] Tracheal intubation should always be performed by a competent healthcare professional using a structured approach with proper equipment and monitoring.

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We recommend continuing with a high FiO_2 immediately after ROSC until the arterial blood oxygen saturation can be monitored reliably – the FiO_2 can then be adjusted. Hypoxaemia has been consistently associated with worse outcomes post-cardiac arrest in children while hyperoxaemia has less of an association with outcomes. [406,407] However, the ERC recommends avoiding sustained SpO_2 values of 100% (with a few exceptions such as carbon monoxide poisoning, severe anaemia and methaemoglobinaemia). To limit possible oxidative stress, in the absence of blood gas analysis, SpO_2 should be targeted at 94-98%.

If the child's lungs are ventilated mechanically, to avoid hyperventilation, the ERC recommends initially using a low-normal respiratory frequency and aiming for mild chest rise. Once tidal volume can be measured, the ERC recommends a tidal volume of 6-8 ml kg^{-1} of ideal body weight and PEEP of 5 cm H_2O and to avoid high airway pressures, and then further adjusting the ventilator settings to optimise ventilation. Seek expert help from a paediatric intensivist in children with complex medical needs.

After an advanced airway is secured, use capnography to continuously monitor for effective ventilation. Measure arterial blood gases as soon as practicable – as $ETCO_2$ values do not reliably reflect blood CO_2 values – and target normocapnia. [408] Use individualised $PaCO_2$ targets in specific situations (lung diseases with chronic hypercapnia, single ventricle physiology). [400]

Healthcare professionals should use multiple clinical signs and measurements, not just blood pressure, to evaluate the child's circulatory status, because normotensive shock is frequently present after cardiac arrest. [402,409] In the pre-hospital setting, the ERC emphasises the importance of using the correct blood pressure cuff size and performing frequent measurement of NIBP. Aim for a systolic and mean arterial blood pressure above the 10th percentile for the child's age. There is insufficient evidence for recommendations on specific treatments to achieve these targets (fluids, vasoactive medication, inotropes). A blood pressure that is too high may cause or worsen myocardial dysfunction. [402]

Treat seizures as soon as they arise, as recommended by an ILCOR CoSTR. [35] Check the blood glucose and treat any hypoglycaemia because it is associated with unfavourable outcomes in critically ill children. [402] Provide analgesia and sedation to treat pain and discomfort. Even short periods of low blood pressure below the 5th percentile are associated with worse outcomes after cardiac arrest. [410] Therefore, the ERC recommends avoiding boluses of medications that might cause sudden changes in blood pressure and to use continuous IV administration of analgosedation whenever possible.

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Fever (> 37.7 °C) is associated with worse outcomes in patients after cardiac arrest and should be always avoided after ROSC.[411]

The presence of the parents/caregivers during pre-hospital care and transportation is legally and ethically justified provided this does not jeopardise their safety or that of the child or care team. It is also perceived as important by parents or other caregivers and improves psychosocial outcomes in family members regardless the outcome of the child.[405]of the outcome of the child.[406]

[h3] Recommendations for in-hospital health care providers

In-hospital, specific paediatric intensive care approaches are used during the acute and post-acute post-resuscitation care phases and for the treatment of post-cardiac arrest syndrome (Figure 5.2). These comprise a variety of diagnostic and therapeutic options usually organised in care-bundles, where more contextualised and individualised care goals can be used based on the child's history, the specific context and the resources available. Multiple treatment modalities might be necessary to treat underlying disease and/or post-cardiac arrest syndrome including airway management, ventilatory support and circulatory support with fluids, blood products, vasoactive medication and inotropes, and extracorporeal life support.[402]

Target normoxaemia and normocapnia.[65,406,407,409,411-414] Patients with hypoxaemia (<8 kPa, 60 mmHg) are less likely to survive to hospital discharge while hyperoxaemia has no effect on outcomes.[406,407] Compared with hypercapnia, patients with normocapnia are more likely to survive to hospital discharge whereas hypocapnia does not affect outcome.[407] No evidence for targets in specific patients (e.g. congenital heart disease, chronic lung disease with chronic hypercapnia) although individualisation of care is recommended by ILCOR.[400] There is insufficient evidence for a firm recommendation for how long oxygenation and ventilation targets should be maintained post-ROSC, but at least 24 hours seems reasonable.[402]

Monitor blood pressure (BP) continuously via an arterial catheter in all patients who remain comatose after ROSC. Post cardiac arrest hypotension occurs in more than 50% of patients and contributes to secondary brain injury through cerebral hypoperfusion.[402] Causes of low blood pressure include myocardial dysfunction, inflammatory response, and vasoplegia.[409,412] Hypotension in the first 24 hours after ROSC is associated with poor outcomes.[65] The optimal BP target (systolic, diastolic or mean pressure) is unknown, but there is evidence that even short periods of a BP slightly below the 5th percentile are associated with unfavourable outcomes.[410] One observational study suggests that systolic BP above the 10th percentile is associated with favourable outcomes. Conversely, a blood pressure that is too high is detrimental because it can cause myocardial

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dysfunction and increase cerebral blood flow. [415] Until further evidence is available, ILCOR recommends maintaining a systolic BP above the 10th percentile. [35,401] Newer studies have focused on mean arterial blood pressure targets and cerebral blood flow. [410,416,417] Pragmatically, the ERC recommends targeting mean arterial blood pressure to above the 10th percentile. There is insufficient evidence for an ERC recommendation on the optimal strategy to achieve this blood pressure target (fluids, vasoactive medication, inotropes, mechanical support). Higher blood pressure targets, (above the 50th or 80th percentile), are justifiable in certain cases, especially following cardiac arrest associated with severe traumatic brain injury. [144]

A 2019 ILCOR CoSTR acknowledged the benefits of temperature control as a neuroprotective strategy following paediatric cardiac arrest but was unable to recommend a specific target as the evidence was neither in favour or against hypothermic (32-34°C) over normothermic (36–37.5°C) temperature control. [168,399] Hyperthermia (>37.5°C) has been consistently associated with worse neurological outcomes. [418,419] Maintaining normothermia reduces metabolic stress on the injured brain. Hypothermic temperature control has been associated with improved long-term health-related quality of life in paediatric cardiac arrest survivors, further supporting its role in post-cardiac arrest care, even in the absence of a clear survival benefit. [420] Hypothermic temperature control requires specialised paediatric neurocritical care to ensure safety, proper sedation, treatment of possible side effects (coagulopathy, bradycardia, metabolic disturbances, infection) and safe rewarming strategies. [402] In settings without such resources, strict normothermia and fever prevention remain the standard of care.

There is no evidence on which to base recommendations about the duration of temperature control. In line with a recent ILCOR evidence update on temperature control, the ERC recommends maintaining normothermic or hypothermic temperature control for at least 24 hours, and avoiding fever for at least 72 hours, after ROSC. [168,411]

Clinical and electroencephalographic seizures are common manifestations of post–cardiac arrest brain injury in children, with an incidence of approximately 10% to 40%, and are associated with poor neurological outcome. [421,422] The ERC and ILCOR currently recommend prompt treatment of seizures following ROSC, but not the prophylactic use of antiseizure medication. This recommendation is based on indirect evidence (adults, children with traumatic brain injury and neonatal hypoxic-ischemic encephalopathy). [35]

The ERC emphasises the importance of high-quality intensive care management of children after cardiac arrest (see Figure 5.2). This includes multimodal monitoring; non-invasive or invasive

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techniques to diagnose and treat underlying conditions as well as post cardiac arrest syndrome, pain, discomfort and delirium, and acute kidney injury, as well as early optimal nutrition, and rehabilitation.

The ERC recommends family-centred care with unrestricted access of parents/caregivers to the child, honest and clear communication, and the early involvement of the specialised assistance of multidisciplinary teams (paediatric neurologists, paediatric psychologists, paediatric palliative care team, social workers, child-life specialists) to address additional needs of the child and family. [405]

[h2] Prognostication after cardiac arrest

The accurate prediction of good outcome is important to patients, parents/caregivers and healthcare providers. A predicted good outcome would justify continued intensive care treatment. Accurate prediction of poor neurological outcome is crucial to avoid false pessimism as well as to justify withdrawal of life sustaining therapy.

The usefulness of blood biomarkers, clinical examination, electrophysiology and neuroimaging for the prediction of neurological outcomes after ROSC has been reviewed in two ILCOR CoSTRs and a systematic review. [198,423,424] The ERC recommends that future outcome studies should ideally be assessed using the Pediatric Core Outcome Set in Cardiac Arrest and should include long-term outcomes in terms of morbidity, functional health and quality of life, and the impact on the family. [403] Visual aids and presentations can help families to better understand the prognostication terminology and enable them to be better involved in the decision-making process. [425]

The ERC advises healthcare providers to use multiple pre-, intra-, and post-cardiac arrest variables for prognostication in the post-cardiac arrest phase and to delay prognostication in children with a depressed level of consciousness for at least 72 hours. Single variables should never be used for prediction of good or poor outcomes. [198,423] These variables include pre-arrest factors (child's baseline health and neurological status), the context of the cardiac arrest (location, PBLS initiation, first rhythm, cause, duration), and post-cardiac arrest care (comprehensive assessment with repeated evaluations).

The ERC recommends including a set of diagnostic modalities in the post-resuscitation care work-up in paediatric intensive care units that can be also used for prediction, and which enable standardisation and better comparability of future research. The minimal set would include pupil reactivity to light at days 1-6, Glasgow Coma Score or its motor score component on days 1-6 and basic available blood biomarkers on day 1 (pH, lactate). Extended investigations should also include additional blood biomarkers of neurological damage such as S100B (a calcium binding protein

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primarily found in astrocytes), NSE (neuron-specific enolase), MBP (myelin basic protein) on day 1, electrophysiological studies (EEG, somatosensory evoked potentials, SSEP) on day 1 and 2, and brain imaging by magnetic resonance between day 3 and 5. The modalities and timings were chosen so that they allow for both multimodal prognostication for good as well as for poor outcome. Suggested results of these investigations that can be used as components of multimodal approach to prognostication are shown in Figure 5.4. [423] The overall certainty of evidence for individual tests is very low for all outcomes.

[h2] Post-discharge care

The occurrence and severity of sequelae in paediatric cardiac arrest survivors, both short-term and long-term, are major concerns for patients, families, and healthcare providers worldwide. Little is known about the long-term outcomes of cardiac arrest survivors. Long term follow-up is crucial to identify problems and to counsel children and parents/caregivers. The goal is to improve long-term outcome in cardiac arrest survivors by early therapeutic interventions and reduce the societal impact (e.g. health care costs, unemployment).

The sequelae of cardiac arrest can have a major impact on all family members. Parents/caregivers and extended family members may suffer from psychosocial sequelae both before and after hospital discharge of the child. They will have to cope with grief and trauma caused by the child's hospital admission, the cardiac arrest event itself and its sequelae. Family dynamics may change, and parents/caregivers may not be able to return to their jobs, with all the financial consequences that this entails.

Considering the greater life-expectancy for children, the relative costs for society in terms of loss of potential productivity, associated health care costs, and the emotional burden for the family are significant.[7]

No scientific evidence has been found on post-discharge care in children except a systematic review on the family needs of cardiac arrest survivors. [405]

The ERC together with community advisors agreed that post-discharge care should ideally be organised for all cardiac arrest survivors and their families as part of standard patient care. Specific care should also be organised for families of non-survivors (i.e. bereavement support, psychology).

Standardisation of care will also increase the quality of outcome data and minimise selection bias in future research, and the development of evidence-based post-discharge guidelines has been suggested. [426] Several barriers to this exist, including low cardiac arrest survival rates for paediatric

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OHCA, small homogeneous cohort sizes, and few national or international cardiac arrest registries that collect data on long-term outcomes in different domains (e.g. physical, neuropsychological, functional health and health related quality of life). International research collaborations are necessary to improve post-discharge care.

The ERC recommends a specific set of actions to improve care after discharge, which are based on expert consensus and the advice of community advisors representing families of both survivors and non-survivors. The ERC recognises that this type of care is difficult to organise because it requires personnel and financial resources and dedicated teams to provide multidisciplinary follow-up programmes. Planning of post-discharge care should start before discharge of the child. Well-coordinated on-site family-centred care is preferred, using case managers such as family liaison teams to improve adherence to post-discharge care and lower the burden on families. Virtual consultation should be considered when hospital visits are difficult to organise. Patients and families should be screened for symptoms of post-intensive care syndrome and referred for professional help as soon as physical or mental health issues are detected. Signposting supportive structures for families of survivors and non-survivors is also important.

[h2] System-level recommendations and recommendations for implementation

[h3] Recommendations for the public

The most common witness in paediatric resuscitation is a parent or caregiver and the most common location is at home. [169] Less commonly, cardiac arrests also occur during physical exercise and at school. [16] In adolescents, violence, drug misuse, mental health and traffic accidents are prevalent but potentially preventable causes.[16] A community-based approach to cardiac arrest prevention is justified and should be aimed mostly at caregivers of children and primary health care providers. [9] Specific preventative interventions targeted at lower socioeconomic populations and ethnic minorities might be especially effective as there is increased probability of arrest in these groups compared with the general population. [13,427] Communities should be involved in training in the recognition and management of cardiac arrest and in first aid interventions. [428] Every child who has had an anaphylactic reaction should have two auto-injectable adrenaline devices prescribed and receive instructions on how to use it (child and caregivers). There is no specific age at which children can be expected to use the adrenaline auto-injector themselves but generally they are secondary school age with sufficient maturity. [168,256,263-266]

The ERC recommends systematic training in PBLS for all persons caring for children, from parents and caregivers to teachers, child minders, lifeguards, first responders and coaches/trainers.

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Paediatric cardiac arrest is a low frequency high-stakes event. Mistakes and substandard performance are common in simulations of paediatric resuscitation and training remains the cornerstone of potential improvements in outcomes. [429-432] CPR training is widely recognised to improve CPR skills and improve survival.[433] Training of the general population has been associated with improved overall bystander CPR rates and survival outcomes. [434] The best timing for training of parents might be during antenatal classes, as almost a half of all paediatric cardiac arrests happen at home during the first year of life. [169,427] Swimming lessons can reduce the incidence of drowning. [435-438]

[h3] Recommendations for all health care systems

The best outcomes are achieved when all the links in the chain of survival are working effectively together and are coordinated over space and time. [439] Healthcare systems should use regular system audit and improvement strategies focussed on the chain of survival to continually improve patient care and outcomes. [439] The ERC recommends systematic training in the recognition of critically ill or injured children and in PBLS at all levels of care, including training those who only occasionally care for children. Training healthcare professionals may improve outcomes and low-dose high-frequency training seems to be an efficient way to improve skills. [398,433,440] Improvement in outcomes and competence after publication of guidelines and standardisation of training are well documented. [441]

The ERC recommends systematic training in PALS at all levels from EMS systems and prehospital care to hospital staff, particularly focusing on those who treat critically ill children. The ILCOR CoSTR on team competencies in resuscitation training concluding that teaching these skills can improve resuscitation performance in the areas of leadership, communication, decision-making, task management and CPR quality [397]. Further evidence demonstrates that training in teamwork with an emphasis on leadership skills, planning, and structured, uniform communication is associated with shorter chest compression pauses. [217,442-444]

A well-structured resuscitation team and an easily accessible activation system are essential for ensuring a seamless transition from PBLS to PALS.[445,446] Team members should ideally have predesignated roles and shared leadership can be considered in some teams e.g. when using a CPR coach (a team member with responsibility for ensuring the team maintain high quality CPR. [398,447]

To strengthen the link between PBLS and PALS, institutions should establish clear protocols for transitioning from one to the other and view these as phases in a continuum. The necessary teamwork for this should be incorporated into training programs. [448] Ensuring that professional PBLS

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providers understand the PALS algorithms, including indications for advanced airway management, vascular access and medication administration, supports a more coordinated approach to paediatric resuscitation. Clear communication is also necessary and training in structured handover of information is invaluable. [449]

Several conditions are recognised as risk factors for sudden cardiac arrest and identifying them might prevent this. These include preterm and very small babies, children with a family history of sudden unexplained death, siblings of children who died of sudden infant distress syndrome (SIDS), congenital abnormalities, primary arrhythmia syndromes, cardiomyopathies, channelopathies, and coronary artery abnormalities. [450-454] Integrating genetic testing and advanced electrophysiological evaluation might identify children at high risk for sudden cardiac arrest. [455] Exercise-related cardiac arrest is rare and pre-participation screening does not seem to be cost-effective. If implemented, then targeting adolescents rather than younger children seems reasonable. [456]

[h3] Recommendations for emergency medical systems and dispatch systems

Field triage is important for all pre-hospital systems to identify critically ill or injured children and to transport them to the most appropriate facilities. [457] Transportation to lower-than-required level paediatric or adult trauma centres is associated with increased mortality and morbidity. [458] However, current protocols do not accurately discriminate between patients at low and high risk, so specific paediatric triage tools are needed to ensure that the right child is transported to the right hospital. [458,459]

[h3] Recommendations for transportation

No studies were found specifically addressing the topic of transportation of children to cardiac arrest centres after cardiac arrest. [35] The ERC recommends, based on expert opinion, that children sustaining cardiac arrest should be preferably transported to hospitals with a paediatric intensive care unit where a multimodal approach to post-resuscitation care is available.

The ERC recommends that EMS systems should establish communication strategies and plans to aid seamless transportation and hand-over of children in or after cardiac arrest. Standardisation of hand-over protocols improves outcomes on all levels - patients, providers and organisations. [460]

The ERC recommends that multiple transfers between hospitals be avoided as this is associated with lower long-term survival in critically ill children. [461] The ERC also acknowledges that in certain situations it may be preferable to transport the child to the closest hospital for stabilisation before transfer to a paediatric intensive care centre. Children with complex medical conditions need more

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specialised care which is only available in a tertiary centre. [427] Centres with facilities for extracorporeal life support or other specialised paediatric care (cardiac, cardiothoracic surgery, trauma) are preferable for certain children (hypothermia, poisoning, trauma, refractory cardiac arrest.

[h3] Recommendations for hospitals, departments and teams

The use of paediatric early warning systems was recommended in an ILCOR CoSTR as these can reduce adverse events, although false alarms are frequent.[446,462,463] The ERC recommends implementing paediatric early warning systems not as a stand-alone measure, but as part of a broader clinical response system which might be modified for use in different settings or added to existing triage systems. [464]

The ERC recommends that hospitals train healthcare providers in the recognition and management of critically ill/injured children, PBLS and PALS. Bag-mask ventilation is the most time-critical intervention and every healthcare professional involved in the care of seriously ill children should be competent in this technique. The ERC recommends that systems enable IO access within 5-10 min in children who require this, as IV access can be challenging. [140]

ILCOR has identified ten key steps to improve IHCA outcomes, emphasising the importance of structured resuscitation systems. [398] The ERC recommends the implementation of these which include dedicated resuscitation teams whose members have predefined roles, comprehensive training programs, standardised equipment and protocols, efficient alarm systems and regular team briefings.

The ERC recommends standard operating procedures for post-resuscitation care in hospitals, departments and paediatric intensive care units. Standardisation improves patient outcomes by reducing unnecessary variability and enhancing efficiency and quality of care. [465] However, successful implementation requires the flexibility to adapt to individual patient needs. [466]

An ILCOR CoSTR recommended that extracorporeal life support, when considered, should be accompanied by institution-specific algorithms which ensure that healthcare teams can rapidly identify suitable candidates, streamline the initiation process and optimise resource allocation, in order to enhance outcomes.[255]

[h3] Recommendations for manufacturers of medical devices

In line with ILCOR, the ERC recommends inclusion of children in public access defibrillator programs and standardisation of AED pad size for infants, children and adults. [187,219] The paediatric mode of an

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AED should be simple to activate (e.g. by pushing a button rather than by using a key or switching the pads), as rescuers find this easier. [467,468] In line with an ILCOR CoSTR, the ERC recommends that manufacturers standardise pictograms for pad position in line with the ERC recommendations. The ERC recommends that manufacturers of publicly available AEDs use one universal size of the pad for cardiac arrest victims of all ages and a simple method of attenuating the energy level for infants and children weighing less than 25 kg.

