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Practice Guideline

European Resuscitation Council Guidelines 2025 Executive Summary

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Abstract

The 2025 European Resuscitation Council (ERC) Guidelines present the most up-to-date evidence-based guidelines for the practice of resuscitation across Europe. The ERC Guidelines 2025 are based on evidence produced by the International Liaison Committee on Resuscitation (ILCOR) in the form of systematic reviews, scoping reviews, and evidence updates, published as the ILCOR Consensus on Science with Treatment Recommendations. The certainty of evidence of these ILCOR treatment recommendations was used to issue the ERC Guidelines 2025 Recommendations. In some cases, the ERC made good practice statements when evidence was absent for certain topics. If no ILCOR review was available, the ERC writing groups conducted their own reviews to provide recommendations. The ERC Guidelines 2025 cover the epidemiology of cardiac arrest, the role that systems play in saving lives, adult basic life support, adult advanced life support, resuscitation in special circumstances, post resuscitation care, newborn resuscitation and support of transition of infants at birth, paediatric basic and advanced life support, resuscitation ethics, education for resuscitation, and first aid. These guidelines are a framework of recommendations for the approach to out-of-hospital and in-hospital resuscitation; the implementation is achieved locally taking local legislation and health care regulations into consideration.

Introduction

The history

The European Resuscitation Council (ERC) aims to preserve human life by making high-quality resuscitation available to all.[2] To achieve this, up-to-date evidence-based European resuscitation guidelines for the prevention and treatment of cardiac arrest and life-threatening emergencies have been published since 1992. The 1992 guidelines covered basic[3] and advanced life support (ALS).[4] Two years later in 1994, a guideline for paediatric life support (PLS)[5] and a guideline for the management of *peri*-arrest arrhythmias[6] followed. Guidelines for basic and advanced management of the airway and ventilation during resuscitation[7] were published in

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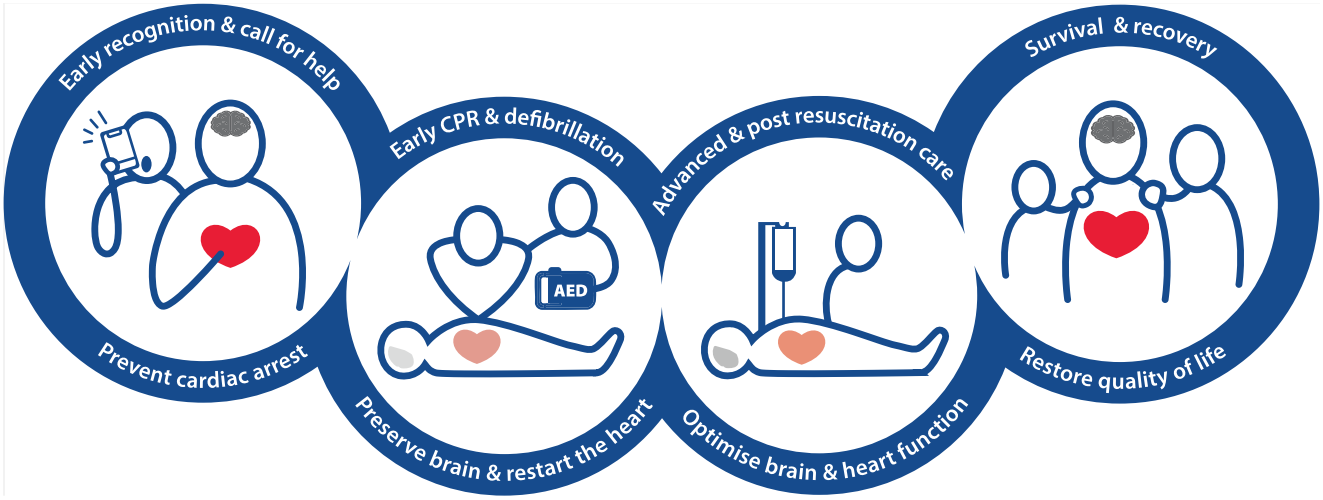

Fig. 1 – Chain of survival.

1996 and updated ERC guidelines on basic life support (BLS) and ALS in 1998.[8,9] In 2000, international guidelines were produced in collaboration with the International Liaison Committee on Resuscitation (ILCOR).[10] Subsequently, the ERC produced its guidelines every 5 years: 2005[11], 2010[12] 2015[13], and 2021[14] (with a one-year delay because of COVID-19). In addition, the ERC published guideline updates in 2017 and 2018[15,16] based on the ILCOR Consensus on CPR Science and Treatment Recommendation (CoSTR) publications.[17,18] An ERC update was published in 2020 and concerned resuscitation in the context of COVID-19.[19] The ERC Guidelines 2025 are based on an extensive update on resuscitation science from ILCOR's CoSTR 2025[27] and provide the most up-to-date evidence-based guidelines for laypersons, healthcare professionals and all stakeholders responsible for health policy across Europe.

The chain of survival

The four-ring ERC Chain of Survival was first presented 20 years ago[1,11] as a concept to highlight time-sensitive interventions that aim to improve survival of cardiac arrest victims. It included early recognition and activation of the emergency medical services in the first ring, early CPR and defibrillation in the second and third ring, and post-resuscitation care in the fourth ring.

The chain of survival has been revised for the ERC Guidelines 2025 so that it reflects recent developments in resuscitation science in prevention of cardiac arrest, survivorship, and long-term recovery following cardiac arrest. Following discussions about the numbers of rings and additional text, the ERC has retained the four-ring chain of survival and retained the simplicity of the original drawing.

Prevention of cardiac arrest was already part of the first ring, but to emphasise its growing importance it was moved to the header of this ring. The content of that ring was kept as before: early recognition of a deteriorating patient or cardiac arrest (in- or out-of-hospital) and early call for help. The second ring condensed the former two central rings and integrated early cardiopulmonary resuscitation and defibrillation as an integrated approach to restart the heart and preserve brain and heart function. The new drawing visualises a person providing an AED while CPR is ongoing. The third ring is now advanced- and post-resuscitation care, aiming to optimise heart and brain function. The newly designed final ring emphasises the importance of recovery to restore the quality of life for the cardiac arrest survivor and their community. Restoration of heart and brain function is depicted by a return to the same colours used for these organs in the first ring (Fig. 1).

International Liaison Committee on Resuscitation[21]

The International Liaison Committee on Resuscitation (ILCOR, https://www.ilcor.org) includes representatives from the American Heart Association (AHA), the ERC, the Heart and Stroke Foundation of Canada (HSFC), the Australian and New Zealand Committee on Resuscitation (ANZCOR), the Resuscitation Council of Southern Africa (RCSA), the Inter-American Heart Foundation (IAHF), the Resuscitation Council of Asia (RCA), and the Indian Resuscitation Council Federation (IRCF), and as a collaborating organization International Federation of Red Cross and Red Crescent (IFRC).