[h2] Recommendations for low resource setting

These guidelines indicate where access to paediatric specialty care should be provided e.g. paediatric cardiologist, paediatric neurologist. The ERC recommends that systems strive for the highest possible level of care but recognise that different modifications and prioritisation may be needed depending on available resources. For example, access to a paediatric specialist is important but where this is not available another competent doctor may be consulted, or remote advice and telemedicine may also be useful. For a detailed definition on resuscitation in low resource settings, we refer to the ERC Guidelines 2025 Systems Saving Lives. [CROSSREFERENCE]

[h3] System-level considerations

Dispatch-assisted CPR may be incorporated into any EMS in any setting although this requires training of personnel. AED deployment in communities is cost-effective for adult OHCA and may be extended to paediatric OHCA. [469] Life support training is considered a cost-effective method to enable providers to deliver the highest possible level of care and improve survival outcomes. [198,433] Life support training can be conducted using low fidelity manikins.[470] Resuscitation training should be conducted in a low-dose, high-frequency manner enabling training activities during clinical working hours. [398,440,471,472] Where there are limited training opportunities, training of specific caregivers and healthcare professionals (e.g. resuscitation teams or others with a high likelihood of encountering cardiac arrest) may be prioritised. Targeted life support training of lay persons in areas with a lower socioeconomic status might be considered as these areas have a higher incidence of cardiac arrest with poorer outcomes. [473,474] Training of lay people is most effective when there is an effective chain of care following the resuscitation. In any setting, consider allocating designated staff who can respond to emergencies and cardiac arrest.

[h3] Prevention of cardiac arrest

In limited resource settings, the most cost-effective ways to detect clinical deterioration and establish appropriate responses should be considered. These may include the use of low-cost

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equipment to detect vital sign changes and educating families to react appropriately to certain signs (e.g. high fever, abnormal breathing and decreased consciousness). [428]

The use of pulse oximetry and oxygen is considered a highly cost-effective strategy to prevent deterioration among children. [109,475] Isotonic saline may be used as an alternative to balanced crystalloids for fluid treatment when these are unavailable for financial or logistic reasons. [476] In the absence of a clinical emergency team, consider establishing a small team or alternate track-and-trigger response. [398]

[h3] Paediatric Life Support

For foreign body airway obstruction, we recommend prioritising basic manoeuvres first in all settings. When starting CPR, prioritise bag-mask ventilation, intubation is not associated with improved survival outcomes. [477] Prioritise the availability of oxygen and a bag and mask. Tracheal intubation with a regular direct laryngoscope is an acceptable alternative when video laryngoscopes are not available.

Self-adhesive pads are recommended for defibrillation, paddles may be used where pads are unavailable. [219] Adult pads may be used on a child with the pads in an anteroposterior position when paediatric pads are unavailable.

Following cardiac arrest, children should ideally be transferred to a centre with facilities for paediatric intensive care. If this is not possible, children should be treated in a setting capable of intensive care monitoring for 24-72 hours. Prioritise careful management of oxygenation, ventilation, circulation and temperature because these are the basic tenets of post cardiac arrest care. [65,402] Where expertise is not available on-site, consider telemedical consultation with an expert(s) (e.g. paediatric intensivist). [478]

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[h1] Collaborators

The following individuals contributed as collaborators to the 2025 version of this guideline as community advisors: Josephine Wren and Eleni Tsoni.

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[h1] Figure legends

Figure 1.1: Paediatric chain of survival.

Figure 1.2: Management of critically ill/injured child using the ABCDE approach. Infographic.

Figure 1.3: Algorithm for the management of generalized seizures in children.

Figure 2.1: Paediatric Basic Life Support algorithm.

Figure 2.2: Three steps to save child's life.

Figure 2.3a: Opening airway in an infant – neutral position.

Figure 2.3b: Opening airway in a child – 'sniffing position'.

Figure 2.4a: Rescue breathing in an infant – mouth-to-mouth-and-nose technique.

Figure 2.4b: Rescue breathing in a child – mouth-to-mouth technique.

Figure 2.5a: Chest compressions in an infant – two-thumb encircling technique.

Figure 2.5b: Chest compressions in a child – one-hand or two-hands technique.

Figure 2.6a: Anteroposterior position of the defibrillation pads in children up to 25 kg.

Figure 2.6b: Anterolateral or anteroposterior position of the defibrillation pads in children more than 25 kg.

Figure 2.7: Algorithm for paediatric foreign body airway obstruction

Figure 2.8a: Back blows and chest thrusts in an infant.

Figure 2.8b: Back blows and chest thrusts in a child or adolescent.

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Figure 3.1: Paediatric Advanced Life Support algorithm.

Figure 3.2: Suggested composition of the resuscitation team.

Figure 3.3: Reversible causes of cardiac arrest.

Figure 5.1: Immediate post-resuscitation care. Infographic.

Figure 5.2: In-hospital post-resuscitation care. Infographic.

Figure 5.3: Prognostication after paediatric cardiac arrest.

Figure 5.4: Prognostication modalities associated with good and poor outcomes.

Figure 5.5: Post-discharge care.

[h1] Table legends

Table 1. The major changes in the 2025 guidelines for Paediatric Life Support

Table 2. Approximation of normal values of respiratory rate, heart rate and blood pressure. The values change continuously as the child grows. Use intermediate values for children between the specified ages in the table.

Legends: RR = respiratory rate, HR = heart rate, BP = blood pressure, MAP = mean arterial pressure

p50/p10/p5 = 50th/10th/5th percentile of BP for the 50th percentile of child's height at that age

Table 3. Clinical signs of respiratory and circulatory failure. Individual deviations are common especially in children with chronic medical conditions. Be aware that cardiovascular collapse can also occur suddenly without any preceding signs or symptoms!

Table 4. Reversible causes of cardiac arrest**.**

[h1] References

1. Garritty C, Gartlehner G, Nussbaumer-Streit B, et al. Cochrane Rapid Reviews Methods Group offers evidence-informed guidance to conduct rapid reviews. J Clin Epidemiol 2021;130:13-22. (In eng). DOI: 10.1016/j.jclinepi.2020.10.007.
2. Jafar AJN, Patel S, Mitchell R, Redmond A. Redefining global health and shifting the balance: the ARC-H principle. BMJ Glob Health 2024;9(2) (In eng). DOI: 10.1136/bmjgh-2023-014487.
3. Sawyer T, McBride ME, Ades A, et al. Considerations on the Use of Neonatal and Pediatric Resuscitation Guidelines for Hospitalized Neonates and Infants: On Behalf of the American Heart Association Emergency Cardiovascular Care Committee and the American Academy of Pediatrics. Pediatrics 2024;153(1) (In eng). DOI: 10.1542/peds.2023-064681.

This is a DRAFT-version

4. Allan KS, Morrison LJ, Pinter A, Tu JV, Dorian P. "Presumed cardiac" arrest in children and young adults: A misnomer? Resuscitation 2017;117:73-79. (In eng). DOI: S0300-9572(17)30246-0 [pii] 10.1016/j.resuscitation.2017.06.003.
5. Fovaeus H, Holmen J, Mandalenakis Z, Herlitz J, Rawshani A, Castellheim AG. Out-of-hospital cardiac arrest: Survival in children and young adults over 30 years, a nationwide registry-based cohort study. Resuscitation 2024;195:110103. (In eng). DOI: S0300-9572(23)00839-0 [pii] 10.1016/j.resuscitation.2023.110103.
6. Engdahl J, Axelsson A, Bang A, Karlson BW, Herlitz J. The epidemiology of cardiac arrest in children and young adults. Resuscitation 2003;58(2):131-8. (In eng). DOI: 10.1016/s0300-9572(03)00108-4.
7. Pinto NP, Scholefield BR, Topjian AA. Pediatric cardiac arrest: A review of recovery and survivorship. Resuscitation 2024;194:110075. (In eng). DOI: 10.1016/j.resuscitation.2023.110075.
8. Markel F, Djakow J, Biarent D, et al. Pediatric cardiac arrest registries and survival outcomes: A European study. Resusc Plus 2025;22:100902. (In eng). DOI: 10.1016/j.resplu.2025.100902.
9. Kelpanides IK, Katzenschlager S, Skogvoll E, et al. Out-of-hospital cardiac arrest in children in Norway: A national cohort study, 2016-2021. Resusc Plus 2024;18:100662. (In eng). DOI: 10.1016/j.resplu.2024.100662.
10. Shimoda-Sakano TM, Schvartsman C, Reis AG. Epidemiology of pediatric cardiopulmonary resuscitation. J Pediatr (Rio J) 2020;96(4):409-421. (In eng). DOI: 10.1016/j.jped.2019.08.004.
11. Cheng FJ, Wu WT, Hung SC, et al. Pre-hospital Prognostic Factors of Out-of-Hospital Cardiac Arrest: The Difference Between Pediatric and Adult. Front Pediatr 2021;9:723327. (In eng). DOI: 10.3389/fped.2021.723327.
12. Abate SM, Nega S, Basu B, Mesfin R, Tadesse M. Global burden of out-of-hospital cardiac arrest in children: a systematic review, meta-analysis, and meta-regression. Pediatr Res 2023;94(2):423-433. (In eng). DOI: 10.1038/s41390-022-02462-5.
13. Idrees S, Abdullah R, Anderson KK, Tijssen JA. Sociodemographic factors associated with paediatric out-of-hospital cardiac arrest: A systematic review. Resuscitation 2023;192:109931. (In eng). DOI: S0300-9572(23)00245-9 [pii]

10.1016/j.resuscitation.2023.109931.
14. Mally D, Namazzi R, Musoke P, Munube D, Luggya TS, Sawe HR. Outcomes of pediatric in-hospital cardiac arrest in the emergency department of a tertiary referral hospital in Tanzania: a retrospective cohort study. BMC Emerg Med 2024;24(1):178. DOI: 10.1186/s12873-024-01086-8.
15. Holgersen MG, Jensen TW, Breindahl N, et al. Pediatric out-of-hospital cardiac arrest in Denmark. Scand J Trauma Resusc Emerg Med 2022;30(1):58. (In eng). DOI: 10.1186/s13049-022-01045-x.
16. Pireddu R, Ristagno G, Gianquintieri L, et al. Out-of-Hospital Cardiac Arrest in the Paediatric Patient: An Observational Study in the Context of National Regulations. J Clin Med 2024;13(11) (In eng). DOI: 10.3390/jcm13113133.
17. Wolthers SA, Jensen TW, Blomberg SN, et al. Out-of-hospital cardiac arrest related to exercise in the general population: Incidence, survival and bystander response. Resuscitation 2022;172:84-91. (In eng). DOI: 10.1016/j.resuscitation.2022.01.021.
18. Cosgrove TC, Gauntt J, Carrillo SA, et al. Proactive risk mitigation for cardiac arrest prevention in high-risk patients with congenital heart disease. JTCVS Open 2023;13:307-319. (In eng). DOI: 10.1016/j.xjon.2022.10.008.

This is a DRAFT-version

19. Alten J, Cooper DS, Klugman D, et al. Preventing Cardiac Arrest in the Pediatric Cardiac Intensive Care Unit Through Multicenter Collaboration. JAMA Pediatr 2022;176(10):1027-1036. (In eng). DOI: 10.1001/jamapediatrics.2022.2238.
20. Skellett S, Orzechowska I, Thomas K, Fortune PM. The landscape of paediatric in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. Resuscitation 2020;155:165-171. (In eng). DOI: 10.1016/j.resuscitation.2020.07.026.
21. Nishisaki A, Reeder RW, McGovern EL, et al. Brief report: incidence and outcomes of pediatric tracheal intubation-associated cardiac arrests in the ICU-RESUS clinical trial. Crit Care 2024;28(1):286. (In eng). DOI: 10.1186/s13054-024-05065-0.
22. Oglesby FC, Scholefield BR, Cook TM, et al. Peri-operative cardiac arrest in children as reported to the 7th National Audit Project of the Royal College of Anaesthetists. Anaesthesia 2024;79(6):583-592. (In eng). DOI: 10.1111/anae.16251.
23. Odetola FO, Gebremariam A. Epidemiology of Acute Respiratory Failure in US Children: Outcomes and Resource Use. Hosp Pediatr 2024;14(8):622-631. (In eng). DOI: 10.1542/hpeds.2023-007166.
24. Hammer J. Acute respiratory failure in children. Paediatr Respir Rev 2013;14(2):64-9. (In eng). DOI: 10.1016/j.prrv.2013.02.001.
25. Florin TA, Plint AC, Zorc JJ. Viral bronchiolitis. Lancet 2017;389(10065):211-224. (In eng). DOI: 10.1016/S0140-6736(16)30951-5.
26. Fleming S, Thompson M, Stevens R, et al. Normal ranges of heart rate and respiratory rate in children from birth to 18 years of age: a systematic review of observational studies. Lancet 2011;377(9770):1011-8. (In eng). DOI: 10.1016/S0140-6736(10)62226-X.
27. Bakker AM, Albrecht M, Verkaik BJ, et al. Sudden cardiac arrest in infants and children: proposal for a diagnostic workup to identify the etiology. An 18-year multicenter evaluation in the Netherlands. Eur J Pediatr 2024;183(1):335-344. (In eng). DOI: 10.1007/s00431-023-05301-9.
28. Somma V, Pflaumer A, Connell V, et al. Epidemiology of pediatric out-of-hospital cardiac arrest compared with adults. Heart Rhythm 2023;20(11):1525-1531. (In eng). DOI: 10.1016/j.hrthm.2023.06.010.
29. Ashine TM, Heliso AZ, Babore GO, et al. Incidence and Predictors of Cardiac Arrest Among Patients Admitted to the Intensive Care Units of a Comprehensive Specialized Hospital in Central Ethiopia. Patient Relat Outcome Meas 2024;15:31-43. (In eng). DOI: 10.2147/PROM.S452338.
30. Torisen TAG, Glanville JM, Loaiza AF, Bidonde J. Emergency pediatric patients and use of the pediatric assessment triangle tool (PAT): a scoping review. BMC Emerg Med 2024;24(1):158. (In eng). DOI: 10.1186/s12873-024-01068-w.
31. Bruinink LJ, Linders M, de Boode WP, Fluit C, Hogeveen M. The ABCDE approach in critically ill patients: A scoping review of assessment tools, adherence and reported outcomes. Resusc Plus 2024;20:100763. (In eng). DOI: 10.1016/j.resplu.2024.100763.
32. Leonard M, Graham S, Bonacum D. The human factor: the critical importance of effective teamwork and communication in providing safe care. Qual Saf Health Care 2004;13 Suppl 1(Suppl 1):i85-90. DOI: 10.1136/qhc.13.suppl_1.i85.
33. Al-Harbi S. Impact of Rapid Response Teams on Pediatric Care: An Interrupted Time Series Analysis of Unplanned PICU Admissions and Cardiac Arrests. Healthcare (Basel) 2024;12(5) (In eng). DOI: healthcare12050518 [pii]

healthcare-12-00518 [pii]

10.3390/healthcare12050518.

This is a DRAFT-version

34. McKeta AS, Hlavacek AM, Chowdhury SM, et al. Improved outcomes after implementation of a specialized pediatric cardiac rapid response team. Cardiol Young 2021;31(10):1582-1588. (In eng). DOI: S104795112100055X [pii]

10.1017/S104795112100055X.

35. Greif R, Bray JE, Djarv T, et al. 2024 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. Resuscitation 2024;205:110414. (In eng). DOI: 10.1016/j.resuscitation.2024.110414.

36. Nabecker S, Nation K, Gilfoyle E, et al. Cognitive aids used in simulated resuscitation: A systematic review. Resusc Plus 2024;19:100675. DOI: 10.1016/j.resplu.2024.100675.

37. Pan D, Foster M, Tagg A, Klim S, Kelly AM. How well does the Best Guess method predict children's weight in an emergency department in 2018-2019? Emerg Med Australas 2020;32(1):135-140. (In eng). DOI: 10.1111/1742-6723.13448.

38. Shieh A, Rogers AJ, Chen CM, Ramgopal S. Comparing the performance of pediatric weight estimation methods. Am J Emerg Med 2024;82:26-32. (In eng). DOI: 10.1016/j.ajem.2024.04.053.

39. Torpiano P, Torpiano K, Sammut F, Zahra J, Aquilina S, Grech V. Accuracy of Emergency Weight Estimation in Maltese School Children. Indian J Pediatr 2022;89(8):822. (In eng). DOI: 10.1007/s12098-022-04238-5.

40. Wells M, Goldstein L. The utility of pediatric age-based weight estimation formulas for emergency drug dose calculations in obese children. J Am Coll Emerg Physicians Open 2020;1(5):947-954. (In eng). DOI: 10.1002/emp2.12099.

41. Edelu BO, Iloh KK, Igbokwe OO, et al. Comparison of age-based weight estimation with actual measured weight in children aged one to twelve years in Enugu. Niger J Clin Pract 2020;23(9):1229-1236. (In eng). DOI: 10.4103/njcp.njcp_41_20.

42. Yakubu RC, Nguah SB, Ayi-Bisah N. Comparison of paediatric weight estimation methods at a tertiary hospital in Ghana. Afr J Emerg Med 2021;11(2):252-257. (In eng). DOI: 10.1016/j.afjem.2021.03.005.

43. Wells M, Goldstein LN. How and Why Paediatric Weight Estimation Systems Fail - A Body Composition Study. Cureus 2020;12(3):e7198. (In eng). DOI: 10.7759/cureus.7198.

44. Zhu S, Zhu J, Zhou H, et al. Validity of Broselow tape for estimating the weight of children in pediatric emergency: A cross-sectional study. Front Pediatr 2022;10:969016. (In eng). DOI: 10.3389/fped.2022.969016.

45. Silvagni D, Baggio L, Mazzi C, et al. The PAWPER tape as a tool for rapid weight assessment in a Paediatric Emergency Department: Validation study and comparison with parents' estimation and Broselow tape. Resusc Plus 2022;12:100301. (In eng). DOI: 10.1016/j.resplu.2022.100301.

46. Ibrahim NH, Kassim N, Othman S, et al. Validation study on a prediction formula to estimate the weight of children & adolescents with special needs aged 2-18 years old. J Health Popul Nutr 2023;42(1):129. (In eng). DOI: 10.1186/s41043-023-00464-5.

47. Cerqueira CT, Mello MJG, Viana LA, Macedo D, Figueiroa JN. Comparison of weight estimation methods in hospitalized Brazilian children and adolescents. Nutr Hosp 2020;37(2):243-250. (In eng). DOI: 10.20960/nh.02594.

48. Yakubu RC, Paintsil V, Nguah SB. Weight estimation in two groups of Ghanaian children with chronic diseases using Broselow, Mercy, PAWPER XL and PAWPER XL-MAC tapes. Afr J Emerg Med 2023;13(2):109-113. (In eng). DOI: 10.1016/j.afjem.2023.04.003.