The vision of ILCOR is to save more lives globally through resuscitation,[22,23] through promoting, disseminating and advocating international implementation of evidence-informed resuscitation and first aid, using transparent evaluation and a consensus summary of scientific data.[24] As one of the founding members, the ERC works closely with ILCOR to achieve those goals. The core activity of the ILCOR task forces is the systematic assessment of evidence to produce the international CoSTR.

From 2000 to 2015, researchers from the ILCOR member councils evaluated resuscitation science in 5-yearly cycles. After the publication of the 2015 international CoSTR,[25] ILCOR committed to a continuous evidence-evaluation process, and publication of annual CoSTR updates.

The 2025 CoSTR summary and the 96 systematic reviews, the 43 scoping reviews, and the 112 evidence updates of resuscitation science were published in *Resuscitation* and *Circulation* as the 2025 CoSTR,[27–34] which are the basis for the evidence informing the ERC Guidelines 2025 (Table 1).

Table 1 – Summary outline of the process steps for the 2025 CoSTR (reproduced from CoSTR 2025[28]).

Processes for Systematic review (SR)
Develop PICOST (including inclusion and exclusion criteria)
Confirm content expert team
Level of importance allocated to individual outcomes
Develop and fine-tune database specific search strategies
Registers systematic reviews (SR) with PROSPERO
Revised search strategies used to search databases
Articles identified by the search are screened according to inclusion and exclusion criteria
Compile final list of studies to include
Assessment of bias for individual studies
Data extracted for creation of tables
GRADE Evidence Profile table created
Evidence to Decision framework completed
Draft Consensus on Science (CoS) statements and Treatment Recommendations (TRs)
Revised draft of CoS and TR
Summary statement created (including recommendation about future reviews)
Public invited to comment on draft CoS and TRs
Detailed iterative review of CoS and TRs to create final version for posting and publication

The ERC Guidelines 2025 development process

High-quality, evidence-informed guidelines are used increasingly to organise healthcare systems, and to guide healthcare professionals in their daily clinical practice.[35]

The Institute of Medicine established quality standards for clinical practice guidelines in 2011,[36] followed by the Guidelines International Network in 2012.[37–39] The ERC follows these principles for guideline development. This includes full transparency of the guidance on panel composition, decision-making processes, conflicts of interest management, guideline objective, development methods, evidence review and creation of recommendations, ratings of evidence, guideline review, and funding. A written protocol describing the guideline development process was developed and approved by the ERC Board before the start of the guideline development process and made available to the public on the ERC website.[40]

Composition of Guidelines Writing Groups

The ERC Articles of Association and Bylaws guided the formal process of the ERC guidelines development.[2] The ERC Director of Guidelines and ILCOR is elected by the General Assembly of the ERC and mandated to co-ordinate the Guidelines development process. The ERC Guidelines Steering Committee was created to support the Director of Guidelines and ILCOR. Key for the formation of the Guidelines Steering Committee was diversity (e.g. gender distribution, early and mid-career and senior resuscitation professionals), which resulted in the following member composition: ERC Director Guidelines and ILCOR (Chair), ERC Director of Science, ERC Director of External Affairs, ERC Chair and Chair-elect, Editor-in-Chief of Resuscitation, representatives from each writing group, Chair of the ERC Diversity, Equity, and Inclusion Committee, and an ERC project manager. All writing groups were represented in the Guidelines Steering Committee, and each Guidelines Steering Committee member was part of no more than two writing groups.

An open call for writing group members was made in February 2024. Following a review of conflicts of interest (described below), writing group chairs and members were appointed by the Board. Members were appointed based on their expertise and credibility as leading (or emerging) resuscitation scientists/clinicians/methodologists, a balance of professions (medicine, physician, non-physician, nursing, paramedicine), diversity (gender, ethnicity, seniority (senior and mid-career level), and geography across Europe.

The ERC also invited content experts for specific ERC Guidelines 2025 from the European associations that have a seat in the ERC General Assembly: members of the European Society for Emergency Medicine (EuSEM) participated in the ERC Guidelines 2025 adult

Basic Life Support (BLS), adult Advanced Life Support (ALS), Paediatric Life support (PLS), Special Circumstances, Systems Saving Lives, Ethics and First Aid; the International Federation of Red Cross and Red Crescent (IFRC) in First Aid and Education, the European Society for Intensive Care Medicine (ESICM) in Post Resuscitation Care and adult ALS; the European Society of Anaesthesiology and Intensive Care (ESAIC) in Special Circumstances, Systems Saving Lives, BLS, ALS; and the European Society of Cardiology (ESC) in ALS and Post Resuscitation Care. Following the recommendations on guideline development, we included a community advisor (volunteer lay persons, survivors, co-survivors, family members of a survivor or non-survivor, etc.) in nearly all writing groups to include also the view of the communities and the public in the ERC guidelines 2025.[41,42]

The appointed writing groups ranged in size from 13 to 22 members, and most were physicians ($n = 86$, 63 %). Thirty-eight percent of writing group members were female, and 28 (20 %) were early or mid-career researchers. The writing group members came from 29 countries including Australia, Austria, Belgium, Brazil, Canada, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Malta, Netherlands, Norway, Poland, Romania, Serbia, Slovenia, Spain, Sri Lanka, Sweden, Switzerland, Tunisia, United Kingdom, and United States.

The competences and role description for writing group members included:

- Provide measurable clinical and scientific expertise in resuscitation (e.g. PubMed citations,[43] h-factor retrieved from Google Scholar,[44] i-Cite RCR).[45]
- Actively participate in the majority of Guidelines writing group virtual meetings.
- Systematically review the published literature on specific topics at the request of the Guidelines writing groups.
- Present review findings and lead discussions within the group on specific topics.
- Develop and refine clinical practice algorithms and the Guidelines.
- Fulfil the International Committee of Medical Journal Editors (ICMJE) requirements for authorship.
- Be prepared to be publicly accountable for the contents of the Guidelines and promote their adoption.
- Being an ERC member (except invited persons from European associations, and community advisors).
- Comply with the ERC non-disclosure agreement and the conflict-of-interest policy.[46] (Fig. 2)

Fig. 2 – Stepwise process for the development of the ERC Guidelines 2025.

Conflict of interest management

Conflict of interest (COI) was managed according to international recommendations[47] and followed the ERC policy for COI (Supplement B).[46] Guidelines Steering Committee and writing group members completed an annual COI declaration. The COI declarations were reviewed by the ERC Governance Committee which prepared and submitted a report to the Guidelines Steering Committee. The ERC guideline development process allowed public access to individual writing group members' COIs through a request form via the ERC webpage.

The members of the Guidelines Steering Committee, the writing group chairs, and at least 50 % of the writing group were required to be free of commercial conflicts of interest. At the chair's discretion, writing group members with a COI were still able to participate in discussions that related to the topic, but were not involved in voting, decisions, drafting or approving recommendations.

The ERC has financial relationships with business partners who support the overall work of the ERC.[48] The development of the ERC guidelines occurred entirely independently from the influence of business partners. None of the Guidelines Steering Committee members or the writing group members were paid by the ERC or any other entity to write these guidelines.

Diversity equality, equity and inclusion[49–52]

The ERC is committed to integrate diversity, equality, equity and inclusion (DEI) as core principles in the development of the ERC guidelines 2025.[50] A representative of the ERC DEI committee joined the Guidelines Steering Committee to guide this integration. The DEI considerations in the guideline process include recommendations for resuscitation in low-resource settings, graphic tables suitable for those with colour vision impairment and subti-

tled linked videos to facilitate understanding for those with hearing difficulties.

Each writing group included at least one early-mid career researcher (20 % of authors in these guidelines), and where possible a lay person was also involved as a community advisor.[53]

Diversity was considered when forming the writing groups and the Guidelines Steering Committee in terms of gender (38 % female, compared with 27 % in 2021), age (51.3 ± 10.9 years, compared with 56.8 ± 10.8 years in 2021), and geographic location (28 countries, 23 European and 5 non-European, compared with 24 countries, 22 European and 2 non-European in 2021).

The ERC guidelines are based on ILCOR treatment recommendations that integrate equity as part of the Evidence to Decision framework.[54,55] Where possible, we checked the equity in the guideline recommendations using (A) the World Health Organization (WHO) INTEGRATE tool for equity to formulate concise guidelines for clinical practice[56], (B) the residence, race, ethnicity, culture, language, occupation, gender/sex, religion, education, socioeconomic status, and social capital (PROGRESS) plus tool, [57,58] and (C) the INternational CLinical Epidemiology Network (INCLEN) tool for low-resource settings.[59] The ERC intends to extend the develop the DEI process in the future.[59–62].

Scope of the guidelines

The ERC Guidelines 2025 address resuscitation practice for the ERC network of 31 national resuscitation councils.[2] The intended audience are lay persons, first aiders, first responders, community healthcare staff, ambulance staff, hospital staff, instructors, teachers in schools, educators, those responsible for healthcare policy and practice, and everybody in the community who is interested in improving survival after cardiac arrest. The ERC Guidelines 2025 are relevant to both the community (out-of-hospital) and hospital settings. The scope of the individual guidelines was developed by the writing groups in the beginning of 2024. The different guideline scopes were posted for public consultation for 2 weeks in May 2024 before being finalised and approved by the ERC General Assembly in June 2024.

The 2025 Guidelines cover the following topics

- Epidemiology in resuscitation[63]
- Systems saving lives[64]
- Adult basic life support[65]
- Adult advanced life support[66]
- Adult special circumstances in resuscitation[67]
- Adult post resuscitation care (in collaboration with the European Society of Intensive Care Medicine)[68]
- Newborn resuscitation and support of transition of infants at birth[69]
- Paediatric life support[70]
- Education of resuscitation[71]
- Ethics in resuscitation[72]
- First Aid[73]

Resuscitation in low-resource settings

Previous ERC guidelines were – and still are – developed predominantly by people from high-resource settings, and for patients and caregivers living in high-resource settings. These guidelines have always assumed an EMS and hospital system equipped with all up-to-date devices, trained personnel (or capacity to train all personnel), and at least 24/7 referral options to tertiary care. This may be true for many parts in Europe, however, not all European regions can be considered as high-resource as there are e.g., lower- or middle-income countries, remote areas, or offshore facilities, etc.[74,75] Within remote areas, the available infrastructure varies.[76] Also, natural disasters, pandemics, or armed conflicts may quickly turn high-resource settings into low-resource settings.

The ERC guidelines are also used in low-income countries and, in line with the ILCOR's focus on the truly global applicability of recommendations,[77] the ERC Guidelines 2025 include considerations on how to apply the recommendations in low-resource settings wherever possible. The guideline recommendations for low-resource settings have been developed together with experts from the respective resource settings whenever possible.

In the context of the ERC Guidelines 2025,'low-resource settings' refers to conditions where healthcare systems are significantly constrained to provide optimal care. Thus, it may not only refer to low-income settings but any area, setting, or situation with significant constraints to the healthcare system, even in in some high-resource countries that are facing increasing financial challenges. Low-resource settings often suffer from a less developed medical infrastructure: This means limited access to essential resources like funding, medications, equipment, transport, or trained staff. These limitations severely impact the ability to provide quality healthcare services to the population at an evidence-based level.

Methods

The step-by-step process for guideline development is summarised in Fig. 2. The ERC Guidelines Steering Committee defined the different ERC Guidelines 2025. An open call for writing group members was made in February 2024. Following a review of conflicts of interest (described below), writing group chairs and members were appointed by the Board. The writing groups developed the scope of their guidelines using a standardised template which contained the overall objective, intended audience, setting for their use, and the key topics that would be covered. These guideline scopes were presented for public comment and revised. The writing groups then identified, discussed, and synthesised the relevant evidence. Based on this, existing guidelines recommendations were updated, new evidence from ILCOR systematic or scoping reviews was integrated into existing recommendations. If topics were not covered by ILCOR, ERC writing groups also undertook their own reviews to assess the available evidence and to synthesise key information and themes.

Evidence reviews

The ERC Guidelines are informed by the continuous ILCOR Evidence Evaluation process which is described in detail elsewhere.[27,28] (Table 1) For the ILCOR CoSTR, three types of evidence evaluation were performed: systematic reviews, scoping reviews, and evidence updates.