This is a DRAFT-version

49. Choi S, Nah S, Kim S, Seong EO, Kim SH, Han S. A validation of newly developed weight estimating tape for Korean pediatric patients. PLoS One 2022;17(7):e0271109. (In eng). DOI: 10.1371/journal.pone.0271109.
50. Ong GJ, Dy E. Validation of two pediatric resuscitation tapes. J Am Coll Emerg Physicians Open 2020;1(6):1587-1593. (In eng). DOI: 10.1002/emp2.12255.
51. Cosmos Yakubu R, Ayi-Bisah N, Nguah SB. Accuracy of Weight Estimation in Children Using the Broselow, PAWPER XL, PAWPER XL-MAC, and Mercy Tapes. Pediatr Emerg Care 2022;38(9):e1517-e1522. (In eng). DOI: 10.1097/PEC.0000000000002638.
52. Wu MT, Wells M. Pediatric weight estimation: validation of the PAWPER XL tape and the PAWPER XL tape mid-arm circumference method in a South African hospital. Clin Exp Emerg Med 2020;7(4):290-301. (In eng). DOI: 10.15441/ceem.19.082.
53. McAlvin SS, Carew-Lyons A. Family presence during resuscitation and invasive procedures in pediatric critical care: a systematic review. Am J Crit Care 2014;23(6):477-84; quiz 485. (In eng). DOI: 10.4037/ajcc2014922.
54. Wool J, Irving SY, Meghani SH, Ulrich CM. Parental Decision-Making in the Pediatric Intensive Care Unit: An Integrative Review. J Fam Nurs 2021;27(2):154-167. (In eng). DOI: 10.1177/1074840720975869.
55. Abela KM, Wardell D, Rozmus C, LoBiondo-Wood G. Impact of Pediatric Critical Illness and Injury on Families: An Updated Systematic Review. J Pediatr Nurs 2020;51:21-31. (In eng). DOI: 10.1016/j.pedn.2019.10.013.
56. Graham HR, Jahan E, Subhi R, et al. The prevalence of hypoxaemia in paediatric and adult patients in health-care facilities in low-income and middle-income countries: a systematic review and meta-analysis. Lancet Glob Health 2025;13(2):e222-e231. (In eng). DOI: 10.1016/S2214-109X(24)00469-8.
57. Wilkes C, Bava M, Graham HR, Duke T. What are the risk factors for death among children with pneumonia in low- and middle-income countries? A systematic review. J Glob Health 2023;13:05003. (In eng). DOI: 10.7189/jogh.13.05003.
58. Enoch AJ, English M, Shepperd S. Does pulse oximeter use impact health outcomes? A systematic review. Arch Dis Child 2016;101(8):694-700. (In eng). DOI: 10.1136/archdischild-2015-309638.
59. Wilkes C, Graham H, Walker P, Duke T. Which children with chest-indrawing pneumonia can be safely treated at home, and under what conditions is it safe to do so? A systematic review of evidence from low- and middle-income countries. J Glob Health 2022;12:10008. (In eng). DOI: 10.7189/jogh.12.10008.
60. Graham HR, King C, Duke T, et al. Hypoxaemia and risk of death among children: rethinking oxygen saturation, risk-stratification, and the role of pulse oximetry in primary care. Lancet Glob Health 2024;12(8):e1359-e1364. (In eng). DOI: 10.1016/S2214-109X(24)00209-2.
61. Martin D, Johns C, Sorrell L, et al. Effect of skin tone on the accuracy of the estimation of arterial oxygen saturation by pulse oximetry: a systematic review. Br J Anaesth 2024;132(5):945-956. (In eng). DOI: 10.1016/j.bja.2024.01.023.
62. Howard MB, McCollum N, Alberto EC, et al. Association of Ventilation during Initial Trauma Resuscitation for Traumatic Brain Injury and Post-Traumatic Outcomes: A Systematic Review. Prehosp Disaster Med 2021;36(4):460-465. (In eng). DOI: 10.1017/S1049023X21000534.
63. McNeill MM, Hardy Tabet C. The Effectiveness of Capnography Versus Pulse Oximetry in Detecting Respiratory Adverse Events in the Postanesthesia Care Unit (PACU): A Narrative Review and Synthesis. J Perianesth Nurs 2022;37(2):264-269 e1. (In eng). DOI: 10.1016/j.jopan.2021.03.013.

This is a DRAFT version

64. Saunders R, Struys M, Pollock RF, Mestek M, Lightdale JR. Patient safety during procedural sedation using capnography monitoring: a systematic review and meta-analysis. BMJ Open 2017;7(6):e013402. (In eng). DOI: 10.1136/bmjopen-2016-013402.
65. Van de Voorde P, Turner NM, Djakow J, et al. European Resuscitation Council Guidelines 2021: Paediatric Life Support. Resuscitation 2021;161:327-387. (In eng). DOI: 10.1016/j.resuscitation.2021.02.015.
66. Gurlu R, Tolu Kendir O, Baspinar O, Erkek N. Can Non-Invasive Capnography and Integrated Pulmonary Index Contribute to Patient Monitoring in the Pediatric Emergency Department? Klin Padiatr 2022;234(1):26-32. (In eng). DOI: 10.1055/a-1546-1473.
67. Duyu M, Bektas AD, Karakaya Z, et al. Comparing the novel microstream and the traditional mainstream method of end-tidal CO(2) monitoring with respect to PaCO(2) as gold standard in intubated critically ill children. Sci Rep 2020;10(1):22042. (In eng). DOI: 10.1038/s41598-020-79054-y.
68. Williams E, Bednarczuk N, Dassios T, Greenough A. Factors affecting the arterial to end-tidal carbon dioxide gradient in ventilated neonates. Physiol Meas 2022;43(2) (In eng). DOI: 10.1088/1361-6579/ac57ca.
69. Fuerch JH, Thio M, Halamek LP, Liley HG, Wyckoff MH, Rabi Y. Respiratory function monitoring during neonatal resuscitation: A systematic review. Resusc Plus 2022;12:100327. (In eng). DOI: 10.1016/j.resplu.2022.100327.
70. Hughes-Davies H, Ukwatte U, Fanshawe TR, et al. Diagnostic accuracy of point-of-care lung ultrasound for community-acquired pneumonia in children in ambulatory settings: A systematic review and meta-analysis. Ultrasound 2024:1742271X241289726. (In eng). DOI: 10.1177/1742271X241289726.
71. Sartini S, Ferrari L, Cutuli O, et al. The Role of Pocus in Acute Respiratory Failure: A Narrative Review on Airway and Breathing Assessment. J Clin Med 2024;13(3) (In eng). DOI: 10.3390/jcm13030750.
72. Ord HL, Griksaitis MJ. Fifteen-minute consultation: Using point of care ultrasound to assess children with respiratory failure. Arch Dis Child Educ Pract Ed 2019;104(1):2-10. (In eng). DOI: 10.1136/archdischild-2017-313795.
73. Giorno EPC, Foronda FK, De Paulis M, et al. Point-of-care lung ultrasound score for predicting escalated care in children with respiratory distress. Am J Emerg Med 2023;68:112-118. (In eng). DOI: 10.1016/j.ajem.2023.02.035.
74. de Boode WP. Clinical monitoring of systemic hemodynamics in critically ill newborns. Early Hum Dev 2010;86(3):137-41. (In eng). DOI: 10.1016/j.earlhumdev.2010.01.031.
75. Assies R, Snik I, Kumwenda M, et al. Etiology, Pathophysiology and Mortality of Shock in Children in Low (Middle) Income Countries: A Systematic Review. J Trop Pediatr 2022;68(4) (In eng). DOI: 10.1093/tropej/fmac053.
76. Dionne JM, Bremner SA, Baygani SK, et al. Method of Blood Pressure Measurement in Neonates and Infants: A Systematic Review and Analysis. J Pediatr 2020;221:23-31 e5. (In eng). DOI: 10.1016/j.jpeds.2020.02.072.
77. Araujo-Moura K, Souza LG, Mello GL, De Moraes ACF. Blood pressure measurement in pediatric population: comparison between automated oscillometric devices and mercury sphygmomanometers-a systematic review and meta-analysis. Eur J Pediatr 2022;181(1):9-22. (In eng). DOI: 10.1007/s00431-021-04171-3.
78. Rahsepar S, Sanie Jahromi MS, Abiri S, et al. Point-of-Care Tests' Role in Time Metrics of Urgent Interventions in Emergency Department; a Systematic Review of Literature. Arch Acad Emerg Med 2022;10(1):e82. (In eng). DOI: 10.22037/aaem.v10i1.1817.
79. Kolodziej M, Jalali A, Lukasik J. Point-of-care ultrasound to assess degree of dehydration in children: a systematic review with meta-analysis. Arch Dis Child 2024;109(4):275-281. (In eng). DOI: 10.1136/archdischild-2023-325403.

This is a DRAFT-version

80. Akkaya B, Inan C, Unlu, II, et al. A silent scream in the pediatric emergency department: child abuse and neglect. Eur J Pediatr 2024;183(7):2905-2912. (In eng). DOI: 10.1007/s00431-024-05526-2.
81. Woodman J, Lecky F, Hodes D, Pitt M, Taylor B, Gilbert R. Screening injured children for physical abuse or neglect in emergency departments: a systematic review. Child Care Health Dev 2010;36(2):153-64. (In eng). DOI: 10.1111/j.1365-2214.2009.01025.x.
82. Luo Z, Chen Y, Epstein RA. Risk factors for child abuse and neglect: Systematic review and meta-analysis. Public Health 2025;241:89-98. (In eng). DOI: 10.1016/j.puhe.2025.01.028.
83. Weihing VK, Crowe EH, Wang HE, Ugalde IT. Prehospital airway management in the pediatric patient: A systematic review. Acad Emerg Med 2022;29(6):765-771. (In eng). DOI: 10.1111/acem.14410.
84. Jarvis JL, Panchal AR, Lyng JW, et al. Evidence-Based Guideline for Prehospital Airway Management. Prehosp Emerg Care 2024;28(4):545-557. (In eng). DOI: 10.1080/10903127.2023.2281363.
85. Katzenschlager S, Mohr S, Kaltschmidt N, et al. Laryngeal mask vs. laryngeal tube trial in paediatric patients (LaMaTuPe): a single-blinded, open-label, randomised-controlled trial. Eur J Emerg Med 2025;32(2):123-130. (In eng). DOI: 10.1097/MEJ.0000000000001178.
86. Solan T, Cudini D, Humar M, et al. Characteristics of paediatric pre-hospital intubation by Intensive Care Paramedics. Emerg Med Australas 2023;35(5):754-758. (In eng). DOI: 10.1111/1742-6723.14207.
87. Morton S, Keane S, O'Meara M. Pediatric Intubations in a Semiurban Helicopter Emergency Medicine Service: A Retrospective Review. Air Med J 2024;43(2):106-110. (In eng). DOI: 10.1016/j.amj.2023.10.007.
88. Renberg M, Hertzberg D, Kornhall D, Gunther M, Gellerfors M. Pediatric Prehospital Advanced Airway Management by Anesthesiologist and Nurse Anesthetist Staffed Critical Care Teams. Prehosp Disaster Med 2021;36(5):547-552. (In eng). DOI: 10.1017/S1049023X21000637.
89. Ramgopal S, Button SE, Owusu-Ansah S, et al. Success of Pediatric Intubations Performed by a Critical Care Transport Service. Prehosp Emerg Care 2020;24(5):683-692. (In eng). DOI: 10.1080/10903127.2019.1699212.
90. Hanlin ER, Chan HK, Covert H, et al. The Epidemiology of Out-of-Hospital Pediatric Airway Management in the 2019 ESO Data Collaborative. Prehosp Emerg Care 2024:1-6. (In eng). DOI: 10.1080/10903127.2024.2383967.
91. Shou D, Levy M, Troncoso R, Scharf B, Margolis A, Garfinkel E. Perceived Versus Actual Time of Prehospital Intubation by Paramedics. West J Emerg Med 2024;25(4):645-650. (In eng). DOI: 10.5811/westjem.18400.
92. Disma N, Asai T, Cools E, et al. Airway management in neonates and infants: European Society of Anaesthesiology and Intensive Care and British Journal of Anaesthesia joint guidelines. Eur J Anaesthesiol 2024;41(1):3-23. (In eng). DOI: 10.1097/EJA.0000000000001928.
93. Jones P. The therapeutic value of atropine for critical care intubation. Arch Dis Child 2016;101(1):77-80. (In eng). DOI: 10.1136/archdischild-2014-308137.
94. Bisesi SA, Stauber SD, Hutchinson DJ, Acquisto NM. Current Practices and Safety of Medication Use During Pediatric Rapid Sequence Intubation. J Pediatr Pharmacol Ther 2024;29(1):66-75. (In eng). DOI: 10.5863/1551-6776-29.1.66.
95. Kovacich NJ, Nelson AC, McCormick T, Kaucher KA. Incidence of Bradycardia and the Use of Atropine in Pediatric Rapid Sequence Intubation in the Emergency Department. Pediatr Emerg Care 2022;38(2):e540-e543. (In eng). DOI: 10.1097/PEC.0000000000002382.
96. de Carvalho CC, Regueira S, Souza ABS, et al. Videolaryngoscopes versus direct laryngoscopes in children: Ranking systematic review with network meta-analyses of

This is a DRAFT version

randomized clinical trials. Paediatr Anaesth 2022;32(9):1000-1014. (In eng). DOI: 10.1111/pan.14521.

97. Thomas RE, Erickson S, Hullett B, et al. Comparison of the efficacy and safety of cuffed versus uncuffed endotracheal tubes for infants in the intensive care setting: a pilot, unblinded RCT. Arch Dis Child Fetal Neonatal Ed 2021;106(6):614-620. (In eng). DOI: 10.1136/archdischild-2020-320764.

98. Sarhan K, Walaa R, Hasanin A, et al. Cuffed versus uncuffed endotracheal tubes in neonates undergoing noncardiac surgeries: A randomized controlled trial. Paediatr Anaesth 2024;34(10):1045-1052. (In eng). DOI: 10.1111/pan.14953.

99. Manimalethu R, Krishna S, Shafy SZ, Hakim M, Tobias JD. Choosing endotracheal tube size in children: Which formula is best? Int J Pediatr Otorhinolaryngol 2020;134:110016. (In eng). DOI: 10.1016/j.ijporl.2020.110016.

100. Duracher C, Schmautz E, Martinon C, Faivre J, Carli P, Orliaguet G. Evaluation of cuffed tracheal tube size predicted using the Khine formula in children. Paediatr Anaesth 2008;18(2):113-8. (In eng). DOI: 10.1111/j.1460-9592.2007.02382.x.

101. Borkar N, Sharma C, Francis J, Kumar M, Singha SK, Shukla A. Applicability of the Broselow Pediatric Emergency Tape to Predict the Size of Endotracheal Tube and Laryngeal Mask Airway in Pediatric Patients Undergoing Surgery: A Retrospective Analysis. Cureus 2023;15(1):e33327. (In eng). DOI: 10.7759/cureus.33327.

102. Pukar K, C., Jha A, Ghimire K, Shrestha R, Shrestha AP. Accuracy of Broselow tape in estimating the weight of the child for management of pediatric emergencies in Nepalese population. Int J Emerg Med 2020;13(1):9. (In eng). DOI: 10.1186/s12245-020-0269-0.

103. Simons T, Soderlund T, Handolin L. Radiological evaluation of tube depth and complications of prehospital endotracheal intubation in pediatric trauma: a descriptive study. Eur J Trauma Emerg Surg 2017;43(6):797-804. (In eng). DOI: 10.1007/s00068-016-0758-2.

104. Apfelbaum JL, Hagberg CA, Connis RT, et al. 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology 2022;136(1):31-81. DOI: 10.1097/ALN.0000000000004002.

105. Cook TM, Woodall N, Frerk C, Fourth National Audit P. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. Br J Anaesth 2011;106(5):617-31. DOI: 10.1093/bja/aer058.

106. Black AE, Flynn PE, Smith HL, et al. Development of a guideline for the management of the unanticipated difficult airway in pediatric practice. Paediatr Anaesth 2015;25(4):346-62. DOI: 10.1111/pan.12615.

107. McGrath BA, Bates L, Atkinson D, Moore JA. Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. Anaesthesia 2012;67(9):1025-41. (In eng). DOI: 10.1111/j.1365-2044.2012.07217.x.

108. Ross E, Stephenson K. Fifteen-minute consultation: Emergency management of tracheostomy problems in children. Arch Dis Child Educ Pract Ed 2019;104(4):189-194. (In eng). DOI: 10.1136/archdischild-2018-316099.

109. Lam F, Stegmuller A, Chou VB, Graham HR. Oxygen systems strengthening as an intervention to prevent childhood deaths due to pneumonia in low-resource settings: systematic review, meta-analysis and cost-effectiveness. BMJ Glob Health 2021;6(12) (In eng). DOI: 10.1136/bmjgh-2021-007468.

110. Peters MJ, Gould DW, Ray S, et al. Conservative versus liberal oxygenation targets in critically ill children (Oxy-PICU): a UK multicentre, open, parallel-group, randomised clinical trial. Lancet 2024;403(10424):355-364. DOI: 10.1016/S0140-6736(23)01968-2.

This is a DRAFT - version

111. Dopper A, Steele M, Bogossian F, Hough JANCDCpA. High flow nasal cannula for respiratory support in term infants. Cochrane Database of Systematic Reviews 2023. (https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD011010.pub2/full).

112. Boghi D, Kim KW, Kim JH, et al. Noninvasive Ventilation for Acute Respiratory Failure in Pediatric Patients: A Systematic Review and Meta-Analysis. Pediatr Crit Care Med 2023;24(2):123-132. (In eng). DOI: 00130478-202302000-00006 [pii] 10.1097/PCC.0000000000003109.

113. Carroll CL, Napolitano N, Pons-Odena M, Iyer NP, Korang SK, Essouri S. Noninvasive Respiratory Support for Pediatric Acute Respiratory Distress Syndrome: From the Second Pediatric Acute Lung Injury Consensus Conference. Pediatr Crit Care Med 2023;24(12 Suppl 2):S135-S147. (In eng). DOI: 00130478-202302001-00011 [pii] 10.1097/PCC.0000000000003165.

114. Armarego M, Forde H, Wills K, Beggs SA. High-flow nasal cannula therapy for infants with bronchiolitis. Cochrane Database of Systematic Reviews 2024.

115. Ray-Barruel G, Pather P, Schults JA, Rickard CM. Handheld Ultrasound Devices for Peripheral Intravenous Cannulation: A Scoping Review. J Infus Nurs 2024;47(2):75-95. (In eng). DOI: 10.1097/NAN.0000000000000540.

116. Hoskins M, Sefick S, Zurca AD, Walter V, Thomas NJ, Krawiec C. Current utilization of interosseous access in pediatrics: a population-based analysis using an EHR database, TriNetX. Int J Emerg Med 2022;15(1):65. (In eng). DOI: 10.1186/s12245-022-00467-9.

117. Pfeiffer D, Olivieri M, Brenner S, Gomes D, Lieftuchter V, Hoffmann F. Factors influencing the success and complications of intraosseous access in pediatric patients-a prospective nationwide surveillance study in Germany. Front Pediatr 2023;11:1294322. (In eng). DOI: 10.3389/fped.2023.1294322.

118. Garabon JJW, Gunz AC, Ali A, Lim R. EMS Use and Success Rates of Intraosseous Infusion for Pediatric Resuscitations: A Large Regional Health System Experience. Prehosp Emerg Care 2023;27(2):221-226. (In eng). DOI: 10.1080/10903127.2022.2072553.

119. Lehr AR, Rached-d'Astous S, Barrowman N, et al. Balanced Versus Unbalanced Fluid in Critically Ill Children: Systematic Review and Meta-Analysis. Pediatr Crit Care Med 2022;23(3):181-191. (In eng). DOI: 10.1097/PCC.0000000000002890.

120. Ranjit S, Natraj R, Kissoon N, Thiagarajan RR, Ramakrishnan B, Monge Garcia MI. Variability in the Hemodynamic Response to Fluid Bolus in Pediatric Septic Shock. Pediatr Crit Care Med 2021;22(8):e448-e458. (In eng). DOI: 10.1097/PCC.0000000000002714.

121. Wu YS, Gennell T, Porigow C, et al. Fluid Management in Critically Ill Children: Single-Center Retrospective Comparison of Trauma and Postoperative Patients, 2020-2022. Pediatr Crit Care Med 2024;25(11):e429-e437. (In eng). DOI: 10.1097/PCC.0000000000003590.

122. Harley A, George S, Phillips N, et al. Resuscitation With Early Adrenaline Infusion for Children With Septic Shock: A Randomized Pilot Trial. Pediatr Crit Care Med 2024;25(2):106-117. (In eng). DOI: 10.1097/PCC.0000000000003351.

123. Iramain R, Ortiz J, Jara A, et al. Fluid Resuscitation and Inotropic Support in Patients With Septic Shock Treated in Pediatric Emergency Department: An Open-Label Trial. Cureus 2022;14(10):e30029. (In eng). DOI: 10.7759/cureus.30029.

124. Marchetto L, Zanetto L, Comoretto RI, et al. Outcomes of Pediatric Fluid-Refractory Septic Shock According to Different Vasoactive Strategies: A Systematic Review and Meta-Analysis. Shock 2024;62(5):599-611. (In eng). DOI: 10.1097/SHK.0000000000002427.

125. Banothu KK, Sankar J, Kumar UV, et al. A Randomized Controlled Trial of Norepinephrine Plus Dobutamine Versus Epinephrine As First-Line Vasoactive Agents in Children With Fluid Refractory Cold Septic Shock. Crit Care Explor 2023;5(1):e0815. (In eng). DOI: 10.1097/CCE.0000000000000815.