ILCOR systematic reviews follow the methodological principles described by the Institute of Medicine, Cochrane Collaboration, and Grading of Recommendations Assessment, Development, and Evaluation (GRADE).[78,79] The reviews are presented according to the Preferred Reporting Items for a Systematic Review and Meta-Analysis (PRISMA).[80]

ILCOR systematic reviews generally have a focused and narrow structured question following the Population, Intervention, Comparison, Outcome, Study design, Timeframe framework. Each treatment recommendation indicated the strength of the recommendation and the certainty of the evidence according to GRADE methodology. The strength of recommendations reflects the extent to which the

ILCOR Task Force was confident that the desirable effects of an action or intervention outweighed the undesirable effects. Such deliberations were informed by the Evidence to Decision Framework developed by GRADE[81] which enables consideration of the desirable effects, undesirable effects, certainty of evidence, values, balance of effects, resources required, cost effectiveness, equity, acceptability and feasibility. A strong recommendation indicates that the desirable effects outweigh the undesirable effects, and typically uses terms such as 'we recommend'. Weak recommendations (low confidence that the desirable effects outweigh the undesirable effects) typically use the term 'we suggest'. Only systematic reviews could result in new or modified ILCOR treatment recommendations that were summarized in the ILCOR CoSTRs.[82]

ILCOR introduced adolopments of recently performed systematic reviews including an update of the literature search and assessment of the evidence according to GRADE methodology,[83] aiming to make a consensus on science statement and, if appropriate, a treatment recommendation.

ILCOR scoping reviews take a broader approach to a topic, and were reported in accordance with the PRISMA extension for scoping reviews utilising narrative summaries across a broader range of subjects that would not be possible through more narrowly focussed systematic reviews.[84,85] Scoping reviews, unlike systematic reviews, cannot formulate a treatment recommendation. Instead, they can trigger a future systematic review, or a good practice statement can be formulated to provide guidance in an area where no or only very weak evidence exists.[86,87] (Table 2)

ILCOR evidence updates[28] were designed to address topics that were previously reviewed to identify if any new evidence had emerged. Such evidence updates either provided assurance that previous treatment recommendations remained valid or highlighted the need to update a previous systematic review. Evidence updates do not enable changes to be made to treatment recommendations or good practice statements but may prompt new recommendations through updated systematic reviews.

Systematic reviews from other organisations available in public domains were eligible for inclusion if they were conducted and reported according to AMSTAR (Assessing the methodological quality of systematic reviews)[88] and PRISMA recommendations.[80]

Table 2 – Certainty of evidence for a specific outcome (or across outcomes).

Grade	Description certainty level
High	We are very confident that the true effect lies close to that of the estimate of the effect
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low	Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low	We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Decision-making processes

The ERC guidelines 2025 are based on the 2025 ILCOR CoSTRs.[27–34] Where treatment recommendations or good practice statements are provided by ILCOR, they have been followed by the ERC. For topics that had no ILCOR recommendation or good practice statement, the ERC writing groups performed their own reviews and discussed the available evidence within the writing groups until consensus was achieved. The writing group chairs ensured that each working group member had the opportunity to present and debate their views and ensured that discussions were open and constructive. All discussions took place during many videoconferences that were held between April 2024 and June 2025. Failure to reach consensus was made clear in the final wording of the recommendation. The quorum for conducting writing group business and for reaching consensus was at least 75 % of the writing group members. The ERC guideline recommendations were endorsed by all writing group members.

Stakeholder consultation and peer review

The scope document was posted on the ERC website for public comment between 16 May 2024 and 12 June 2024. The drafts of all ERC Guidelines 2025 were posted between 5 and 30 May 2025 for open peer review via the ERC guidelines web site. The opportunities to review and comment on these documents were advertised through e-mail, social media (Facebook, Instagram, LinkedIn, X/former Twitter) and the ERC network of 31 national resuscitation councils. Those providing feedback had to identify themselves and highlight any relevant conflict of interest. All national resuscitation councils of the ERC were asked to comment on the guidelines and agreed to the ERC Guidelines 2025.

The ERC Guidelines 2025 drafts received 820 written responses – 7 % of responders reported a conflict of interest of which 29 % were commercial conflicts and 71 % academic. Feedback comments were distributed to the writing groups. Where appropriate, writing groups adapted their draft guidelines accordingly. The final drafts of the guidelines were approved by the ERC Board and the members of the ERC General Assembly in June 2025.

Guideline updates

In 2016, ILCOR started a continuous evidence evaluation process and published each completed CoSTR on the ILCOR website along with annual ILCOR CoSTRs in Circulation and Resuscitation. The ERC recognises the substantial time, effort and resources required to implement new evidence in resuscitation science and to incorporate this into resuscitation guidelines. As the ERC is cognisant of the confusion that could be caused by frequent changes to guidelines, the ERC decided to maintain the 5-year cycles for routine updates to its guidelines and resuscitation course materials. Each new CoSTR published by ILCOR is reviewed by the ERC Science and Educational Committees, and the ERC Directors of Science and ILCOR, to assess its potential impact on the ERC guidelines and education programmes. If important practice changing ILCOR statements are made, which are in conflict with ERC guidelines, the ERC may provide guideline updates to those topics in between the 5-year cycles. This ensures timely judgement of the potential impact of implementing any new science (lives saved, improved neurological outcome, reduced costs) while considering the challenges of a change (cost, logistical consequences, dissemination and communication).

Availability

All ERC guidelines and updates will be freely available through the ERC website and as a freely-downloadable open-access publication in the ERC official journal, *Resuscitation*. National resuscitation councils can translate ERC guidelines for non-commercial use locally.

Financial support and sponsoring organisation
These guidelines are supported by the ERC, which is a non-profit organisation. A budget is set annually by the ERC Board to support the guideline development process.

Concise guidelines for clinical practice

Each ERC Guidelines 2025 has an extended table with changes or new recommendations compared with the ERC Guidelines 2021. Most of the ERC guidelines will be used in emergencies where efficient and timely action is critical. The concise guidelines for clinical practice sections are intended to provide clear, succinct recommendations with easily understood algorithms to provide the reader, mostly healthcare professionals but also trained or untrained lay persons, with unambiguous, step-by-step instructions. As such, these components of the ERC guidelines do not include information about the certainty of evidence or strength of recommendations which can be found in the evidence informing the guidelines sections or in the ILCOR CoSTR publications.[89]

Evidence informing the guidelines

The concise guidelines for clinical practice are followed by the evidence that informs these guidelines in each of the ERC Guidelines 2025. Most ERC recommendations are based on the ILCOR CoSTRs. The certainty of evidence is determined by the ILCOR task forces and ranges from very low to high (see Table 2).[90,91]

In many areas of resuscitation science, there is no evidence or insufficient evidence to formulate an evidence-informed recommendation.[92] However, treatment options are needed for clinical practice, and in such cases the expert opinion of the writing group produced a consensus on current approaches to treatment based on best clinical experience and practice. The guidelines clearly document which aspects are evidence informed versus expert consensus.

The recommendations of the ERC Guidelines on Resuscitation 2025 – Concise guidelines for clinical practice

Epidemiology in resuscitation
These ERC Guidelines 2025 cover the key information on the epidemiology and outcome of out of hospital cardiac arrest (OHCA) and in hospital cardiac arrest and (IHCA).[63] (Fig. 3).