This is a DRAFT-version

126. Tran QK, Mester G, Bzhilyanskaya V, et al. Complication of vasopressor infusion through peripheral venous catheter: A systematic review and meta-analysis. Am J Emerg Med 2020;38(11):2434-2443. (In eng). DOI: 10.1016/j.ajem.2020.09.047.
127. Kohn-Loncarica G, Hualde G, Fustinana A, et al. Use of Inotropics by Peripheral Vascular Line in the First Hour of Treatment of Pediatric Septic Shock: Experience at an Emergency Department. Pediatr Emerg Care 2022;38(1):e371-e377. (In eng). DOI: 10.1097/PEC.0000000000002295.
128. Yeong YQ, Chan JMF, Chan JKY, Huang HL, Ong GY. Safety and outcomes of short-term use of peripheral vasoactive infusions in critically ill paediatric population in the emergency department. Sci Rep 2022;12(1):16340. (In eng). DOI: 10.1038/s41598-022-20510-2.
129. Levy RA, Reiter PD, Spear M, et al. Peripheral Vasoactive Administration in Critically Ill Children With Shock: A Single-Center Retrospective Cohort Study. Pediatr Crit Care Med 2022;23(8):618-625. (In eng). DOI: 10.1097/PCC.0000000000002970.
130. Charbel RC, Ollier V, Julliand S, et al. Safety of early norepinephrine infusion through peripheral vascular access during transport of critically ill children. J Am Coll Emerg Physicians Open 2021;2(2):e12395. (In eng). DOI: 10.1002/emp2.12395.
131. Matsushita FY, Krebs VLJ, de Campos CV, de Vincenzi Gaiolla PV, de Carvalho WB. Reassessing the role of milrinone in the treatment of heart failure and pulmonary hypertension in neonates and children: a systematic review and meta-analysis. Eur J Pediatr 2024;183(2):543-555. (In eng). DOI: 10.1007/s00431-023-05342-0.
132. Silvetti S, Belletti A, Bianzina S, Momeni M. Effect of Levosimendan Treatment in Pediatric Patients With Cardiac Dysfunction: An Update of a Systematic Review and Meta-Analysis of Randomized Controlled Trials. J Cardiothorac Vasc Anesth 2022;36(3):657-664. (In eng). DOI: 10.1053/j.jvca.2021.09.018.
133. Lapere M, Rega F, Rex S. Levosimendan in paediatric cardiac anaesthesiology: A systematic review and meta-analysis. Eur J Anaesthesiol 2022;39(8):646-655. (In eng). DOI: 10.1097/EJA.0000000000001711.
134. Nicholls G, Eaton G, Ortega M, et al. improving Pain mAnagement for childreN and young people attendeD by Ambulance (PANDA): protocol for a realist review. NIHR Open Res 2024;4:42. (In eng). DOI: 10.3310/nihropenres.13627.2.
135. Philpott NG, Dante SA, Philpott D, et al. Treatment Guideline Nonadherence Pretransport Associated With Need for Higher Level of Care in Children Transferred to a Pediatric Tertiary Care Center for Status Epilepticus. Pediatr Emerg Care 2023;39(10):780-785. (In eng). DOI: 10.1097/PEC.0000000000002952.
136. Kenyon N, Zeki AA, Albertson TE, Louie S. Definition of critical asthma syndromes. Clin Rev Allergy Immunol 2015;48(1):1-6. (In eng). DOI: 10.1007/s12016-013-8395-6.
137. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention. Updated May 2024. Available from: www.ginasthma.org. (www.ginasthma.org).
138. Craig SS, Dalziel SR, Powell CVE, Graudins A, Babl FE, Lunny C. Interventions for acute severe asthma attacks in children: an overview of Cochrane Reviews. . (https://www.cochrane.org/CD012977/AIRWAYS_interventions-acute-severe-asthma-attacks-children-overview-cochrane-reviews).
139. Chavasse R, Scott S. The Differences in Acute Management of Asthma in Adults and Children. Front Pediatr 2019;7:64. DOI: 10.3389/fped.2019.00064.
140. Weiss SL, Peters MJ, Alhazzani W, et al. Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children. Pediatr Crit Care Med 2020;21(2):e52-e106. (In eng). DOI: 10.1097/PCC.0000000000002198.
141. Pitre T, Drover K, Chaudhuri D, et al. Corticosteroids in Sepsis and Septic Shock: A Systematic Review, Pairwise, and Dose-Response Meta-Analysis. Crit Care Explor 2024;6(1):e1000. (In eng). DOI: 10.1097/CCE.0000000000001000.

This is a DRAFT version

142. Chaudhuri D, Nei AM, Rochwerg B, et al. 2024 Focused Update: Guidelines on Use of Corticosteroids in Sepsis, Acute Respiratory Distress Syndrome, and Community-Acquired Pneumonia. Crit Care Med 2024;52(5):e219-e233. (In eng). DOI: 10.1097/CCM.0000000000006172.
143. Brissaud O, Botte A, Cambonie G, et al. Experts' recommendations for the management of cardiogenic shock in children. Ann Intensive Care 2016;6(1):14. DOI: 10.1186/s13613-016-0111-2.
144. Suttipongkaset P, Chaikittisilpa N, Vavilala MS, et al. Blood Pressure Thresholds and Mortality in Pediatric Traumatic Brain Injury. Pediatrics 2018;142(2) (In eng). DOI: 10.1542/peds.2018-0594.
145. Spinella PC, Leonard JC, Gaines BA, et al. Use of Antifibrinolytics in Pediatric Life-Threatening Hemorrhage: A Prospective Observational Multicenter Study. Crit Care Med 2022;50(4):e382-e392. (In eng). DOI: 10.1097/CCM.0000000000005383.
146. Kornelsen E, Kuppermann N, Nishijima DK, et al. Effectiveness and safety of tranexamic acid in pediatric trauma: A systematic review and meta-analysis. Am J Emerg Med 2022;55:103-110. (In eng). DOI: 10.1016/j.ajem.2022.01.069.
147. Ross CE, Moskowitz A, Grossestreuer AV, et al. Trends over time in drug administration during pediatric in-hospital cardiac arrest in the United States. Resuscitation 2021;158:243-252. (In eng). DOI: 10.1016/j.resuscitation.2020.09.040.
148. Hanna A, Crowe RP, Fishe JN. Pediatric Bradycardia Is Undertreated in the Prehospital Setting: A Retrospective Multi-Agency Analysis. Prehosp Emerg Care 2023;27(1):101-106. (In eng). DOI: 10.1080/10903127.2021.2018075.
149. Topjian A, Scholefield B, Gray J, et al. Bradycardia with haemodynamic compromise – a scoping review: Consensus on Science with Treatment Recommendations on behalf of Paediatric Life Support Task Force. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/bradycardia-with-haemodynamic-compromise-in-children-pls-4030-30-tf-scr).
150. Brugada J, Blom N, Sarquella-Brugada G, et al. Pharmacological and non-pharmacological therapy for arrhythmias in the pediatric population: EHRA and AEPC-Arrhythmia Working Group joint consensus statement. Europace 2013;15(9):1337-82. (In eng). DOI: 10.1093/europace/eut082.
151. Brugada J, Katritsis DG, Arbelo E, et al. 2019 ESC Guidelines for the management of patients with supraventricular tachycardiaThe Task Force for the management of patients with supraventricular tachycardia of the European Society of Cardiology (ESC). Eur Heart J 2020;41(5):655-720. (In eng). DOI: 10.1093/eurheartj/ehz467.
152. Oeffl N, Krainer M, Kurath-Koller S, et al. Cardiac Arrhythmias Requiring Electric Countershock during the Neonatal Period-A Systematic Review. Children (Basel) 2023;10(5) (In eng). DOI: 10.3390/children10050838.
153. Randall MM, Burt T, Cruise S, Mesisca MK, Minahan T. Safety of adenosine for pediatric tachyarrhythmia treatment in the emergency department: a multi-hospital 10-year cross-sectional study. Int J Emerg Med 2024;17(1):103. (In eng). DOI: 10.1186/s12245-024-00683-5.
154. Wei N, Lamba A, Franciosi S, et al. Medical Management of Infants With Supraventricular Tachycardia: Results From a Registry and Review of the Literature. CJC Pediatr Congenit Heart Dis 2022;1(1):11-22. (In eng). DOI: 10.1016/j.cjcpc.2021.09.001.
155. Batra AS, Silka MJ, Borquez A, et al. Pharmacological Management of Cardiac Arrhythmias in the Fetal and Neonatal Periods: A Scientific Statement From the American Heart Association: Endorsed by the Pediatric & Congenital Electrophysiology Society (PACES). Circulation 2024;149(10):e937-e952. (In eng). DOI: 10.1161/CIR.0000000000001206.

This is a DRAFT version

156. Arvind B, Kothari SS, Juneja R, et al. Ivabradine Versus Amiodarone in the Management of Postoperative Junctional Ectopic Tachycardia: A Randomized, Open-Label, Noninferiority Study. JACC Clin Electrophysiol 2021;7(8):1052-1060. (In eng). DOI: 10.1016/j.jacep.2021.01.020.
157. Younis NK, Abi-Saleh B, Al Amin F, et al. Ivabradine: A Potential Therapeutic for Children With Refractory SVT. Front Cardiovasc Med 2021;8:660855. (In eng). DOI: 10.3389/fcvm.2021.660855.
158. Sagawa K, Suzuki T, Takei K, et al. Control of Heart Rate in Infant and Child Tachyarrhythmia With Reduced Cardiac Function Using Landiolol (HEARTFUL) - Results of a Prospective, Multicenter, Uncontrolled Clinical Study. Circ J 2022;87(1):130-138. (In eng). DOI: 10.1253/circj.CJ-21-0967.
159. Malloy-Walton LE, Von Bergen NH, Balaji S, et al. IV Sotalol Use in Pediatric and Congenital Heart Patients: A Multicenter Registry Study. J Am Heart Assoc 2022;11(9):e024375. (In eng). DOI: 10.1161/JAHA.121.024375.
160. McTague A, Martland T, Appleton R. Drug management for acute tonic-clonic convulsions including convulsive status epilepticus in children. Cochrane Database Syst Rev 2018;1(1):CD001905. DOI: 10.1002/14651858.CD001905.pub3.
161. Hasan SU, Pervez A, Bhatty S, Shamim S, Naeem A, Naseeb MW. Termination of seizures in the paediatric age group, best benzodiazepine and route of administration: A network meta-analysis. Eur J Neurosci 2022;56(3):4234-4245. (In eng). DOI: 10.1111/ejn.15732.
162. Klowak JA, Hewitt M, Catenacci V, et al. Levetiracetam Versus Phenytoin or Fosphenytoin for Second-Line Treatment of Pediatric Status Epilepticus: A Meta-Analysis. Pediatr Crit Care Med 2021;22(9):e480-e491. (In eng). DOI: 10.1097/PCC.0000000000002703.
163. Abdelgadir I, Hamud A, Kadri A, et al. Levetiracetam for convulsive status epilepticus in childhood: systematic review and meta-analysis. Arch Dis Child 2021;106(5):470-476. (In eng). DOI: 10.1136/archdischild-2020-319573.
164. AlMulihi QA, AlMuhanna FA, AlMuhanna MA, AlSultan EA. Comparison of Safety and Effectiveness between Levetiracetam and Phenytoin in the Treatment of Pediatric Status Epilepticus: A Meta- Analysis. CNS Neurol Disord Drug Targets 2023;22(5):745-751. (In eng). DOI: 10.2174/1568007X04666220509215121.
165. Xue T, Wei L, Shen X, Wang Z, Chen Z. Levetiracetam versus Phenytoin for the Pharmacotherapy of Benzodiazepine-Refractory Status Epilepticus: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. CNS Drugs 2020;34(12):1205-1215. (In eng). DOI: 10.1007/s40263-020-00770-0.
166. Kim SY, Lee SY, Kim TH, Shin SD, Song KJ, Park JH. Location of out-of-hospital cardiac arrest and the awareness time interval: a nationwide observational study. Emerg Med J 2022;39(2):118-123. (In eng). DOI: 10.1136/emermed-2020-209903.
167. Goto Y, Funada A, Maeda T. Dispatcher-assisted conventional cardiopulmonary resuscitation and outcomes for paediatric out-of-hospital cardiac arrests. Resuscitation 2022;172:106-114. (In eng). DOI: 10.1016/j.resuscitation.2021.10.003.
168. Wyckoff MH, Greif R, Morley PT, et al. 2022 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. Resuscitation 2022;181:208-288. (In eng). DOI: 10.1016/j.resuscitation.2022.10.005.
169. Naim MY, Griffis HM, Berg RA, et al. Compression-Only Versus Rescue-Breathing Cardiopulmonary Resuscitation After Pediatric Out-of-Hospital Cardiac Arrest. J Am Coll Cardiol 2021;78(10):1042-1052. (In eng). DOI: 10.1016/j.jacc.2021.06.042.

This is a DRAFT version

170. Iwami T, Scapigliati A, Matsuyama T, et al. Willingness to perform bystander-CPR Scoping Review and Task Force Insights International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/willingness-to-perform-bystander-cpr-eit-626-scoping-review).

171. Lee YJ, Song KJ, Shin SD, et al. Dispatcher-Assisted Cardiopulmonary Resuscitation Program and Outcomes After Pediatric Out-of-Hospital Cardiac Arrest. Pediatr Emerg Care 2019;35(8):561-567. (In eng). DOI: 10.1097/PEC.0000000000001365.

172. Kim TH, Jung JH, Song KJ, Hong KJ, Jeong J, Lee SGW. Association between patient age and pediatric cardiac arrest recognition by emergency medical dispatchers. Am J Emerg Med 2022;58:275-280. (In eng). DOI: 10.1016/j.ajem.2022.05.038.

173. Olasveengen TM, Semeraro F, Ristagno G, et al. European Resuscitation Council Guidelines 2021: Basic Life Support. Resuscitation 2021;161:98-114. (In eng). DOI: 10.1016/j.resuscitation.2021.02.009.

174. Skrisovska T, Djakow J, Jabandziev P, et al. Ventilation efficacy during paediatric cardiopulmonary resuscitation (PEDIVENT): simulation-based comparative study. Front Med (Lausanne) 2024;11:1400948. (In eng). DOI: 10.3389/fmed.2024.1400948.

175. Dainty KN, Debaty G, Vaillancourt C, et al. Interventions used with Dispatcher-assisted CPR: A scoping review. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/optimization-of-dispatcher-assisted-cpr-instructions-a-scoping-review-bls-2113-scr).

176. Pan DF, Li ZJ, Ji XZ, Yang LT, Liang PF. Video-assisted bystander cardiopulmonary resuscitation improves the quality of chest compressions during simulated cardiac arrests: A systemic review and meta-analysis. World J Clin Cases 2022;10(31):11442-11453. (In eng). DOI: 10.12998/wjcc.v10.i31.11442.

177. Katzenschlager S, Scholefield B, de Caen A, Acworth J, Force. obotILCoRPLST. Pulse check accuracy in pediatrics during resuscitation – Pediatric Consensus on Science with Treatment Recommendations. (https://costr.ilcor.org/document/pulse-check-accuracy-in-pediatrics-during-resuscitation-pls-4080-18-tf-sr).

178. Bray J, Dassanayake V, Considine J, et al. Starting CPR (ABC vs. CAB) for Cardiac Arrest in Adults and Children Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/starting-cpr-abc-vs-cab-pls-4070-02-tf-sr).

179. Geerts A, Herbelet S, Borremans G, Coppens M, Christiaens-Leysen E, Van de Voorde P. Five vs. two initial rescue breaths during infant basic life support: A manikin study using bag-mask-ventilation. Front Pediatr 2022;10:1067971. (In eng). DOI: 10.3389/fped.2022.1067971.

180. Martinez-Isasi S, Jorge-Soto C, Castro-Fernandez C, et al. Pediatric Ventilation Skills by Non-Healthcare Students: Effectiveness, Self-Perception, and Preference. Int J Environ Res Public Health 2023;20(4) (In eng). DOI: 10.3390/ijerph20043026.

181. Santos-Folgar M, Lafuente-Filgueira P, Otero-Agra M, et al. Quality of Ventilations during Infant Resuscitation: A Simulation Study Comparing Endotracheal Tube with Face Mask. Children (Basel) 2022;9(11) (In eng). DOI: 10.3390/children9111757.

182. Michel J, Hofbeck M, Neunhoeffer F, Muller M, Heimberg E. Evaluation of a Multimodal Resuscitation Program and Comparison of Mouth-to-Mouth and Bag-Mask Ventilation by Relatives of Children With Chronic Diseases. Pediatr Crit Care Med 2020;21(2):e114-e120. (In eng). DOI: 10.1097/PCC.0000000000002204.

183. Nehme Z, R. C, Dicker B, et al. Chest compression-to-ventilation ratios for cardiopulmonary resuscitation: A systematic review Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR).

This is a DRAFT version

(https://costr.ilcor.org/document/chest-compression-to-ventilation-ratios-for-cardiopulmonary-resuscitation-bls-2202-tf-sr).

184. Manrique G, Gonzalez A, Iguiniz M, et al. Quality of chest compressions during pediatric resuscitation with 15:2 and 30:2 compressions-to-ventilation ratio in a simulated scenario. Sci Rep 2020;10(1):6828. (In eng). DOI: 10.1038/s41598-020-63921-9.

185. Olasveengen T, Semeraro F, Bray J, et al. Minimizing pauses in chest compressions Consensus on Science with Treatment Recommendations (https://costr.ilcor.org/document/bls-358-minimizing-pauses).

186. Chen CY, Che-Hung Tsai J, Weng SJ, Chen YJ. An innovative Hearing AED alarm system shortens delivery time of automated external defibrillator - A randomized controlled simulation study. Resusc Plus 2024;20:100781. (In eng). DOI: 10.1016/j.resplu.2024.100781.

187. Atkins D, Acworth J, Chung SP, Reis A, Van de Voorde P. Application of Automated External Defibrillators in Infants, Children and Adolescents in Cardiac Arrest Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR) Pediatric and Basic Life Support Task Forces. (https://costr.ilcor.org/document/inclusion-of-infants-children-and-adolescents-in-public-access-defibrillation-programs).

188. Griffis H, Wu L, Naim MY, et al. Characteristics and outcomes of AED use in pediatric cardiac arrest in public settings: The influence of neighborhood characteristics. Resuscitation 2020;146:126-131. (In eng). DOI: 10.1016/j.resuscitation.2019.09.038.

189. Kim M, Yu J, Chang H, et al. National Surveillance of Pediatric Out-of-Hospital Cardiac Arrest in Korea: The 10-Year Trend From 2009 to 2018. J Korean Med Sci 2022;37(44):e317. (In eng). DOI: 10.3346/jkms.2022.37.e317.

190. Tejman-Yarden S, Katz U, Rubinstein M, et al. Inappropriate Shocks and Power Delivery Using Adult Automatic External Defibrillator Pads in a Pediatric Patient. Pediatr Emerg Care 2021;37(12):e1708-e1710. (In eng). DOI: 10.1097/PEC.0000000000001074.

191. Rossano JW, Jones WE, Lerakis S, et al. The Use of Automated External Defibrillators in Infants: A Report From the American Red Cross Scientific Advisory Council. Pediatr Emerg Care 2015;31(7):526-30. (In eng). DOI: 10.1097/PEC.0000000000000490.

192. Douma MJ, Handley AJ, MacKenzie E, et al. The recovery position for maintenance of adequate ventilation and the prevention of cardiac arrest: A systematic review. Resusc Plus 2022;10:100236. (In eng). DOI: 10.1016/j.resplu.2022.100236.

193. Navarro-Paton R, Freire-Tellado M, Fernandez-Gonzalez N, Basanta-Camino S, Mateos-Lorenzo J, Lago-Ballesteros J. What is the best position to place and re-evaluate an unconscious but normally breathing victim? A randomised controlled human simulation trial on children. Resuscitation 2019;134:104-109. (In eng). DOI: 10.1016/j.resuscitation.2018.10.030.

194. Paal P, Niederklapfer T, Keller C, et al. Head-position angles in children for opening the upper airway. Resuscitation 2010;81(6):676-8. (In eng). DOI: 10.1016/j.resuscitation.2010.01.022.

195. Dewan M, Perkins G, Schachna E, et al. Firm surface for the delivery of CPR: An Updated Systematic Review and Meta-analysis. . (https://costr.ilcor.org/document/firm-surface-for-cpr-an-updated-systematic-review-bls-2510-1).

196. Dewan M, Schachna E, Eastwood K, Perkins G, Bray J. The optimal surface for delivery of CPR: An updated systematic review and meta-analysis. Resusc Plus 2024;19:100718. (In eng). DOI: 10.1016/j.resplu.2024.100718.

197. Raffay V, Olasveengen TM, Bray J, Force obotILCoRBT. Hand position during compressions Consensus on Science with Treatment Recommendations. (https://costr.ilcor.org/document/hand-position-during-compressions-bls-2502-tf-sr).

This is a DRAFT-version

198. Berg KM, Bray JE, Ng KC, et al. 2023 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. Resuscitation 2023;195:109992. (In eng). DOI: 10.1016/j.resuscitation.2023.109992.

199. Chang CY, Hou YT, Chien YJ, et al. Two-Thumb or Two-Finger Technique in Infant Cardiopulmonary Resuscitation by a Single Rescuer? A Meta-Analysis with GOSH Analysis. Int J Environ Res Public Health 2020;17(14) (In eng). DOI: 10.3390/ijerph17145214.

200. Chang CY, Lin PC, Chien YJ, Chen CS, Wu MY. Analysis of Chest-Compression Depth and Full Recoil in Two Infant Chest-Compression Techniques Performed by a Single Rescuer: Systematic Review and Meta-Analysis. Int J Environ Res Public Health 2020;17(11) (In eng). DOI: 10.3390/ijerph17114018.

201. Ramachandran S, Bruckner M, Wyckoff MH, Schmolzer GM. Chest compressions in newborn infants: a scoping review. Arch Dis Child Fetal Neonatal Ed 2023;108(5):442-450. (In eng). DOI: 10.1136/archdischild-2022-324529.

202. Jahnsen J, Gonzalez A, Fabres J, Bahamondes A, Estay A. Effect of two different chest compression techniques on ventilation during neonatal resuscitation. J Perinatol 2021;41(7):1571-1574. (In eng). DOI: 10.1038/s41372-021-01061-2.

203. Tellier E, Lacaze M, Naud J, et al. Comparison of two infant cardiopulmonary resuscitation techniques explained by phone in a non-health professionals' population: Two-thumbs encircling hand technique vs. two-fingers technique, a randomised crossover study in a simulation environment. Am J Emerg Med 2022;61:163-168. (In eng). DOI: 10.1016/j.ajem.2022.09.012.

204. Jeon W, Kim J, Ko Y, Lee J. New chest compression method in infant resuscitation: Cross thumb technique. PLoS One 2022;17(8):e0271636. (In eng). DOI: 10.1371/journal.pone.0271636.

205. Barcala-Furelos R, Barcala-Furelos M, Cano-Noguera F, et al. A Comparison between Three Different Techniques Considering Quality Skills, Fatigue and Hand Pain during a Prolonged Infant Resuscitation: A Cross-Over Study with Lifeguards. Children (Basel) 2022;9(6) (In eng). DOI: 10.3390/children9060910.

206. Tsou JY, Kao CL, Tu YF, Hong MY, Su FC, Chi CH. Biomechanical analysis of force distribution in one-handed and two-handed child chest compression- a randomized crossover observational study. BMC Emerg Med 2022;22(1):13. (In eng). DOI: 10.1186/s12873-022-00566-z.

207. Considine J, Gazmuri RJ, Perkins GD, et al. Chest compression components (rate, depth, chest wall recoil and leaning): A scoping review. Resuscitation 2020;146:188-202. (In eng). DOI: 10.1016/j.resuscitation.2019.08.042.

208. Ong GY, Chen ZJ, Niles DE, et al. Poor Concordance of One-Third Anterior-Posterior Chest Diameter Measurements With Absolute Age-Specific Chest Compression Depth Targets in Pediatric Cardiac Arrest Patients. J Am Heart Assoc 2023;12(14):e028418. (In eng). DOI: 10.1161/JAHA.122.028418.

209. Eimer C, Huhndorf M, Sattler O, et al. Optimal Chest Compression Point During Pediatric Resuscitation: Implications for Pediatric Resuscitation Practice by CT Scans. Pediatr Crit Care Med 2024;25(10):928-936. (In eng). DOI: 10.1097/PCC.0000000000003553.

210. Ikeyama T, Hozumi T, Kikuyama K, Niles D, Nadkarni V, Ito K. Chest Compression Depth Targets in Critically Ill Infants and Children Measured With a Laser Distance Meter: Single-Center Retrospective Study From Japan, 2019-2022. Pediatr Crit Care Med 2024;25(8):720-727. (In eng). DOI: 10.1097/PCC.0000000000003515.

This is a DRAFT version

211. Noh H, Lee W, Yang D, Oh JH. Effects of resuscitation guideline terminology on pediatric cardiopulmonary resuscitation. Am J Emerg Med 2022;54:65-70. (In eng). DOI: 10.1016/j.ajem.2022.01.051.
212. Lee W, Yang D, Oh JH. Differences in the performance of resuscitation according to the resuscitation guideline terminology during infant cardiopulmonary resuscitation: "Approximately 4 cm" versus "at least one-third the anterior-posterior diameter of the chest". PLoS One 2020;15(3):e0230687. (In eng). DOI: 10.1371/journal.pone.0230687.
213. Falco L, Timmons Z, Swing T, Luciano W, Bulloch B. Measuring the Quality of Cardiopulmonary Resuscitation in the Emergency Department at a Quaternary Children's Hospital. Pediatr Emerg Care 2022;38(10):521-525. (In eng). DOI: 10.1097/PEC.0000000000002673.
214. Yu P, Lasa JJ, Zhang X, et al. Are chest compression quality metrics different in children with and without congenital heart disease? A report from the pediatric resuscitation quality collaborative. Resusc Plus 2024;20:100802. (In eng). DOI: 10.1016/j.resplu.2024.100802.
215. Rappold TE, Morgan RW, Reeder RW, et al. The association of arterial blood pressure waveform-derived area duty cycle with intra-arrest hemodynamics and cardiac arrest outcomes. Resuscitation 2023;191:109950. (In eng). DOI: 10.1016/j.resuscitation.2023.109950.
216. De Roos E, Vanwulpen M, Hachimi-Idrissi S. Chest compression release velocity: An independent determinant of end-tidal carbon dioxide in out-of-hospital cardiac arrest. Am J Emerg Med 2022;54:71-75. (In eng). DOI: 10.1016/j.ajem.2022.01.053.
217. Lauridsen KG, Morgan RW, Berg RA, et al. Association Between Chest Compression Pause Duration and Survival After Pediatric In-Hospital Cardiac Arrest. Circulation 2024;149(19):1493-1500. (In eng). DOI: 10.1161/CIRCULATIONAHA.123.066882.
218. Han P, Rasmussen L, Su F, et al. High Variability in the Duration of Chest Compression Interruption is Associated With Poor Outcomes in Pediatric Extracorporeal Cardiopulmonary Resuscitation. Pediatr Crit Care Med 2024;25(5):452-460. (In eng). DOI: 10.1097/PCC.0000000000003461.
219. Lopez-Herce J, Del Castillo J, Ristagno G, et al. Pad positions and size in Adults and Children Consensus on Science with Treatment Recommendations International Liaison Committee on Resuscitation. (https://costr.ilcor.org/document/paddle-pad-size-and-placement-in-infants-and-children-pls-4080-17-updated-systematic-review).
220. Heyer Y, Baumgartner D, Baumgartner C. A Systematic Review of the Transthoracic Impedance during Cardiac Defibrillation. Sensors (Basel) 2022;22(7) (In eng). DOI: 10.3390/s22072808.
221. Balaji S, Atkins DL, Berger S, Etheridge SP, Shah MJ. The Case for Home AED in Children, Adolescents, and Young Adults Not Meeting Criteria for ICD. JACC Clin Electrophysiol 2022;8(9):1165-1172. (In eng). DOI: 10.1016/j.jacep.2022.07.020.
222. Chua C, Schmolzer GM, Davis PG. Airway manoeuvres to achieve upper airway patency during mask ventilation in newborn infants - An historical perspective. Resuscitation 2012;83(4):411-6. (In eng). DOI: 10.1016/j.resuscitation.2011.11.007.
223. Aranda-Garcia S, San Roman-Mata S, Otero-Agra M, et al. Is the Over-the-Head Technique an Alternative for Infant CPR Performed by a Single Rescuer? A Randomized Simulation Study with Lifeguards. Pediatric Reports 2024;16(1):100-109.
224. Santos-Folgar M, Fernandez-Mendez F, Otero-Agra M, et al. Infant Cardiopulmonary Resuscitation Quality While Walking Fast: A Simulation Study. Pediatr Emerg Care 2022;38(2):e973-e977. (In eng). DOI: 10.1097/PEC.0000000000002505.
225. Couper K, Abu Hassan A, Ohri V, et al. Removal of foreign body airway obstruction: A systematic review of interventions. Resuscitation 2020;156:174-181. (In eng). DOI: 10.1016/j.resuscitation.2020.09.007.

This is a DRAFT-version

226. Dunne CL, Cirone J, Blanchard IE, et al. Evaluation of basic life support interventions for foreign body airway obstructions: A population-based cohort study. Resuscitation 2024;201:110258. (In eng). DOI: 10.1016/j.resuscitation.2024.110258.
227. Norii T, Igarashi Y, Yoshino Y, et al. The effects of bystander interventions for foreign body airway obstruction on survival and neurological outcomes: Findings of the MOCHI registry. Resuscitation 2024;199:110198. (In eng). DOI: 10.1016/j.resuscitation.2024.110198.
228. Suga R, Igarashi Y, Kitano S, et al. Effectiveness of the Abdominal Thrust Maneuver for Airway Obstruction Removal: Analysis of Data from the National Emergency Medical Services Information System. J Nippon Med Sch 2024;91(3):270-276. (In eng). DOI: 10.1272/jnms.JNMS.2024_91-305.
229. Couper KAH, A.; Ohri, V.; Patterson, E.; Tang, H.T.;Bingham, B.; Perkins, G.D.; Avis, S.; Brooks, S.; Castren, M.; Chung, C.; Considine. J.; Kudenchuck, P.; Nishiyama, C.; Ristagno, G.; Semeraro. F.; Smith, C.; Smyth, M.; Morley, P.; Olasveengen, TM.; on behalf of the International Liaison Committee on Resuscitation Basic and Paediatric Life Support Task Forces. . Foreign body airway obstruction in Adults and Children International Liaison Committee on Resuscitation (ILCOR) Basic Life Support Task Force. (http://ilcor.org).
230. Özlü S, Bilgin S, Yamanoglu A, et al. Comparison of carotid artery ultrasound and manual method for pulse check in cardiopulmonary resuscitation. Am J Emerg Med 2023;70:157-162. (In eng). DOI: 10.1016/j.ajem.2023.05.045.
231. Cohen AL, Li T, Becker LB, et al. Femoral artery Doppler ultrasound is more accurate than manual palpation for pulse detection in cardiac arrest. Resuscitation 2022;173:156-165. (In eng). DOI: 10.1016/j.resuscitation.2022.01.030.
232. Topjian A SB, Gray J, Ashworth J, Kienzle M, Ross C, O'halloran A, Gray S, Morrison LJ, on behalf of the Pediatric Life Support Task Force. Bradycardia with haemodynamic compromise – a scoping review: Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/bradycardia-with-haemodynamic-compromise-in-children-pls-4030-30-tf-scr).
233. Lupton JR, Newgard CD, Dennis D, et al. Initial Defibrillator Pad Position and Outcomes for Shockable Out-of-Hospital Cardiac Arrest. JAMA Netw Open 2024;7(9):e2431673. (In eng). DOI: 10.1001/jamanetworkopen.2024.31673.
234. Steinberg MF, Olsen JA, Persse D, Souders CM, Wik L. Efficacy of defibrillator pads placement during ventricular arrhythmias, a before and after analysis. Resuscitation 2022;174:16-19. (In eng). DOI: 10.1016/j.resuscitation.2022.03.004.
235. Cheskes S, Drennan IR, Turner L, Pandit SV, Dorian P. The impact of alternate defibrillation strategies on shock-refractory and recurrent ventricular fibrillation: A secondary analysis of the DOSE VF cluster randomized controlled trial. Resuscitation 2024;198:110186. (In eng). DOI: 10.1016/j.resuscitation.2024.110186.
236. Cheskes S, Verbeek PR, Drennan IR, et al. Defibrillation Strategies for Refractory Ventricular Fibrillation. N Engl J Med 2022;387(21):1947-1956. (In eng). DOI: 10.1056/NEJMoa2207304.
237. Haskell SE, Hoyme D, Zimmerman MB, et al. Association between survival and number of shocks for pulseless ventricular arrhythmias during pediatric in-hospital cardiac arrest in a national registry. Resuscitation 2024;198:110200. (In eng). DOI: 10.1016/j.resuscitation.2024.110200.
238. Jason Acworth JdC, Lokesh Tiwari, Dianne Atkins, Allan de Caen, on behalf of the International Liaison Committee on Resuscitation Pediatric Life Support Task Force. . Energy doses for pediatric defibrillation during resuscitation - Paediatric Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/energy-doses-for-pediatric-defibrillation-during-resuscitation-pls-4080-12-tf-sr).

This is a DRAFT version

239. Hoyme DB, Zhou Y, Girotra S, et al. Improved survival to hospital discharge in pediatric in-hospital cardiac arrest using 2 Joules/kilogram as first defibrillation dose for initial pulseless ventricular arrhythmia. Resuscitation 2020;153:88-96. (In eng). DOI: 10.1016/j.resuscitation.2020.05.048.

240. Jason Acworth JdC, Elliott Acworth, Lokesh Tiwari, Jesus Lopez-Herce, Eric Lavonas, Laurie Morrison, on behalf of the International Liaison Committee on Resuscitation Pediatric Life Support Task Force. Advanced Airway Interventions in Pediatric Cardiac Arrest - Paediatric Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/advanced-airway-interventions-in-pediatric-cardiac-arrest-pls-p1-tfsr).

241. Del Castillo J AJ, López-Herce J, Kleinman M, Atkins D, on behalf of the International Liaison Committee on Resuscitation Pediatric Life Support Task Force. Ventilation rates in pediatric CPR with an advanced airway - Pediatric Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/ventilation-rates-in-pediatric-cpr-with-an-advanced-airway-pls-1587-tf-sr).

242. Kienzle MF, Morgan RW, Reeder RW, et al. Epinephrine Dosing Intervals Are Associated With Pediatric In-Hospital Cardiac Arrest Outcomes: A Multicenter Study. Crit Care Med 2024;52(9):1344-1355. (In eng). DOI: 10.1097/ccm.0000000000006334.

243. Chang CY, Wu PH, Hsiao CT, Chang CP, Chen YC, Wu KH. Sodium bicarbonate administration during in-hospital pediatric cardiac arrest: A systematic review and meta-analysis. Resuscitation 2021;162:188-197. DOI: 10.1016/j.resuscitation.2021.02.035.

244. Cashen K, Reeder RW, Ahmed T, et al. Sodium Bicarbonate Use During Pediatric Cardiopulmonary Resuscitation: A Secondary Analysis of the ICU-RESUScitation Project Trial. Pediatr Crit Care Med 2022;23(10):784-792. DOI: 10.1097/PCC.0000000000003045.

245. Holmberg MJ, Granfeldt A, Andersen LW. Bicarbonate, calcium, and magnesium for in-hospital cardiac arrest - An instrumental variable analysis. Resuscitation 2023;191:109958. (In eng). DOI: 10.1016/j.resuscitation.2023.109958.

246. Gray JM CA, Nuthall G, Morrison LJ, Sahai A, Frazier M, Loeb D, Carlisle MA, Scholefield B, on behalf of the Pediatric Life Support Task Force. Measuring invasive blood pressure during pediatric in-hospital cardiac arrest: Consensus on Science with Treatment Recommendations International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/measuring-invasive-blood-pressure-during-pediatric-in-hospital-cardiac-arrest-pls-4160-08-tf-sr).

247. Berg RA, Morgan RW, Reeder RW, et al. Diastolic Blood Pressure Threshold during Pediatric Cardiopulmonary Resuscitation and Survival Outcomes: A Multicenter Validation Study∗. Critical Care Medicine 2023;51(1):91-102. DOI: 10.1097/CCM.0000000000005715.

248. Berg RA, Sutton RM, Reeder RW, et al. Association between diastolic blood pressure during pediatric in-hospital cardiopulmonary resuscitation and survival. Circulation 2018;137(17):1784-1795. DOI: 10.1161/CIRCULATIONAHA.117.032270.

249. Kienzle MF, Morgan RW, Alvey JS, et al. Clinician-reported physiologic monitoring of cardiopulmonary resuscitation quality during pediatric in-hospital cardiac arrest: A propensity-weighted cohort study. Resuscitation 2023;188((Kienzle M.F., kienzlem@chop.edu; Morgan R.W.; Berg R.A.; Nadkarni V.; Topjian A.A.; Sutton R.M.) Department of Anesthesiology and Critical Care Medicine, The Children's Hospital of Philadelphia, University of Pennsylvania Perelman School of Medicine, Phi). DOI: 10.1016/j.resuscitation.2023.109807.

250. Morgan RW, Reeder RW, Bender D, et al. Associations Between End-Tidal Carbon Dioxide During Pediatric Cardiopulmonary Resuscitation, Cardiopulmonary Resuscitation Quality,

This is a DRAFT version

and Survival. Circulation 2024;149(5):367-378. (In eng). DOI: 10.1161/CIRCULATIONAHA.123.066659.

251. Sorcher JL, Hunt EA, Shaffner DH, et al. Association of end-tidal carbon dioxide levels during cardiopulmonary resuscitation with survival in a large paediatric cohort. Resuscitation 2022;170((Sorcher J.L.; Hunt E.A.; Shaffner D.H.; O'Brien C.E.; Jeffers J.M.; Jones S.I.; Duval-Arnould J., ehunt@jhmi.edu) Johns Hopkins University School of Medicine, United States(Hunt E.A.; Shaffner D.H.; O'Brien C.E.; Duval-Arnould J., ehunt@jhmi.edu) Departm):316-323. DOI: 10.1016/j.resuscitation.2021.10.029.

252. Yates AR, Naim MY, Reeder RW, et al. Early Cardiac Arrest Hemodynamics, End-Tidal C o2 , and Outcome in Pediatric Extracorporeal Cardiopulmonary Resuscitation: Secondary Analysis of the ICU-RESUScitation Project Dataset (2016-2021). Pediatr Crit Care Med 2024;25(4):312-322. DOI: 10.1097/PCC.0000000000003423.

253. Raymond TT, Esangbedo ID, Rajapreyar P, et al. Cerebral Oximetry During Pediatric In-Hospital Cardiac Arrest: A Multicenter Study of Survival and Neurologic Outcome. Crit Care Med 2024;52(5):775-785. (In eng). DOI: 10.1097/CCM.0000000000006186.

254. Singh Y, Tissot C, Fraga MV, et al. International evidence-based guidelines on Point of Care Ultrasound (POCUS) for critically ill neonates and children issued by the POCUS Working Group of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC). Crit Care 2020;24(1):65. (In eng). DOI: 10.1186/s13054-020-2787-9.

255. Holmberg MJ, Granfeldt A, Guerguerian AM, et al. Extracorporeal cardiopulmonary resuscitation for cardiac arrest: An updated systematic review. Resuscitation 2023;182:109665. (In eng). DOI: 10.1016/j.resuscitation.2022.12.003.

256. Golden DBK, Wang J, Waserman S, et al. Anaphylaxis: A 2023 practice parameter update. Ann Allergy Asthma Immunol 2024;132(2):124-176. DOI: 10.1016/j.anai.2023.09.015.

257. Ballesteros Pena SRL, A. Does the Trendelenburg position affect hemodynamics? A systematic review. Emergencias 2012;24:143-150.

258. Cardona V, Ansotegui IJ, Ebisawa M, et al. World allergy organization anaphylaxis guidance 2020. World Allergy Organ J 2020;13(10):100472. DOI: 10.1016/j.waojou.2020.100472.

259. Pouessel G, Neukirch C. Alternatives to Injectable Adrenaline for Treating Anaphylaxis. Clin Exp Allergy 2025;55(1):36-51. DOI: 10.1111/cea.14598.

260. Carlson JN, Cook S, Djarv T, Woodin JA, Singletary E, Zideman DA. Second Dose of Epinephrine for Anaphylaxis in the First Aid Setting: A Scoping Review. Cureus 2020;12(11):e11401. DOI: 10.7759/cureus.11401.

261. Choo KJ, Simons E, Sheikh A. Glucocorticoids for the treatment of anaphylaxis: Cochrane systematic review. Allergy 2010;65(10):1205-11. DOI: 10.1111/j.1398-9995.2010.02424.x.

262. Shaker MS, Wallace DV, Golden DBK, et al. Anaphylaxis-a 2020 practice parameter update, systematic review, and Grading of Recommendations, Assessment, Development and Evaluation (GRADE) analysis. J Allergy Clin Immunol 2020;145(4):1082-1123. DOI: 10.1016/j.jaci.2020.01.017.

263. Santos AF, Riggioni C, Agache I, et al. EAACI guidelines on the management of IgE-mediated food allergy. Allergy 2025;80(1):14-36. DOI: 10.1111/all.16345.