Out-of-hospital cardiac arrest

- The annual incidence of emergency medical services (EMS) treated OHCA in Europe is 55 per 100,000 inhabitants.
- The mean age of patients is of 67 ± 17 years and 65 % are male.
- Seventy percent of OHCAs occur in private locations.
- A shockable rhythm is the initial presentation in 20 % of cardiac arrests; 91 % have a medical aetiology.

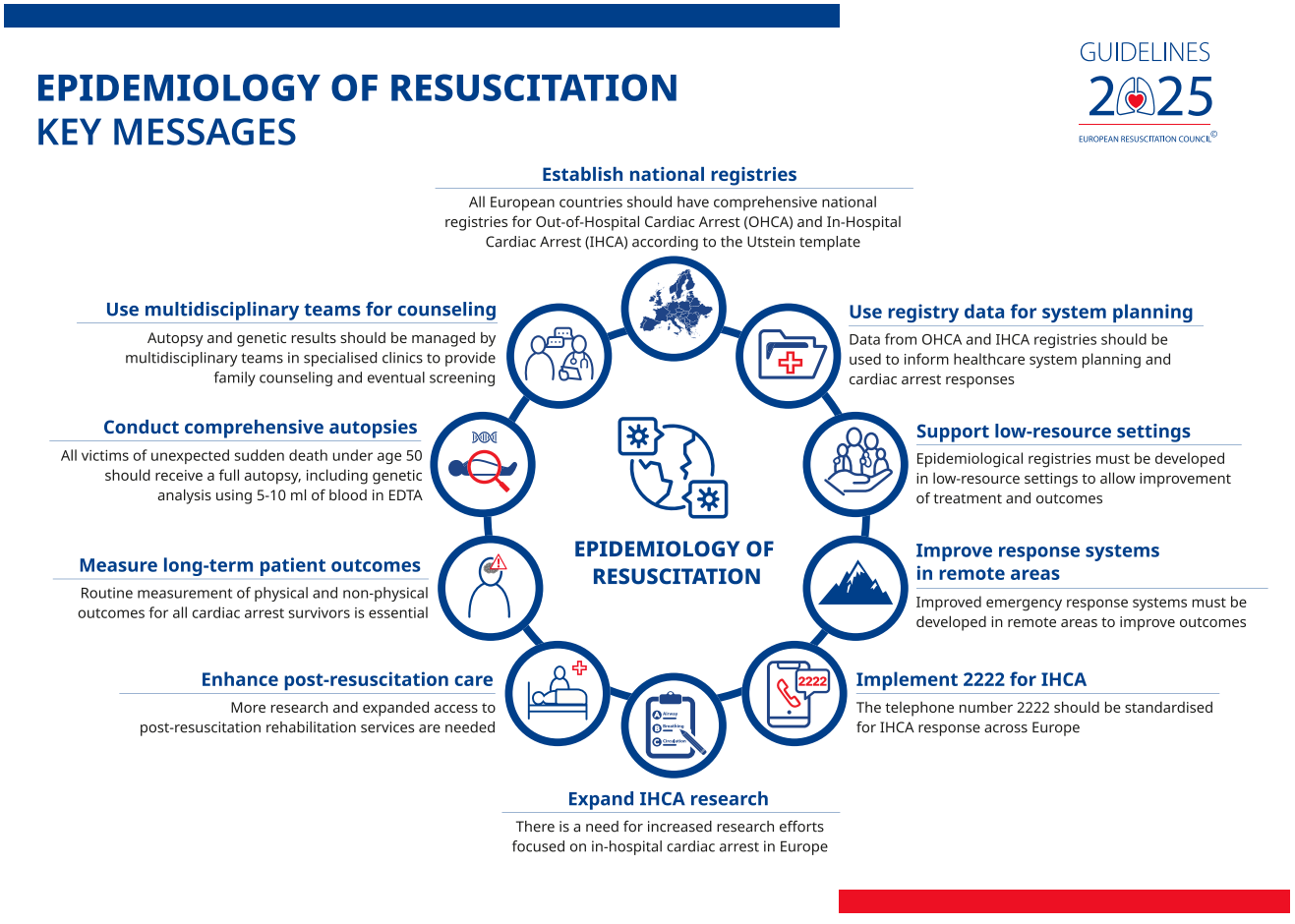

Fig. 3 – Key messages epidemiology in resuscitation.

- Nine European countries have an OHCA registry with full population coverage and 17 countries have a first responder system at least at a local level.
- The bystander CPR rate in Europe is 58 % with significant regional variations (from 13 % to 82 %).
- The use of an automated external defibrillator (AED) before the EMS arrive varies from 2.6 % to 59 % between European countries.
- Survival after OHCA in Europe is 7.5 % with a range in European countries from 3.1 % to 35 %.

In-hospital cardiac arrest

- The annual incidence of IHCA in Europe is 1.5–2.8 per 1000 hospital admissions.
- The proposed standard internal telephone number to alert the emergency team (2222) for IHCA in Europe is implemented in only 2 % of countries (Fig. 4).

Long term survival and return to societal participation

- In European countries where withdrawal of life sustaining treatment is practised, poor neurological outcomes occur in less than 10 % of cardiac arrest survivors, whilst in situations where withdrawal of life sustaining treatment is not practised survival with poor neurological outcome is more common.
- The majority of OHCA survivors indicate the need for post-discharge follow-up with access to a multi-disciplinary team.
- One out of three OHCA survivors receive cardiac rehabilitation and only one out of ten receive brain injury rehabilitation.

Genetic variants and autopsy in cardiac arrest patients

- A clinically actionable pathogenic or likely pathogenic variant in a gene potentially related to the cause of sudden cardiac arrest is identified in up to 25 % of OHCA cases younger than 50 years.
- Autopsy in young sudden cardiac arrest victims is currently not routinely performed in many European countries.

Low resource settings and remote areas

- The rate of bystander CPR and AED use is lower in low resource settings compared to high-resource settings.
- Lower resourced countries tend to lack OHCA registries according to the Utstein template and based on a reference territory.
- Early BLS and rapid response by an EMS are crucial and determines the prognosis of an OHCA patient also in remote areas.

Systems saving lives

The Systems Saving Lives Guidelines 2025 of the ERC address the impact, organisation, and implementation of topics that support and enable successful resuscitation beyond the individual rescuers competences.[64] (Fig. 5).

The chain of survival

- The chain of survival is a concept that summarises the complex systems saving lives approach. It is intended for everyone involved in resuscitation care, including laypersons, healthcare professionals, educators, and stakeholders. The concept can be used for a variety of purposes, ranging from raising awareness to inclusion in educational materials.
- For simplicity and consistency, the four-link format is used by the ERC.
- For specific situations or target audiences, a multifaceted chain system (i.e., the basic chain of survival plus additional elements) may be applied.