264. Muraro A, Worm M, Alviani C, et al. EAACI guidelines: Anaphylaxis (2021 update). Allergy 2022;77(2):357-377. DOI: 10.1111/all.15032.

265. Maddukuri C, Kartha N, Conway AE, Shaker MS. Pearls for practice from the 2023 joint task force anaphylaxis practice parameter. Curr Opin Pediatr 2025;37(1):99-106. DOI: 10.1097/MOP.0000000000001397.

266. Brown JC, Simons E, Rudders SA. Epinephrine in the Management of Anaphylaxis. J Allergy Clin Immunol Pract 2020;8(4):1186-1195. DOI: 10.1016/j.jaip.2019.12.015.

267. Goto Y, Funada A, Maeda T, Goto Y. Temporal trends in neurologically intact survival after paediatric bystander-witnessed out-of-hospital cardiac arrest: A nationwide population-

This is a DRAFT -version

based observational study. Resuscitation plus 2021;6:100104. (In eng). DOI: doi:10.1016/j.resplu.2021.100104.

268. Fuchs A, Bockemuehl D, Jegerlehner S, et al. Favourable neurological outcome following paediatric out-of-hospital cardiac arrest: a retrospective observational study. Scandinavian journal of trauma, resuscitation and emergency medicine 2023;31(1):106. (In eng). DOI: doi:10.1186/s13049-023-01165-y.

269. Lockhart-Bouron M, Canon V, Leteurtre S, Hubert H, Recher M. Paediatric traumatic out-of-hospital cardiac arrest is associated with lower survival rates compared to those of medical aetiology: Results from the French national registry. Ann Intensive Care 2023;13 (In English). DOI: doi:10.1186/s13613-023-01131-y LK.

270. Shi D, McLaren C, Evans C. Neurological outcomes after traumatic cardiopulmonary arrest: A systematic review. Trauma Surg Acute Care open 2021;6(1) (In English). DOI: doi:10.1136/tsaco-2021-000817 LK - https://utrechtuniversity.on.worldcat.org/atoztitles/link?sid=EMBASE&sid=EMBASE&issn=23975776&id=doi:10.1136%2Ftsaco-2021-000817&atitle=Neurological+outcomes+after+traumatic+cardiopulmonary+arrest%3A+A+systematic+review&stitle=Trauma+Surg.+Acute+Care+open&title=Trauma+Surgery+and+Acute+Care+Open&volume=6&issue=1&spage=&epage=&aulast=Shi&aufirst=Daniel&auinit=D.&aufull=Shi+D.&coden=&isbn=&pages=-&date=2021&auinit1=D&auinitm=.

271. Faulkner J, Carballo C, Colosimo C, Gratton A, Mentzer C, Yon J. Traumatic Cardiac Arrest in Pediatric Patients: An Analysis of the National Trauma Database 2007-2016. Am Surg 2022;88(9):2252-2254. DOI: 10.1177/00031348221091937.

272. Lewis J, Perkins G. Traumatic cardiac arrest. Current opinion in critical care 2023;29(3):162-167. (In eng). DOI: doi:10.1097/MCC.0000000000001043.

273. Schober P, Giannakopoulos G, Bulte C, Schwarte L. Traumatic Cardiac Arrest-A Narrative Review. Journal of clinical medicine 2024;13(2) (In eng). DOI: doi:10.3390/jcm13020302.

274. Soar J, Becker L, Berg K, et al. Cardiopulmonary resuscitation in special circumstances. Lancet (London, England) 2021;398(10307):1257-1268. (In eng). DOI: doi:10.1016/S0140-6736(21)01257-5.

275. Deasy C, Bray J, Smith K, et al. Paediatric traumatic out-of-hospital cardiac arrests in Melbourne, Australia. Ireland2012.

276. Hosomi S, Kitamura T, Sobue T, Zha L, Kiyohara K, Oda J. Epidemiology and Outcome of Pediatric Out-of-Hospital Cardiac Arrest after Traffic Collision in Japan: A Population-Based Study. J Clin Med 2022;11(3) (In eng). DOI: doi:10.3390/jcm11030831.

277. Vianen N, Van Lieshout E, Maissan I, et al. Prehospital traumatic cardiac arrest: a systematic review and meta-analysis. European journal of trauma and emergency surgery : official publication of the European Trauma Society 2022;48(4):3357-3372. (In eng). DOI: doi:10.1007/s00068-022-01941-y.

278. Kleber C, Giesecke MT, Lindner T, Haas NP, Buschmann CT. Requirement for a structured algorithm in cardiac arrest following major trauma: epidemiology, management errors, and preventability of traumatic deaths in Berlin. (1873-1570 (Electronic)) (In eng).

279. Alqudah Z, Nehme Z, Williams B, Oteir A, Bernard S, Smith K. Impact of a trauma-focused resuscitation protocol on survival outcomes after traumatic out-of-hospital cardiac arrest: An interrupted time series analysis. Resuscitation 2021;162:104-111. (In eng). DOI: 10.1016/j.resuscitation.2021.02.026.

280. Charlton N, Goolsby C, Zideman D, Maconochie I, Morley P, Singletary E. Appropriate Tourniquet Types in the Pediatric Population: A Systematic Review. Cureus 2021;13(4):e14474. (In eng). DOI: doi:10.7759/cureus.14474.

281. Djarv T. ILCOR Evidence Update FA 7334: Hemostatic Agents for Life-threatening External Bleeding - Draft. 2021.

This is a DRAFT version

282. Hewett Brumberg EK DM, Alibertis K, Charlton NP, Goldman MP, Harper-Kirksey K, Hawkins SC, Hoover AV, Kule A, Leichtle S, McClure SF, Wang GS, Whelchel M, White L, Lavonas EJ, on behalf of the American Heart Association and American Red Cross. 2024 American Heart Association and American Red Cross Guidelines for First Aid. Circulation 2024;150. DOI: 10.1161/CIR.0000000000001281.

283. Laermans J DT, Singletary EM, Macneil F, Williamson F, Cimpoesu D, Flores G on behalf of the International Liaison Committee on Resuscitation First Aid Task Force. Spinal motion restriction Task Force Synthesis of a Scoping Review - draft. ILCOR FA 7311. 2024 ed. https://costr.ilcor.org/document/spinal-motion-restriction-fa-7311-tf-scr: International Liaison Committee on Resuscitation (ILCOR) First Aid Task Force 2024

284. Wongtanasarasin WT, T. Kasirawat, C. et al. . reatment outcomes of epinephrine for traumatic out-of-hospital cardiac arrest: a systematic review and meta-analysis. J Emerg Trauma Shock 2021;14:195–200

285. Hannon L, St Clair T, Smith K, et al. Finger thoracostomy in patients with chest trauma performed by paramedics on a helicopter emergency medical service. Emerg Med Australas 2020;32(4):650-656. (In eng). DOI: 10.1111/1742-6723.13549.

286. Radulovic NW, R. Nolan, B. . Predictors of survival in trauma patients requiring resuscitative thoracotomy: A scoping review. Trauma 2023;26. DOI: 10.1177/14604086231156265.

287. Zhu W. Global, regional, and national drowning trends from 1990 to 2021: Results from the 2021 Global Burden of Disease Study. Acad Emerg Med 2024;31:1212-1222.

288. Barcala-Furelos R, de Oliveira J, Duro-Pichel P, Colón-Leira S, Sanmartín-Montes M, Aranda-García S. In-water resuscitation during a surf rescue: Time lost or breaths gained? A pilot study. The American journal of emergency medicine 2024;79:48-51. (In eng). DOI: doi:10.1016/j.ajem.2024.02.010.

289. Bierens J, Bray J, Abelairas-Gomez C, et al. A systematic review of interventions for resuscitation following drowning. Resuscitation plus 2023;14:100406. (In eng). DOI: doi:10.1016/j.resplu.2023.100406.

290. Berger S, Siekmeyer M, Petzold-Quinque S, Kiess W, Merkenschlager A. Drowning and Nonfatal Drowning in Children and Adolescents: A Subsequent Retrospective Data Analysis. Child 2024;11(4) (In English). DOI: 10.3390/children11040439 LK.

291. Tobin JM, Ramos WD, Pu Y, Wernicki PG, Quan L, Rossano JW. Bystander CPR is associated with improved neurologically favourable survival in cardiac arrest following drowning. (1873-1570 (Electronic)) (In eng).

292. Bierens J, Abelairas-Gomez C, Barcala Furelos R, et al. Resuscitation and emergency care in drowning: A scoping review. Resuscitation 2021;162:205-217. DOI: 10.1016/j.resuscitation.2021.01.033.

293. Claesson AL, AJ. Herlitz, J. Cardiac arrest due to drowning--changes over time and factors of importance for survival. Resuscitation 2014;85:644-8.

294. Dyson K, Morgans A Fau - Bray J, Bray J Fau - Matthews B, Matthews B Fau - Smith K, Smith K. Drowning related out-of-hospital cardiac arrests: characteristics and outcomes. (1873-1570 (Electronic)) (In eng).

295. Nitta M, Kitamura T, Iwami T, et al. Out-of-hospital cardiac arrest due to drowning among children and adults from the Utstein Osaka Project. Resuscitation 2013;84(11):1568-73. DOI: 10.1016/j.resuscitation.2013.06.017.

296. Buick JE, Lin S, Rac VE, Brooks SC, Kierzek G, Morrison LJ. Drowning: an overlooked cause of out-of-hospital cardiac arrest in Canada. CJEM 2014;16(4):314-21. DOI: 10.2310/8000.2013.131069.

297. Van Tilburg C, Paal P, Strapazzon G, et al. Wilderness Medical Society Clinical Practice Guidelines for Prevention and Management of Avalanche and Nonavalanche Snow Burial

This is a DRAFT version

Accidents: 2024 Update. Wilderness Environ Med 2024;35(1_suppl):20S-44S. (In eng). DOI: 10.1016/j.wem.2023.05.014.

298. Watanabe M, Matsuyama T, Morita S, et al. Impact of rewarming rate on the mortality of patients with accidental hypothermia: analysis of data from the J-Point registry. Scand J Trauma Resusc Emerg Med 2019;27(1):105. DOI: 10.1186/s13049-019-0684-5.

299. Andre MC, Vuille-Dit-Bille RN, Berset A, Hammer J. Rewarming Young Children After Drowning-Associated Hypothermia and Out-of-Hospital Cardiac Arrest: Analysis Using the CAse REport Guideline. Pediatr Crit Care Med 2023;24(9):e417-e424. (In eng). DOI: 10.1097/PCC.0000000000003254.

300. Pellegrino JL, Charlton NP, Carlson JN, et al. 2020 American Heart Association and American Red Cross Focused Update for First Aid. Circulation 2020;142(17):e287-e303. DOI: 10.1161/CIR.0000000000000900.

301. Bierens J B-FR, Beerman S, Claesson A, Dunne C, Elsenga H, Abelairas-Gomez C, Morgan P, Mecrow T, Pereira JCC, Scapigliati A, Seesink J, Schmidt A, Sempsrott J, Szpliman D, Warner DS, Webber J, Johnson S, Avis S, Mancini MB, Nation K, Brooks S, Castren M, Chung S, Considine J, Kudenchuk P, Nishiyama C, Ristagno G, Semeraro F, Smyth M, Vaillancourt C, Olasveengen T, Morley P, Perkins GD on behalf of the International Liaison Committee on Resuscitation Basic Life Support Task Force(s). . Extra Corporeal Membrane Oxygenator (ECMO) in Drowning. . Brussels, Belgium: International Liaison Committee on Resuscitation (ILCOR) Basic Life Support Task Force. Review and Task Force Insights [Internet] 2020.

302. Grindy AK BE, Levin AB, Stockwell DC, Noje C. Pediatric Cardiac Arrest: A Story of Hypothermia, Transport, and 300 Minutes of CPR. . Pediatrics 149 954.

303. Mroczek T, Gladki M, Skalski J. Successful resuscitation from accidental hypothermia of 11.8 degrees C: where is the lower bound for human beings? Eur J Cardiothorac Surg 2020;58(5):1091-1092. (In eng). DOI: 10.1093/ejcts/ezaa159.

304. Dow J, Giesbrecht GG, Danzl DF, et al. Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update. Wilderness Environ Med 2019;30(4S):S47-S69. (In eng). DOI: 10.1016/j.wem.2019.10.002.

305. Musi ME, Sheets A, Zafren K, et al. Clinical staging of accidental hypothermia: The Revised Swiss System: Recommendation of the International Commission for Mountain Emergency Medicine (ICAR MedCom). Resuscitation 2021;162:182-187. (In eng). DOI: 10.1016/j.resuscitation.2021.02.038.

306. Pasquier M, Strapazzon G, Kottmann A, et al. On-site treatment of avalanche victims: Scoping review and 2023 recommendations of the international commission for mountain emergency medicine (ICAR MedCom). Resuscitation 2023;184:109708. (In eng). DOI: 10.1016/j.resuscitation.2023.109708.

307. Paal P, Pasquier M, Darocha T, et al. Accidental Hypothermia: 2021 Update. Int J Environ Res Public Health 2022;19(1). DOI: 10.3390/ijerph19010501.

308. Schön CA GL, Hölzl N, Milani M, Paal P, Zafren K. . Determination of Death in Mountain Rescue: Recommendations of the International Commission for Mountain Emergency Medicine (ICAR MedCom). . Wilderness Environ Med 2020;31:506–20. .

309. Lott C, Truhlar A, Alfonzo A, et al. European Resuscitation Council Guidelines 2021: Cardiac arrest in special circumstances. Resuscitation 2021;161:152-219. (In eng). DOI: 10.1016/j.resuscitation.2021.02.011.

310. Mariño RB AE, Ribas M, Robledo XR, Martínez IS, Strapazzon G, et al. . Anesthetic Management of Successful Extracorporeal Resuscitation After Six Hours of Cardiac Arrest Due to Severe Accidental Hypothermia. J Cardiothorac Vasc Anesth 2021;35:3303–6. (https://doi.org/10.1053/j.jvca.2020.11.016.).

This is a DRAFT version

311. Pasquier M RV, Darocha T, Bouzat P, Kosiński S, Sawamoto K, et al. . Hypothermia outcome prediction after extracorporeal life support for hypothermic cardiac arrest patients: An external validation of the HOPE score. . Resuscitation 2019;139:321-8. (https://doi.org/10.1016/j.resuscitation.2019.03.017.).
312. Scaife JH, Hewes HA, Iantorno SE, et al. Optimizing patient selection for ECMO after pediatric hypothermic cardiac arrest. Injury 2025;56(1):111731. (In eng). DOI: 10.1016/j.injury.2024.111731.
313. Grin N RV, Darocha T, Hugli O, Carron P-N, Zingg T, et al. Hypothermia Outcome Prediction after Extracorporeal Life Support for Hypothermic Cardiac Arrest Patients: Assessing the Performance of the HOPE Score in Case Reports from the Literature. . International Journal of Environmental Research and Public Health 2021;18:11896 (https://doi.org/10.3390/ijerph182211896.).
314. Cools E, Brugger H, Darocha T, et al. About Rewarming Young Children After Drowning-Associated Hypothermia and Out-of-Hospital Cardiac Arrest. Pediatr Crit Care Med 2024;25(3):e171-e172. (In eng). DOI: 10.1097/PCC.0000000000003411.
315. Huan NC, Sidhu C, Thomas R. Pneumothorax: Classification and Etiology. Clin Chest Med 2021;42(4):711-727. (In eng). DOI: 10.1016/j.ccm.2021.08.007.
316. Jahanshir A, Moghari SM, Ahmadi A, Moghadam PZ, Bahreini M. Value of point-of-care ultrasonography compared with computed tomography scan in detecting potential life-threatening conditions in blunt chest trauma patients. Ultrasound J 2020;12(1):36. (In eng). DOI: 10.1186/s13089-020-00183-6.
317. Garner A, Poynter E, Parsell R, Weatherall A, Morgan M, Lee A. Association between three prehospital thoracic decompression techniques by physicians and complications: a retrospective, multicentre study in adults. Eur J Trauma Emerg Surg 2023;49(1):571-581. (In eng). DOI: 10.1007/s00068-022-02049-z.
318. Quinn N, Palmer CS, Bernard S, Noonan M, Teague WJ. Thoracostomy in children with severe trauma: An overview of the paediatric experience in Victoria, Australia. Emerg Med Australas 2020;32(1):117-126. (In eng). DOI: 10.1111/1742-6723.13392.
319. Herron C, Forbes TJ, Kobayashi D. Pericardiocentesis in children: 20-year experience at a tertiary children's hospital. Cardiol Young 2022;32(4):606-611. (In eng). DOI: 10.1017/S104795112100278X.
320. Tiwar iLS, B. Kleinman, M. Nadkarni, V. Wang, SG. Ross, C. de Caen, A. Acworth, J. on behalf of the International Liaison Committee on Resuscitation Pediatric Life Support Task Force. . Reversible causes of pediatric cardiac arrest - Pulmonary Embolism. International Liaison Committee on Resuscitation (ILCOR) Paediatric Advanced Life Support Task Force.
321. O'Brien S, Stanek J, Witmer C, Raffini L. The Continued Rise of Venous Thromboembolism Across US Children's Hospitals. Pediatrics 2022;149(3) (In eng). DOI: doi:10.1542/peds.2021-054649.
322. Chima M, Williams D, Thomas N, Krawiec C. COVID-19-Associated Pulmonary Embolism in Pediatric Patients. Hospital pediatrics 2021;11(6):e90-e94. (In eng). DOI: doi:10.1542/hpeds.2021-005866.
323. Keller K, Hobohm L, Ebner M, et al. Trends in thrombolytic treatment and outcomes of acute pulmonary embolism in Germany. European heart journal 2020;41(4):522-529. (In eng). DOI: doi:10.1093/eurheartj/ehz236.
324. Reynolds J, Nicholson T, O'Neil B, Drennan I, Issa M, Welsford M. Diagnostic test accuracy of point-of-care ultrasound during cardiopulmonary resuscitation to indicate the etiology of cardiac arrest: A systematic review. Resuscitation 2022;172:54-63. (In eng). DOI: doi:10.1016/j.resuscitation.2022.01.006.

This is a DRAFT version

325. Hennelly K, Ellison A, Neuman M, Kline J. Clinical variables that increase the probability of pulmonary embolism diagnosis in symptomatic children. Research and practice in thrombosis and haemostasis 2020;4(1):124-130. (In eng). DOI: doi:10.1002/rth2.12265.
326. Su Y, Zou D, Liu Y, Wen C, Zhang X. Anticoagulant Impact on Clinical Outcomes of Pulmonary Embolism Compared With Thrombolytic Therapy; Meta-Analysis. United States2024.
327. Ross C, Kumar R, Pelland-Marcotte M, et al. Acute Management of High-Risk and Intermediate-Risk Pulmonary Embolism in Children: A Review. Chest 2022;161(3):791-802. (In eng). DOI: doi:10.1016/j.chest.2021.09.019.
328. Pietrasik A, Gąsecka A, Szarpak Ł, et al. Catheter-Based Therapies Decrease Mortality in Patients With Intermediate and High-Risk Pulmonary Embolism: Evidence From Meta-Analysis of 65,589 Patients. Switzerland2022.
329. Boey J, Dhundi U, Ling R, et al. Extracorporeal Membrane Oxygenation for Pulmonary Embolism: A Systematic Review and Meta-Analysis. Journal of clinical medicine 2023;13(1) (In eng). DOI: doi:10.3390/jcm13010064.
330. Goldberg J, Giri J, Kobayashi T, et al. Surgical Management and Mechanical Circulatory Support in High-Risk Pulmonary Embolisms: Historical Context, Current Status, and Future Directions: A Scientific Statement From the American Heart Association. Circulation 2023;147(9):e628-e647. (In eng). DOI: doi:10.1161/CIR.0000000000001117.
331. Kim J, Barrett C, Hyslop R, Buckvold S, Gist K. Survival of Children With Pulmonary Embolism Supported by Extracorporeal Membrane Oxygenation. Frontiers in pediatrics 2022;10:877637. (In eng). DOI: doi:10.3389/fped.2022.877637.
332. Carreiro S, Miller S, Wang B, Wax P, Campleman S, Manini AF. Clinical predictors of adverse cardiovascular events for acute pediatric drug exposures. Clin Toxicol (Phila) 2020;58(3):183-189. DOI: 10.1080/15563650.2019.1634272.
333. Safranek DJ, Eisenberg MS, Larsen MP. The epidemiology of cardiac arrest in young adults. Ann Emerg Med 1992;21(9):1102-6. DOI: 10.1016/s0196-0644(05)80651-1.
334. Thompson TM, Theobald J, Lu J, Erickson TB. The general approach to the poisoned patient. Dis Mon 2014;60(11):509-24. DOI: 10.1016/j.disamonth.2014.10.002.
335. Sun X, Chen X, Lu J, Tao Y, Zhang L, Dong L. Extracorporeal treatment in children with acute severe poisoning. Medicine (Baltimore) 2019;98(47):e18086. DOI: 10.1097/MD.0000000000018086.
336. Di Nardo M, Alunni Fegatelli D, Marano M, Danoff J, Kim HK. Use of Extracorporeal Membrane Oxygenation in Acutely Poisoned Pediatric Patients in United States: A Retrospective Analysis of the Extracorporeal Life Support Registry From 2003 to 2019. Crit Care Med 2022;50(4):655-664. (In eng). DOI: 10.1097/CCM.0000000000005436.
337. Sorabella RA, Gray WH, Dabal RJ, et al. Central Extracorporeal Membrane Oxygenation Support Following Calcium Channel Blocker Overdose in Children. ASAIO J 2024;70(7):e92-e96. (In eng). DOI: 10.1097/MAT.0000000000002102.
338. Zideman DA, Singletary EM, Borra V, et al. European Resuscitation Council Guidelines 2021: First aid. Resuscitation 2021;161:270-290. (In eng). DOI: 10.1016/j.resuscitation.2021.02.013.
339. Kanda J, Nakahara S, Nakamura S, et al. Association between active cooling and lower mortality among patients with heat stroke and heat exhaustion. PLoS One 2021;16(11):e0259441. DOI: 10.1371/journal.pone.0259441.
340. Adams WM, Hosokawa Y, Casa DJ. The Timing of Exertional Heat Stroke Survival Starts prior to Collapse. Curr Sports Med Rep 2015;14(4):273-4. DOI: 10.1249/JSR.0000000000000166.
341. Rublee C, Dresser C, Giudice C, Lemery J, Sorensen C. Evidence-Based Heatstroke Management in the Emergency Department. West J Emerg Med 2021;22(2):186-195. DOI: 10.5811/westjem.2020.11.49007.