The formula of survival

- The formula of survival depicts the overarching system behind a successful chain of survival and its underlying factors. It can be used to highlight the complex interaction of science, education and implementation to achieve optimal outcomes.

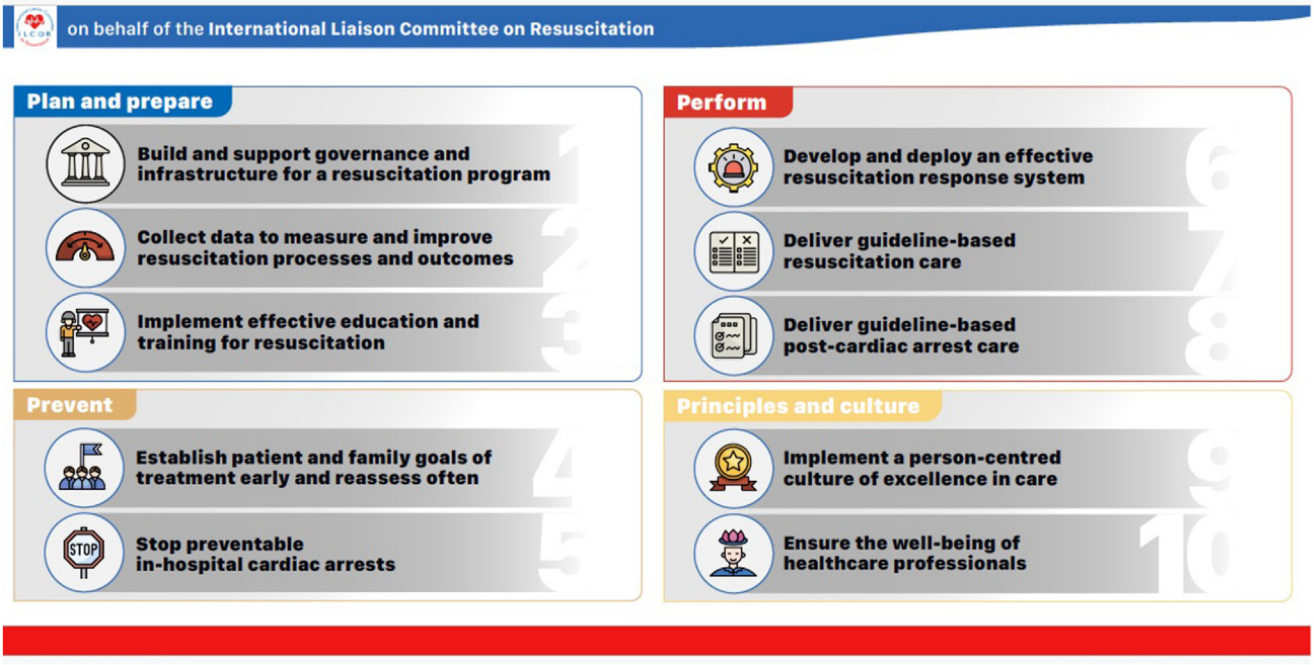

Fig. 4 – 10 Steps to improve in-hospital cardiac arrest quality of care and outcomes.

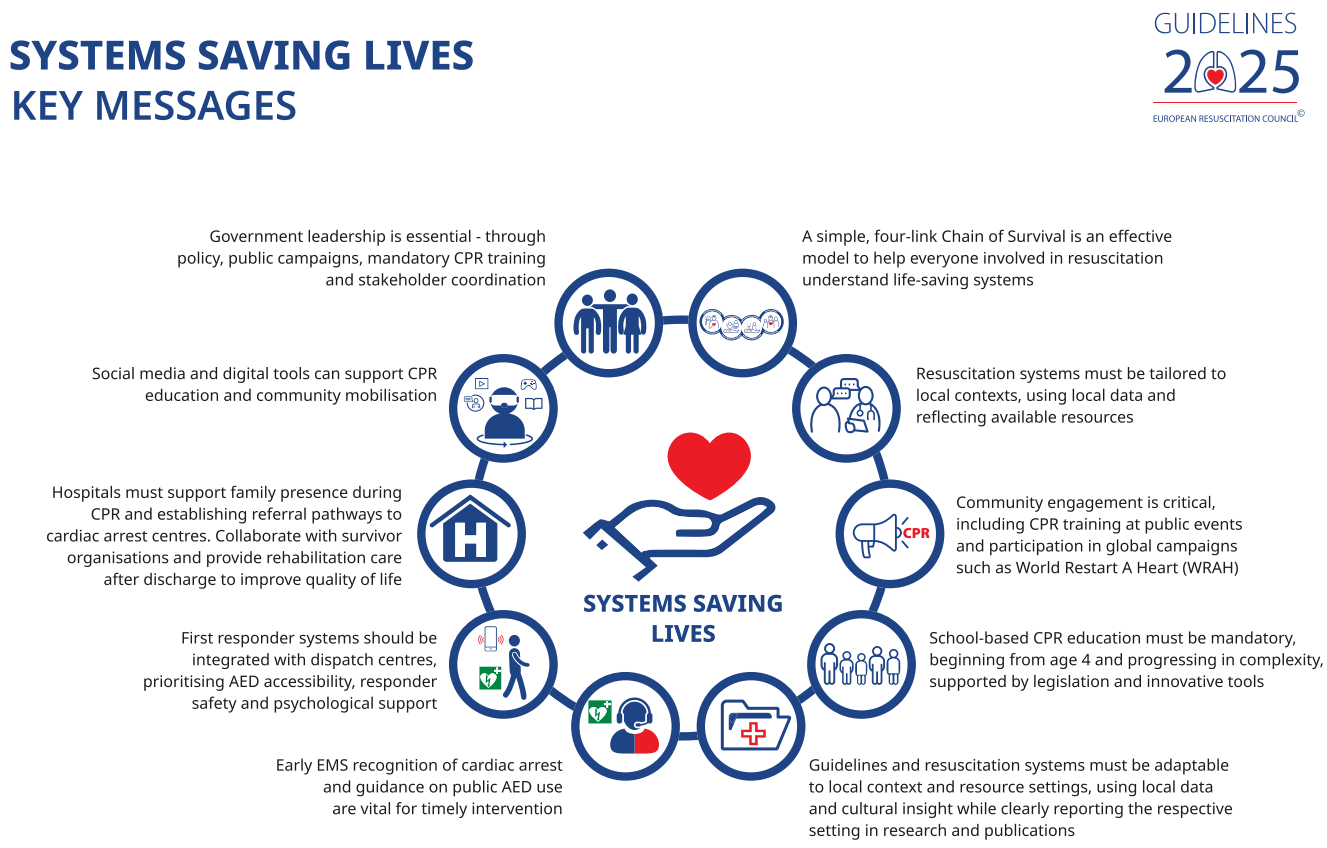

Fig. 5 – Key messages systems saving lives.