This is a DRAFT version

342. Flouris AD, Notley SR, Stearns RL, Casa DJ, Kenny GP. Recommended water immersion duration for the field treatment of exertional heat stroke when rectal temperature is unavailable. Eur J Appl Physiol 2024;124(2):479-490. DOI: 10.1007/s00421-023-05290-5.
343. Hosokawa Y, Nagata T, Hasegawa M. Inconsistency in the Standard of Care-Toward Evidence-Based Management of Exertional Heat Stroke. Front Physiol 2019;10:108. DOI: 10.3389/fphys.2019.00108.
344. Douma Mea. First aid cooling techniques for heat stroke and exertional hyperthermia: A systematic review and meta-analysis. Resuscitation 2020;148:173.
345. Moore E, Fuller JT, Bellenger CR, et al. Effects of Cold-Water Immersion Compared with Other Recovery Modalities on Athletic Performance Following Acute Strenuous Exercise in Physically Active Participants: A Systematic Review, Meta-Analysis, and Meta-Regression. Sports Med 2023;53(3):687-705. DOI: 10.1007/s40279-022-01800-1.
346. Wood F, Roiz-de-Sa D, Pynn H, Smith JE, Bishop J, Hemingway R. Outcomes of UK military personnel treated with ice cold water immersion for exertional heat stroke. BMJ Mil Health 2024;170(3):216-222. DOI: 10.1136/military-2022-002133.
347. Stone GL, Sanchez LD. Hypothermia following cold-water immersion treatment for exertional heat illness. Res Sports Med 2023;31(3):255-259. DOI: 10.1080/15438627.2021.1966007.
348. Laitano O, Leon LR, Roberts WO, Sawka MN. Controversies in exertional heat stroke diagnosis, prevention, and treatment. J Appl Physiol (1985) 2019;127(5):1338-1348. DOI: 10.1152/japplphysiol.00452.2019.
349. Pryor RR, Haboian K, Fitts T, Stooks JJ. Tarp-Assisted Cooling for Exertional Heat Stroke Treatment in Wildland Firefighting. Wilderness Environ Med 2023;34(4):490-497. DOI: 10.1016/j.wem.2023.08.002.
350. Tucker L, Evans E. Heatstroke on the Rise: A Guide to Implementing Tarp-Assisted Cooling With Oscillation (TACO) in the Emergency Department. Adv Emerg Nurs J 2023;45(3):210-216. DOI: 10.1097/TME.0000000000000470.
351. McDermott BP, Atkins WC. Whole-body cooling effectiveness of cold intravenous saline following exercise hyperthermia: a randomized trial. Am J Emerg Med 2023;72:188-192. DOI: 10.1016/j.ajem.2023.07.053.
352. Adams WM, Butke EE, Lee J, Zaplatosch ME. Cooling Capacity of Transpulmonary Cooling and Cold-Water Immersion After Exercise-Induced Hyperthermia. J Athl Train 2021;56(4):383-388. DOI: 10.4085/1062-6050-0146.20.
353. Miller KC, Amaria NY. Excellent Rectal Temperature Cooling Rates in the Polar Life Pod Consistent With Stationary Tubs. J Athl Train 2023;58(3):244-251. DOI: 10.4085/1062-6050-0732.21.
354. Miller KC, Amaria NY, Casa DJ, et al. Exertional Heatstroke Survivors' Knowledge and Beliefs About Exertional Heatstroke Diagnosis, Treatment, and Return to Play. J Athl Train 2024;59(11):1063-1069. DOI: 10.4085/1062-6050-0677.23.
355. DeGroot DW, O'Connor FG, Roberts WO. Exertional heat stroke: an evidence based approach to clinical assessment and management. Exp Physiol 2022;107(10):1172-1183. DOI: 10.1113/EP090488.
356. Caldwell AR, Saillant MM, Pitsas D, Johnson A, Bradbury KE, Charkoudian N. The Effectiveness of a Standardized Ice-Sheet Cooling Method Following Exertional Hyperthermia. Mil Med 2022;187(9-10):e1017-e1023. DOI: 10.1093/milmed/usac047.
357. Zhang Y, Liu Y. [Design and application of a cooling device based on the phase-change material for heat stroke]. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue 2022;34(2):191-193. DOI: 10.3760/cma.j.cn121430-20210330-00461.

This is a DRAFT-version

358. Wang J, Zhang Y. [Experience of treating batches of exertional heat stroke patients in military training]. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue 2020;32(12):1522-1525. DOI: 10.3760/cma.j.cn121430-20200303-00236.
359. Klous L, van Diemen F, Ruijs S, et al. Efficiency of three cooling methods for hyperthermic military personnel linked to water availability. Appl Ergon 2022;102:103700. DOI: 10.1016/j.apergo.2022.103700.
360. Naito T, Saito T, Ohhashi M, Hayashi S. Recovery with a fan-cooling jacket after exposure to high solar radiation during exercise in hot outdoor environments. Front Sports Act Living 2023;5:1106882. DOI: 10.3389/fspor.2023.1106882.
361. Brew A, O'Beirne S, Johnson MJ, et al. Airflow rates and breathlessness recovery from submaximal exercise in healthy adults: prospective, randomised, cross-over study. BMJ Support Palliat Care 2024;14(4):442-448. DOI: 10.1136/spcare-2023-004309.
362. Hosokawa Y, Belval LN, Adams WM, Vandermark LW, Casa DJ. Chemically Activated Cooling Vest's Effect on Cooling Rate Following Exercise-Induced Hyperthermia: A Randomized Counter-Balanced Crossover Study. Medicina (Kaunas) 2020;56(10). DOI: 10.3390/medicina56100539.
363. Fisher JD, Shah AP, Norozian F. Clinical Spectrum of Pediatric Heat Illness and Heatstroke in a North American Desert Climate. Pediatr Emerg Care 2022;38(2):e891-e893. DOI: 10.1097/PEC.0000000000002438.
364. Djakow J, Ng KC, Raymond T, et al. Pharmacological Interventions for the Treatment of Hyperkalaemia in Paediatric Patients with Cardiac arrest - Paediatric Consensus on Science and Treatment Recommendations. Internationa Liaison Committee on Resuscitation. (https://costr.ilcor.org/document/pharmacological-interventions-for-the-treatment-of-hyperkalaemia-in-paediatric-patients-with-cardiac-arrest-pls-4160-17-tfsr).
365. Jessen MK, Andersen LW, Djakow J, et al. Pharmacological interventions for the acute treatment of hyperkalaemia: A systematic review and meta-analysis. Resuscitation 2025;208:110489. (In eng). DOI: 10.1016/j.resuscitation.2025.110489.
366. Piktel JS, Wan X, Kouk S, Laurita KR, Wilson LD. Beneficial Effect of Calcium Treatment for Hyperkalemia Is Not Due to "Membrane Stabilization". Crit Care Med 2024;52(10):1499-1508. (In eng). DOI: 10.1097/CCM.0000000000006376.
367. Celebi Yamanoglu NG, Yamanoglu A. The effect of calcium gluconate in the treatment of hyperkalemia. Turk J Emerg Med 2022;22(2):75-82. (In eng). DOI: 10.4103/2452-2473.342812.
368. Wardi G, Holgren S, Gupta A, et al. A Review of Bicarbonate Use in Common Clinical Scenarios. J Emerg Med 2023;65(2):e71-e80. (In eng). DOI: 10.1016/j.jemermed.2023.04.012.
369. Piner A, Spangler R. Disorders of Potassium. Emerg Med Clin North Am 2023;41(4):711-728. (In eng). DOI: 10.1016/j.emc.2023.07.005.
370. Lloyd C, Mohar C, Priano J. Hypokalemic Cardiac Arrest: Narrative Review of Case Reports and Current State of Science. J Emerg Nurs 2022;48(3):310-316. (In eng). DOI: 10.1016/j.jen.2021.12.008.
371. Bamgbola OF. Review of the Pathophysiologic and Clinical Aspects of Hypokalemia in Children and Young Adults: an Update. Curr Treat Options Pediatr 2022;8(3):96-114. (In eng). DOI: 10.1007/s40746-022-00240-3.
372. American Diabetes Association Professional Practice C. 6. Glycemic Goals and Hypoglycemia: Standards of Care in Diabetes-2024. Diabetes Care 2024;47(Suppl 1):S111-S125. DOI: 10.2337/dc24-S006.
373. Abraham MB, Karges B, Dovc K, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Assessment and management of hypoglycemia in children and adolescents with diabetes. Pediatr Diabetes 2022;23(8):1322-1340. DOI: 10.1111/pedi.13443.

This is a DRAFT version

374. Goodhart AL. Dasiglucagon: A Novel Ready-to-Use Treatment for Severe Hypoglycemia. Ann Pharmacother 2023;57(3):300-305. DOI: 10.1177/10600280221108425.
375. Ng KC. Management of pulmonary hypertension with cardiac arrest in infants and children in the hospital setting: PLS ScR. ILCOR.
376. Morgan RW, Topjian AA, Wang Y, et al. Prevalence and Outcomes of Pediatric In-Hospital Cardiac Arrest Associated With Pulmonary Hypertension. Pediatr Crit Care Med 2020;21(4):305-313. DOI: 10.1097/PCC.0000000000002187.
377. Raymond TG, AM. Acworth, J. Scholefield, B. Atkins, DL. on behalf of the International Liaison Committee on Resuscitation Pediatric Life Support Task Force. IHCA due to Suspected Cardiac Shunt/Stent Obstruction Consensus on Science with Treatment Recommendations [Internet] International Liaison Committee on Resuscitation (ILCOR) Pediatric Life Support Task Force.
378. Disma N, Veyckemans F, Virag K, et al. Morbidity and mortality after anaesthesia in early life: results of the European prospective multicentre observational study, neonate and children audit of anaesthesia practice in Europe (NECTARINE). Br J Anaesth 2021;126(6):1157-1172. DOI: 10.1016/j.bja.2021.02.016.
379. Habre W, Disma N, Virag K, et al. Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe. Lancet Respir Med 2017;5(5):412-425. DOI: 10.1016/S2213-2600(17)30116-9.
380. Christensen RE, Lee AC, Gowen MS, Rettiganti MR, Deshpande JK, Morray JP. Pediatric Perioperative Cardiac Arrest, Death in the Off Hours: A Report From Wake Up Safe, The Pediatric Quality Improvement Initiative. Anesth Analg 2018;127(2):472-477. DOI: 10.1213/ANE.0000000000003398.
381. Bhananker SM, Ramamoorthy C, Geiduschek JM, et al. Anesthesia-related cardiac arrest in children: update from the Pediatric Perioperative Cardiac Arrest Registry. Anesth Analg 2007;105(2):344-50. DOI: 10.1213/01.ane.0000268712.00756.dd.
382. Gonzalez LP, Pignaton W, Kusano PS, Modolo NS, Braz JR, Braz LG. Anesthesia-related mortality in pediatric patients: a systematic review. Clinics (Sao Paulo) 2012;67(4):381-7. DOI: 10.6061/clinics/2012(04)12.
383. Lee JH, Kim EK, Song IK, et al. Critical incidents, including cardiac arrest, associated with pediatric anesthesia at a tertiary teaching children's hospital. Paediatr Anaesth 2016;26(4):409-17. DOI: 10.1111/pan.12862.
384. Harper NJN, Nolan JP, Soar J, Cook TM. Why chest compressions should start when systolic arterial blood pressure is below 50 mm Hg in the anaesthetised patient. Br J Anaesth 2020;124(3):234-238. DOI: 10.1016/j.bja.2019.11.005.
385. Nolan JA, RA. Kane, AD. Kursumovic, E. Davies, MT. Moppett, IK. et al. Advanced life support interventions during intra-operative cardiac arrest among adults as reported to the 7th National Audit Project of the Royal College of Anaesthetists. Anaesthesia 2024;79:914-23.
386. Soar J. Epinephrine for cardiac arrest: knowns, unknowns and controversies. Curr Opin Crit Car 2020;26:590-5.
387. Hernandez-Tejedor A, Gonzalez Puebla V, Corral Torres E, Benito Sanchez A, Pinilla Lopez R, Galan Calategui MD. Ventilatory improvement with mechanical ventilator versus bag in non-traumatic out-of-hospital cardiac arrest: SYMEVECA study, phase 1. Resuscitation 2023;192:109965. DOI: 10.1016/j.resuscitation.2023.109965.
388. Malinverni S, Wilmin S, de Longueville D, et al. A retrospective comparison of mechanical cardio-pulmonary ventilation and manual bag valve ventilation in non-traumatic out-of-hospital cardiac arrests: A study from the Belgian cardiac arrest registry. Resuscitation 2024;199:110203. DOI: 10.1016/j.resuscitation.2024.110203.

This is a DRAFT version

389. Orso D, Vetrugno L, Federici N, et al. Mechanical Ventilation Management During Mechanical Chest Compressions. Respir Care 2021;66(2):334-346. DOI: 10.4187/respcare.07775.

390. Tangpaisarn T, Tosibphanom J, Sata R, Kotruchin P, Drumheller B, Phungoen P. The effects of mechanical versus bag-valve ventilation on gas exchange during cardiopulmonary resuscitation in emergency department patients: A randomized controlled trial (CPR-VENT). Resuscitation 2023;193:109966. DOI: 10.1016/j.resuscitation.2023.109966.

391. Anez C, Becerra-Bolanos A, Vives-Lopez A, Rodriguez-Perez A. Cardiopulmonary Resuscitation in the Prone Position in the Operating Room or in the Intensive Care Unit: A Systematic Review. Anesth Analg 2021;132(2):285-292. DOI: 10.1213/ANE.0000000000005289.

392. Berg KC, J. Pawar, R. Cellini, J. Schexnayder, S. Soar, J. Olasveengen, T. on behalf of the Advanced Life Support, Basic Life Support and Paediatric Life Support Task Force. Cardiopulmonary Resuscitation and Defibrillation for Cardiac Arrest when Patients are in the Prone Position Consensus on Science with Treatment Recommendations International Liaison Committee on Resuscitation (ILCOR) Advanced Life Support and Basic Life Task Forces.

393. Malik N, Claus PL, Illman JE, et al. Air embolism: diagnosis and management. Future Cardiol 2017;13(4):365-378. DOI: 10.2217/fca-2017-0015.

394. Marsh PL, Moore EE, Moore HB, et al. Iatrogenic air embolism: pathoanatomy, thromboinflammation, endotheliopathy, and therapies. Front Immunol 2023;14:1230049. DOI: 10.3389/fimmu.2023.1230049.

395. Rahman ZU, Murtaza G, Pourmorteza M, et al. Cardiac Arrest as a Consequence of Air Embolism: A Case Report and Literature Review. Case Rep Med 2016;2016:8236845. DOI: 10.1155/2016/8236845.

396. Hinkelbein J, Andres J, Bottiger BW, et al. Cardiac arrest in the perioperative period: a consensus guideline for identification, treatment, and prevention from the European Society of Anaesthesiology and Intensive Care and the European Society for Trauma and Emergency Surgery. Eur J Trauma Emerg Surg 2023;49(5):2031-2046. DOI: 10.1007/s00068-023-02271-3.

397. Farquharson B, Cortegiani A, Lauridsen KG, et al. Teaching team competencies within resuscitation training: A systematic review. Resusc Plus 2024;19:100687. DOI: 10.1016/j.resplu.2024.100687.

398. Chan PS, Greif R, Anderson T, et al. Ten Steps Toward Improving In-Hospital Cardiac Arrest Quality of Care and Outcomes. Resuscitation 2023;193:109996. (In eng). DOI: 10.1016/j.resuscitation.2023.109996.

399. Aickin R, de Caen AR, Atkins DL, et al. Pediatric targeted temperature management post cardiac arrest. International Liaison Committee on Resuscitation (ILCOR) Pediatric Life Support Task Force. (https://costr.ilcor.org/document/pediatric-targeted-temperature-management-post-cardiac-arrest).

400. Berg KM, Holmberg MJ, Nicholson T, et al. Oxygenation and Ventilation Targets in Adults and Children with Return of Spontaneous Circulation after Cardiac Arrest. (https://costr.ilcor.org/document/oxygen-and-carbon-dioxide-targets-in-pediatric-patients-with-return-of-spontaneous-circulation-after-cardiac-arrest-task-force-systematic-review).

401. Nuthall G, Christoff A, Morrison LJ, Scholefield B, Force obotPLST. Blood pressure targets following return of circulation after cardiac arrest: Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR) Paediatric Life Support Task Force. (https://costr.ilcor.org/document/blood-pressure-targets-following-return-of-circulation-after-pediatric-cardiac-arrest-pls-4190-01-tf-sr).

This is a DRAFT-version

402. Topjian AA, de Caen A, Wainwright MS, et al. Pediatric Post-Cardiac Arrest Care: A Scientific Statement From the American Heart Association. Circulation 2019;140(6):e194-e233. (In eng). DOI: 10.1161/CIR.0000000000000697.

403. Topjian AA, Scholefield BR, Pinto NP, et al. P-COSCA (Pediatric Core Outcome Set for Cardiac Arrest) in Children: An Advisory Statement From the International Liaison Committee on Resuscitation. Resuscitation 2021;162:351-364. (In eng). DOI: 10.1016/j.resuscitation.2021.01.023.

404. Fowler JC, Morgan RW, O'Halloran A, et al. The impact of pediatric post-cardiac arrest care on survival: A multicenter review from the AHA get with the Guidelines(R)-resuscitation post-cardiac arrest care registry. Resuscitation 2024;202:110301. (In eng). DOI: S0300-9572(24)00195-3 [pii]

10.1016/j.resuscitation.2024.110301.

405. Douma MJ, Myhre C, Ali S, et al. What Are the Care Needs of Families Experiencing Sudden Cardiac Arrest? A Survivor- and Family-Performed Systematic Review, Qualitative Meta-Synthesis, and Clinical Practice Recommendations. J Emerg Nurs 2023;49(6):912-950. (In eng). DOI: 10.1016/j.jen.2023.07.001.

406. Barreto JA, Weiss NS, Nielsen KR, Farris R, Roberts JS. Hyperoxia after pediatric cardiac arrest: Association with survival and neurological outcomes. Resuscitation 2022;171:8-14. (In eng). DOI: 10.1016/j.resuscitation.2021.12.003.

407. Frazier AH, Topjian AA, Reeder RW, et al. Association of Pediatric Postcardiac Arrest Ventilation and Oxygenation with Survival Outcomes. Ann Am Thorac Soc 2024;21(6):895-906. (In eng). DOI: 10.1513/AnnalsATS.202311-948OC.

408. Yang JT, Erickson SL, Killien EY, Mills B, Lele AV, Vavilala MS. Agreement Between Arterial Carbon Dioxide Levels With End-Tidal Carbon Dioxide Levels and Associated Factors in Children Hospitalized With Traumatic Brain Injury. JAMA Netw Open 2019;2(8):e199448. (In eng). DOI: 10.1001/jamanetworkopen.2019.9448.

409. Mick NW, Williams RJ. Pediatric Cardiac Arrest Resuscitation. Emerg Med Clin North Am 2020;38(4):819-839. (In eng). DOI: 10.1016/j.emc.2020.06.007.

410. Liu R, Majumdar T, Gardner MM, et al. Association of Postarrest Hypotension Burden With Unfavorable Neurologic Outcome After Pediatric Cardiac Arrest. Crit Care Med 2024;52(9):1402-1413. (In eng). DOI: 10.1097/CCM.0000000000006339.

411. Wyckoff MH, Singletary EM, Soar J, et al. 2021 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Neonatal Life Support; Education, Implementation, and Teams; First Aid Task Forces; and the COVID-19 Working Group. Resuscitation 2021;169:229-311. (In eng). DOI: 10.1016/j.resuscitation.2021.10.040.

412. Morgan RW, Kirschen MP, Kilbaugh TJ, Sutton RM, Topjian AA. Pediatric In-Hospital Cardiac Arrest and Cardiopulmonary Resuscitation in the United States: A Review. JAMA Pediatr 2021;175(3):293-302. (In eng). DOI: 10.1001/jamapediatrics.2020.5039.

413. Holmberg MJ, Nicholson T, Nolan JP, et al. Oxygenation and ventilation targets after cardiac arrest: A systematic review and meta-analysis. Resuscitation 2020;152:107-115. (In eng). DOI: 10.1016/j.resuscitation.2020.04.031.

414. Albrecht M, de Jonge RCJ, Del Castillo J, et al. Association of cumulative oxygen and carbon dioxide levels with neurologic outcome after pediatric cardiac arrest resuscitation: A multicenter cohort study. Resusc Plus 2024;20:100804. (In eng). DOI: 10.1016/j.resplu.2024.100804.

This is a DRAFT-version

415. Gardner MM, Hehir DA, Reeder RW, et al. Identification of post-cardiac arrest blood pressure thresholds associated with outcomes in children: an ICU-Resuscitation study. Crit Care 2023;27(1):388. (In eng). DOI: 10.1186/s13054-023-04662-9.
416. Kirschen MP, Majmudar T, Beaulieu F, et al. Deviations from NIRS-derived optimal blood pressure are associated with worse outcomes after pediatric cardiac arrest. Resuscitation 2021;168:110-118. (In eng). DOI: 10.1016/j.resuscitation.2021.09.023.
417. Chun MK, Park JS, Han J, Jhang WK, Kim DH. The association between initial post-resuscitation diastolic blood pressure and survival after pediatric cardiac arrest: a retrospective study. BMC Pediatr 2024;24(1):563. (In eng). DOI: 10.1186/s12887-024-05037-x.
418. Hickey RW, Kochanek PM, Ferimer H, Graham SH, Safar P. Hypothermia and hyperthermia in children after resuscitation from cardiac arrest. Pediatrics 2000;106(1 Pt 1):118-22. (In eng). DOI: 10.1542/peds.106.1.118.
419. Bembea MM, Nadkarni VM, Diener-West M, et al. Temperature patterns in the early postresuscitation period after pediatric inhospital cardiac arrest. Pediatr Crit Care Med 2010;11(6):723-30. (In eng). DOI: 10.1097/PCC.0b013e3181dde659.
420. Magee A, Deschamps R, Delzoppo C, et al. Temperature Management and Health-Related Quality of Life in Children 3 Years After Cardiac Arrest. Pediatr Crit Care Med 2022;23(1):13-21. (In eng). DOI: 10.1097/PCC.0000000000002821.
421. Smith AE, Friess SH. Neurological Prognostication in Children After Cardiac Arrest. Pediatr Neurol 2020;108:13-22. DOI: 10.1016/j.pediatrneurol.2020.03.010.
422. Topjian AA, Sanchez SM, Shults J, Berg RA, Dlugos DJ, Abend NS. Early Electroencephalographic Background Features Predict Outcomes in Children Resuscitated From Cardiac Arrest. Pediatr Crit Care Med 2016;17(6):547-57. DOI: 10.1097/PCC.0000000000000740.
423. Scholefield BR, Tijssen J, Ganesan SL, et al. Prediction of good neurological outcome after return of circulation following paediatric cardiac arrest: A systematic review and meta-analysis. Resuscitation 2024:110483. (In eng). DOI: 10.1016/j.resuscitation.2024.110483.
424. Scholefield BT, J.; Ganesan, S.L.; Kool, M.; Topjian, A.; Bittencourt Couto, T.; Guerguerian, A.; on behalf of the International Liaison Committee on Resuscitation Pediatric Life Support Task Force. Biomarkers for the prediction of survival with good neurological outcome after return of circulation following pediatric cardiac arrest Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR) Pediatric Life Support Task Force, . (http://ilcor.org;).
425. Abukmail E, Bakhit M, Del Mar C, Hoffmann T. Effect of different visual presentations on the comprehension of prognostic information: a systematic review. BMC Med Inform Decis Mak 2021;21(1):249. (In eng). DOI: 10.1186/s12911-021-01612-9.
426. Hunfeld M, Dulfer K, Del Castillo J, Vazquez M, Buysse CMP. Long-term multidisciplinary follow-up programs in pediatric cardiac arrest survivors. Resusc Plus 2024;17:100563. (In eng). DOI: 10.1016/j.resplu.2024.100563.
427. Tijssen JA, McClean M, Lam M, Le B, To T. Epidemiology of paediatric out-of-hospital cardiac arrest in Ontario, Canada. Resusc Plus 2023;15:100442. (In eng). DOI: 10.1016/j.resplu.2023.100442.
428. Mackintosh NJ, Davis RE, Easter A, et al. Interventions to increase patient and family involvement in escalation of care for acute life-threatening illness in community health and hospital settings. Cochrane Database Syst Rev 2020;12(12):CD012829. (In eng). DOI: 10.1002/14651858.CD012829.pub2.
429. Sutton RM, Niles D, French B, et al. First quantitative analysis of cardiopulmonary resuscitation quality during in-hospital cardiac arrests of young children. Resuscitation 2014;85(1):70-4. (In eng). DOI: 10.1016/j.resuscitation.2013.08.014.

This is a DRAFT version

430. Hansen M, Walker-Stevenson G, Bahr N, et al. Comparison of Resuscitation Quality in Simulated Pediatric and Adult Out-of-Hospital Cardiac Arrest. JAMA Netw Open 2023;6(5):e2313969. (In eng). DOI: 10.1001/jamanetworkopen.2023.13969.
431. O'Halloran A, Nishisaki A. Understanding Challenges to High-quality Pediatric Out-of-Hospital Cardiac Arrest Resuscitation Performance. JAMA Netw Open 2023;6(5):e2313931. (In eng). DOI: 10.1001/jamanetworkopen.2023.13931.
432. Niles DE, Duval-Arnould J, Skellett S, et al. Characterization of Pediatric In-Hospital Cardiopulmonary Resuscitation Quality Metrics Across an International Resuscitation Collaborative. Pediatr Crit Care Med 2018;19(5):421-432. (In eng). DOI: 10.1097/PCC.0000000000001520.
433. Patocka C, Lockey A, Lauridsen KG, Greif R. Impact of accredited advanced life support course participation on in-hospital cardiac arrest patient outcomes: A systematic review. Resusc Plus 2023;14:100389. (In eng). DOI: S2666-5204(23)00032-2 [pii]

100389 [pii]

10.1016/j.resplu.2023.100389.
434. Wissenberg M, Lippert FK, Folke F, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. JAMA 2013;310(13):1377-84. (In eng). DOI: 10.1001/jama.2013.278483.
435. Brenner RA, Taneja GS, Haynie DL, et al. Association between swimming lessons and drowning in childhood: a case-control study. Arch Pediatr Adolesc Med 2009;163(3):203-10. DOI: 10.1001/archpediatrics.2008.563.
436. Denny SA, Quan L, Gilchrist J, et al. Prevention of Drowning. Pediatrics 2019;143(5). DOI: 10.1542/peds.2019-0850.
437. Yang L, Nong QQ, Li CL, Feng QM, Lo SK. Risk factors for childhood drowning in rural regions of a developing country: a case-control study. Inj Prev 2007;13(3):178-82. DOI: 10.1136/ip.2006.013409.
438. Petrass LA, Blitvich JD. Preventing adolescent drowning: understanding water safety knowledge, attitudes and swimming ability. The effect of a short water safety intervention. Accid Anal Prev 2014;70:188-94. DOI: 10.1016/j.aap.2014.04.006.
439. Semeraro F, Greif R, Bottiger BW, et al. European Resuscitation Council Guidelines 2021: Systems saving lives. Resuscitation 2021;161:80-97. (In eng). DOI: 10.1016/j.resuscitation.2021.02.008.
440. Lauridsen KG, Lofgren B, Brogaard L, Paltved C, Hvidman L, Krogh K. Cardiopulmonary Resuscitation Training for Healthcare Professionals: A Scoping Review. Simul Healthc 2022;17(3):170-182. (In eng). DOI: 10.1097/SIH.0000000000000608.
441. Holmberg MJ, Wiberg S, Ross CE, et al. Trends in Survival After Pediatric In-Hospital Cardiac Arrest in the United States. Circulation 2019;140(17):1398-1408. (In eng). DOI: 10.1161/CIRCULATIONAHA.119.041667.
442. Kessler DO, Peterson DT, Bragg A, et al. Causes for Pauses During Simulated Pediatric Cardiac Arrest. Pediatr Crit Care Med 2017;18(8):e311-e317. DOI: 10.1097/PCC.0000000000001218.
443. Bro-Jeppesen J, Kjaergaard J, Wanscher M, et al. The inflammatory response after out-of-hospital cardiac arrest is not modified by targeted temperature management at 33 degrees C or 36 degrees C. Resuscitation 2014;85(11):1480-7. DOI: 10.1016/j.resuscitation.2014.08.007.
444. Yeung JH, Ong GJ, Davies RP, Gao F, Perkins GD. Factors affecting team leadership skills and their relationship with quality of cardiopulmonary resuscitation. Crit Care Med 2012;40(9):2617-21. DOI: 10.1097/CCM.0b013e3182591fda.

This is a DRAFT version

445. Allan KA Y, J, Flaim B, Aves T, Olejarz M, Cheng A, Kishibe T, Greif R on behalf of the International Liaison Committee on Resuscitation from the Education Implementation Teams Task Force (EIT). . Medical Emergency Systems/ Rapid Response Teams for adult in-hospital patients. Consensus on Science with Treatment Recommendations. International Liaison Committee on Resuscitation (ILCOR). (https://costr.ilcor.org/document/medical-emergency-systems-rapid-response-teams-for-adult-in-hospital-patients-eit-6309-tf-sr).

446. Ong G, Acworth J, Ng KC, et al. Pediatric Early Warning Systems (PEWS) With Or Without Rapid Response Teams: Consensus on Science with Treatment Recommendations.

.

447. Lauridsen KG, Burgstein E, Nabecker S, et al. Cardiopulmonary resuscitation coaching for resuscitation teams: A systematic review. Resusc Plus 2025;21:100868. DOI: 10.1016/j.resplu.2025.100868.

448. Soar J, Bottiger BW, Carli P, et al. European Resuscitation Council Guidelines 2021: Adult advanced life support. Resuscitation 2021;161:115-151. (In eng). DOI: 10.1016/j.resuscitation.2021.02.010.

449. Lauridsen KG, Krogh K, Muller SD, et al. Barriers and facilitators for in-hospital resuscitation: A prospective clinical study. Resuscitation 2021;164:70-78. DOI: 10.1016/j.resuscitation.2021.05.007.

450. Stiles MK, Wilde AAM, Abrams DJ, et al. 2020 APHRS/HRS expert consensus statement on the investigation of decedents with sudden unexplained death and patients with sudden cardiac arrest, and of their families. Heart Rhythm 2021;18(1):e1-e50. (In eng). DOI: 10.1016/j.hrthm.2020.10.010.

451. Dalal A, Czosek RJ, Kovach J, et al. Clinical Presentation of Pediatric Patients at Risk for Sudden Cardiac Arrest. J Pediatr 2016;177:191-196. (In eng). DOI: 10.1016/j.jpeds.2016.06.088.

452. Waaler Loland V, Agesen FN, Lynge TH, et al. Low Birth Weight Increases the Risk of Sudden Cardiac Death in the Young: A Nationwide Study of 2.2 Million People. J Am Heart Assoc 2021;10(7):e018314. (In eng). DOI: 10.1161/JAHA.120.018314.

453. Meyer L, Stubbs B, Fahrenbruch C, et al. Incidence, causes, and survival trends from cardiovascular-related sudden cardiac arrest in children and young adults 0 to 35 years of age: a 30-year review. Circulation 2012;126(11):1363-72. (In eng). DOI: 10.1161/CIRCULATIONAHA.111.076810.

454. Glinge C, Rossetti S, Oestergaard LB, et al. Risk of Sudden Infant Death Syndrome Among Siblings of Children Who Died of Sudden Infant Death Syndrome in Denmark. JAMA Netw Open 2023;6(1):e2252724. (In eng). DOI: 10.1001/jamanetworkopen.2022.52724.

455. Pupaza A, Cinteza E, Vasile CM, Nicolescu A, Vatasescu R. Assessment of Sudden Cardiac Death Risk in Pediatric Primary Electrical Disorders: A Comprehensive Overview. Diagnostics (Basel) 2023;13(23) (In eng). DOI: 10.3390/diagnostics13233551.

456. Graziano F, Schiavon M, Cipriani A, et al. Causes of sudden cardiac arrest and death and the diagnostic yield of sport preparticipation screening in children. Br J Sports Med 2024;58(5):255-260. (In eng). DOI: 10.1136/bjsports-2023-107357.

457. van der Sluijs R, van Rein EAJ, Wijnand JGJ, Leenen LPH, van Heijl M. Accuracy of Pediatric Trauma Field Triage: A Systematic Review. JAMA Surg 2018;153(7):671-676. (In eng). DOI: 10.1001/jamasurg.2018.1050.

458. van der Sluijs R, Lokerman RD, Waalwijk JF, et al. Accuracy of pre-hospital trauma triage and field triage decision rules in children (P2-T2 study): an observational study. Lancet Child Adolesc Health 2020;4(4):290-298. (In eng). DOI: 10.1016/S2352-4642(19)30431-6.

This is a DRAFT-version

459. Lupton JR, Davis-O'Reilly C, Jungbauer RM, et al. Under-Triage and Over-Triage Using the Field Triage Guidelines for Injured Patients: A Systematic Review. Prehosp Emerg Care 2023;27(1):38-45. (In eng). DOI: 10.1080/10903127.2022.2043963.
460. Keebler JR, Lazzara EH, Patzer BS, et al. Meta-Analyses of the Effects of Standardized Handoff Protocols on Patient, Provider, and Organizational Outcomes. Hum Factors 2016;58(8):1187-1205. (In eng). DOI: 10.1177/0018720816672309.
461. Hannegard Hamrin T, Radell PJ, Flaring U, Berner J, Eksborg S. Short- and Long-Term Outcome in Critically Ill Children After Acute Interhospital Transport to a PICU in Sweden. Pediatr Crit Care Med 2020;21(7):e414-e425. (In eng). DOI: 10.1097/PCC.0000000000002319.
462. Chong SL, Goh MSL, Ong GY, et al. Do paediatric early warning systems reduce mortality and critical deterioration events among children? A systematic review and meta-analysis. Resusc Plus 2022;11:100262. (In eng). DOI: S2666-5204(22)00062-5 [pii]

100262 [pii]

10.1016/j.resplu.2022.100262.
463. Allen D, Lloyd A, Edwards D, et al. Development, implementation and evaluation of an evidence-based paediatric early warning system improvement programme: the PUMA mixed methods study. BMC Health Serv Res 2022;22(1):9. (In eng). DOI: 10.1186/s12913-021-07314-2 [pii]

7314 [pii]

10.1186/s12913-021-07314-2.
464. Zachariasse JM, Espina PR, Borensztajn DM, et al. Improving triage for children with comorbidity using the ED-PEWS: an observational study. Arch Dis Child 2022;107(3):229-233. (In eng). DOI: 10.1136/archdischild-2021-322068.
465. Wessler JD, Stant J, Duru S, Rabbani L, Kirtane AJ. Updates to the ACCF/AHA and ESC STEMI and NSTEMI guidelines: putting guidelines into clinical practice. Am J Cardiol 2015;115(5 Suppl):23A-8A. (In eng). DOI: 10.1016/j.amjcard.2015.01.004.
466. Cortes-Puch I, Applefeld WN, Wang J, Danner RL, Eichacker PQ, Natanson C. Individualized Care Is Superior to Standardized Care for the Majority of Critically Ill Patients. Crit Care Med 2020;48(12):1845-1847. (In eng). DOI: 10.1097/CCM.0000000000004373.
467. Hansen MV, Lofgren B, Nadkarni VM, Lauridsen KG. Impact of different methods to activate the pediatric mode in automated external defibrillators by laypersons - A randomized controlled simulation study. Resusc Plus 2022;10:100223. (In eng). DOI: 10.1016/j.resplu.2022.100223.
468. Foster AG, Deakin CD. Accuracy of instructional diagrams for automated external defibrillator pad positioning. Resuscitation 2019;139:282-288. (In eng). DOI: 10.1016/j.resuscitation.2019.04.034.
469. Andersen LW, Holmberg MJ, Granfeldt A, James LP, Caulley L. Cost-effectiveness of public automated external defibrillators. Resuscitation 2019;138:250-258. (In eng). DOI: 10.1016/j.resuscitation.2019.03.029.
470. Greif R, Bhanji F, Bigham BL, et al. Education, Implementation, and Teams: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2020;156:A188-A239. (In eng). DOI: 10.1016/j.resuscitation.2020.09.014.
471. Yeung J, Djarv T, Hsieh MJ, et al. Spaced learning versus massed learning in resuscitation - A systematic review. Resuscitation 2020;156:61-71. (In eng). DOI: 10.1016/j.resuscitation.2020.08.132.

This is a DRAFT version

472. Niles D, Sutton RM, Donoghue A, et al. "Rolling Refreshers": a novel approach to maintain CPR psychomotor skill competence. Resuscitation 2009;80(8):909-12. DOI: 10.1016/j.resuscitation.2009.04.021.
473. Ko YC, Hsieh MJ, Schnaubelt S, Matsuyama T, Cheng A, Greif R. Disparities in layperson resuscitation education: A scoping review. Am J Emerg Med 2023;72:137-146. (In eng). DOI: 10.1016/j.ajem.2023.07.033.
474. Schnaubelt S, Veigl C, Snijders E, et al. Tailored Basic Life Support Training for Specific Layperson Populations-A Scoping Review. J Clin Med 2024;13(14) (In eng). DOI: 10.3390/jcm13144032.
475. Tesfaye SH, Loha E, Johansson KA, Lindtjorn B. Cost-effectiveness of pulse oximetry and integrated management of childhood illness for diagnosing severe pneumonia. PLOS Glob Public Health 2022;2(7):e0000757. (In eng). DOI: 10.1371/journal.pgph.0000757.
476. Florez ID, Sierra J, Perez-Gaxiola G. Balanced crystalloid solutions versus 0.9% saline for treating acute diarrhoea and severe dehydration in children. Cochrane Database Syst Rev 2023;5(5):CD013640. (In eng). DOI: 10.1002/14651858.CD013640.pub2.
477. Andersen LW, Raymond TT, Berg RA, et al. Association Between Tracheal Intubation During Pediatric In-Hospital Cardiac Arrest and Survival. JAMA 2016;316(17):1786-1797. (In eng). DOI: 10.1001/jama.2016.14486.
478. Umoren RA, Birnie K. Pediatric Telemedicine Consults to Improve Access to Intensive Care in Rural Environments. Pediatr Clin North Am 2025;72(1):123-132. (In eng). DOI: 10.1016/j.pcl.2024.07.028.

This is a DRAFT-version