- The three interactive factors are: science (referring to the continuous evaluation of evidence by ILCOR and the development of evidence-informed guidelines by the ERC); education (referring to resuscitation training for those who may potentially, or actually take care of cardiac arrest patients—training that must be effective and up to date); and implementation (referring to a well-functioning chain of survival at both regional and local levels, potentially adapted to various resource settings).

Advocacy

- Multi-national collaborative bodies, national governments, local authorities, and national resuscitation councils (NRC) should advocate for policies that increase survival rates and improve the quality of life for cardiac arrest patients through the following actions:
  - o Promotion of comprehensive policies/legislation: advocate for policies that increase survival rates and enhance the quality of life for cardiac arrest patients.
  - o Public awareness campaigns: increase public awareness through initiatives such as World Restart a Heart and Get Trained, Save Lives.
  - o Mandatory CPR education: implement mandatory CPR education for children, students (e.g., Kids Save Lives), and drivers (e.g., Learn to Drive, Learn CPR).
  - o Enhanced workplace preparedness: strengthen policies for workplace preparedness (e.g., Alliance for Workplace Awareness and Response to Emergencies – AWARE).
  - o Stakeholder engagement: collaborate with stakeholders to support cardiovascular health and harmonise CPR policies (e.g., the European Alliance for Cardiovascular Health).
  - o CPR training at major sporting and large-scale events: offer free short CPR training sessions at major sporting events and other large-scale gatherings to raise awareness and increase knowledge among attendees.

Awareness campaigns and initiatives to promote CPR

- Community initiatives to promote the implementation of BLS should be endorsed and supported.
- Multi-national collaborative bodies, national governments, local authorities, and national resuscitation councils should actively participate in World Restart a Heart (WRAH) to raise awareness of bystander CPR and the use of AEDs, train as many citizens as possible, and develop new and innovative systems and policies.

Kids save lives (KSL)

- All schoolchildren should receive BLS training every year, with an emphasis on the Check–Call–Compress approach.
- BLS education should start at an early age (around four years of age), progressing to comprehensive training that includes chest compressions by ages 10–12, ventilation by age 14, and AED usage by ages 13–16.
- Children who have been trained should be encouraged to educate family members and friends, aiming to teach at least ten others within two weeks. Take-home CPR training kits should be distributed to maximise the multiplier effect.
- CPR education should also be extended to higher education, particularly for healthcare and teaching students.
- Technology-enhanced learning (e.g., extended reality, serious games, smartphone apps) should be incorporated to engage schoolchildren effectively and supplement traditional training methods.
- Ministries of education and policymakers should mandate BLS education in schools by law across Europe and beyond, supported by legislation, funding, and public awareness campaigns in every country.

Resuscitation in low-resource settings

- Experts from all resource settings are encouraged to investigate and report on populations, aetiologies, and outcomes of resuscitation, following established reporting standards such as the Utstein reporting template.
- Experts from all resource settings should be consulted regarding cultural differences and the regional and local acceptability, applicability, and implementation of guidelines and recommendations.
- All reports and research on resuscitation should include a brief section on the respective resource setting, for example the income classification of the country.
- In situations where standard guidelines are not applicable, specific recommendations may be developed for low-resource settings (such as areas with limited funding, ships, alpine regions, or remote areas) concerning essential equipment, education, and procedures for managing cardiac arrest both during and after the event.

Social media

- Social media (SoMe) platforms should be leveraged to support public awareness campaigns, disseminate knowledge on CPR for any age group, foster community participation, and further the mission of the ERC.
- SoMe platforms could be used as research tools for data collection, analysis, education, awareness campaigns, communication, and information sharing on cardiac arrest.
- SoMe platforms should be incorporated into CPR training programmes. Educational and healthcare institutions are encouraged to use concise, engaging videos and interactive materials to reinforce learning and retention.
- Real-time engagement should be encouraged. Live question-and-answer sessions, interactive posts, and gamified learning should be used to increase engagement and knowledge retention in CPR training.
- The validation of SoMe content by experts should be promoted. Institutions are encouraged to ensure that educational materials shared on social media align with international BLS guidelines to prevent the spread of misinformation.
- SoMe-driven initiatives should be monitored and evaluated. Further research is needed to determine their impact on CPR training efficacy, bystander CPR rates, and patient survival outcomes.

First responders

- Every healthcare system should implement a first responder programme.
- Registered first responders who are near a suspected OHCA should be notified by the EMS dispatch centre and dispatched to both public locations and private residences, in order to reduce the time to first chest compression and shock delivery, and to improve survival rates with favourable neurological outcome.
- Systems that dispatch first responders should be linked to AED registries and should prioritise both the physical safety and psychological support of first responders.
- Cardiac arrest events should be reported in a standardised manner to monitor system performance and support continuous quality improvement.

EMS organisation in response to cardiac arrest

- EMS should use standardised algorithms or criteria to identify cardiac arrest promptly.
- EMS should teach, monitor, and improve OHCA recognition in dispatch centres.
- EMS should implement and evaluate dispatcher-assisted public access AED systems, including linkage to AED registries.
- EMS dispatch centres should implement systems allowing call handlers to deliver CPR instructions for cardiac arrest patients.
- The use of locked or inaccessible AED cabinets is discouraged.
- All ambulances responding to OHCA should be equipped with a defibrillator.
- EMS should organise prehospital critical care teams for adult and paediatric OHCA.
- EMS should monitor and address low resuscitation exposure among personnel to ensure teams include members with recent experience and implement proper training to overcome low exposure.
- EMS systems treating OHCA should implement system improvement strategies to enhance patient outcomes.
- EMS systems may implement termination of resuscitation (TOR) rules to determine whether to stop resuscitation or continue during transport following local validation of the TOR criteria and considering specific local legal, organisational and cultural context (Fig. 6).

In-hospital cardiac arrest management

- Hospitals should consider introducing a rapid response system (RRS).
- Hospitals should use system improvement strategies to enhance patient outcomes.
- Hospitals should implement protocols for managing family presence during CPR and provide respective education for healthcare teams.
- Hospitals are encouraged to use the “Ten Steps Toward Improving In-Hospital Cardiac Arrest Quality of Care and Outcomes” framework to guide structured, system-wide improvements in resuscitation quality, outcome, and team well-being.

Fig. 6 – Optimising emergency dispatch for cardiac arrest response.

Cardiac arrest centres (CAC)

- Adult patients with non-traumatic OHCA should be cared for at a CAC whenever possible.
- Healthcare systems should establish local protocols to develop and maintain a cardiac arrest network.

System performance improvement

- Organisations or communities that treat cardiac arrest should implement system performance improvement strategies to enhance patient outcomes.

Survivorship and co-survivorship

- Healthcare systems should create and implement policies for the care of cardiac arrest survivors and their co-survivors (e.g. families, close friends, and partners also impacted by the event) from pre-discharge to long-term follow-up. These policies should adopt a multidisciplinary approach, responsive to the needs of both survivors and co-survivors. Healthcare professionals should receive adequate education to support both the identification of needs and the provision of appropriate care.
- National resuscitation councils (NRCs) should connect with and support cardiac arrest survivor organisations within their countries, strengthening ties with healthcare systems, survivors, and co-survivors.
- Engaging in partnerships among NRCs, and with organisations that have broader missions—such as cardiovascular healthcare organisations—can help address the diverse needs of survivors and co-survivors and optimise resource utilisation.
- Healthcare systems should actively engage cardiac arrest survivors, co-survivors, and the public as partners in policy development and research to enhance the quality, relevance, and integrity of outcomes.

New technologies and artificial intelligence

- Artificial intelligence (AI) and digital health technologies show potential to improve cardiac arrest outcomes but are not yet ready for routine clinical use, and their application should be limited to research or controlled settings.

Adult basic life support

The ERC Guidelines 2025 adult Basic Life Support cover cardiac arrest recognition, alerting emergency services, chest compressions, rescue breaths, automated external defibrillation and safety considerations.[65] Evidence pertaining to CPR quality measurement and new technologies are embedded within each of the relevant sections (Fig. 7).

If you encounter someone who appears to be unresponsive follow the **3 steps to save a life**:

- **Check**
  - o Is it safe to approach?
  - o Is the person conscious?
- **Call** EMS immediately if they are unresponsive.
  - o Assess breathing.
  - o If you are unsure the call-taker will assist you.

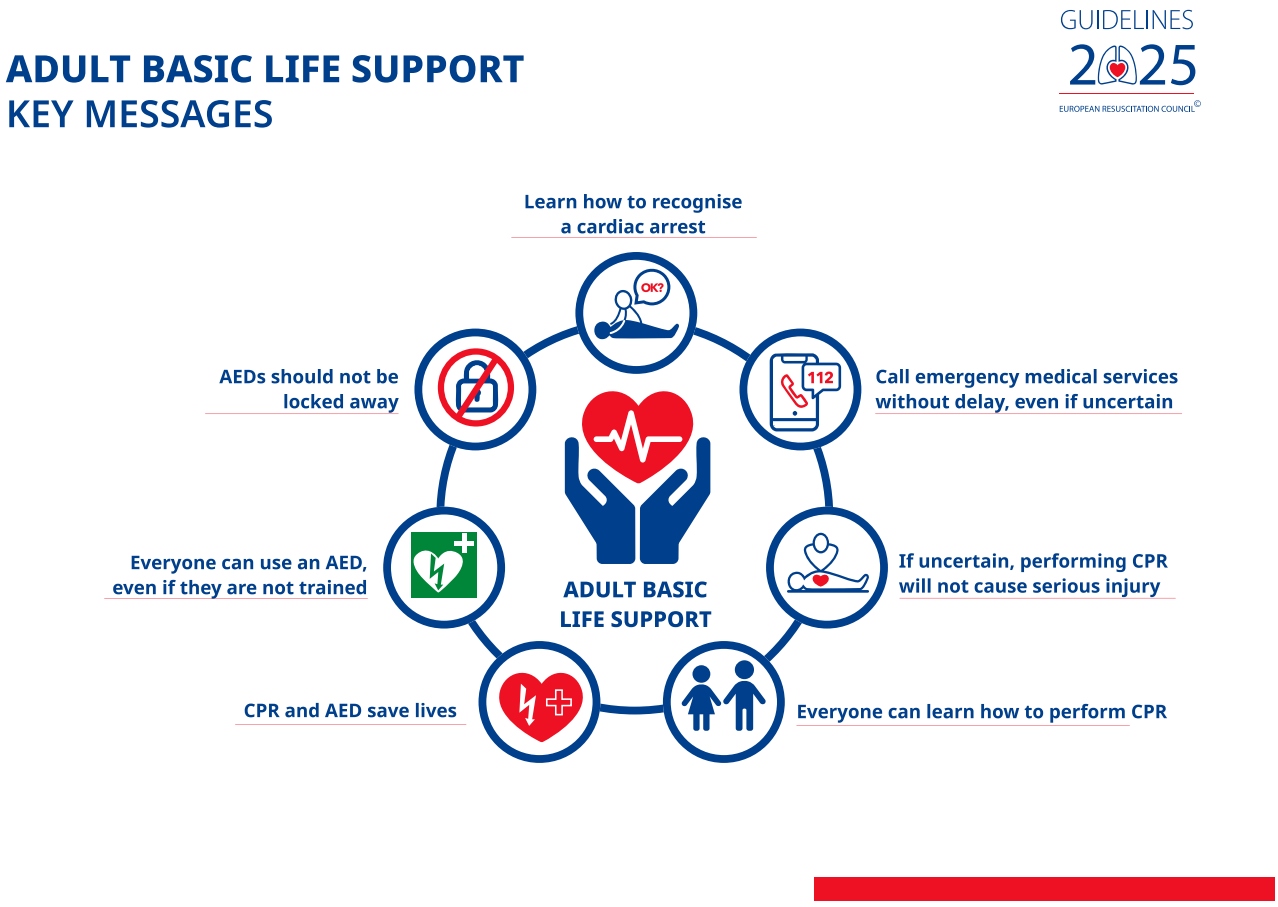

Fig. 7 – Key messages adult Basic Life Support.

- **CPR**: Start CPR immediately if they are **unresponsive with abnormal breathing**.
  - As soon as an AED is available, attach it and follow the AED instructions.
  - If you are unsure the call-taker will assist you (Fig. 8).

Recognising cardiac arrest

- Suspect cardiac arrest in any person who is unresponsive.
- Call your local emergency number without delay.
- Assess breathing while you wait for the call to be answered.
- Slow, laboured breathing, as well as other abnormal patterns such as agonal gasping or panting, must be recognised as signs of cardiac arrest; in such cases, or when in doubt, always start CPR.
- A short period of seizure-like activity may occur at the onset of cardiac arrest. Once the seizure stops, assess breathing.
- If any person is unresponsive with abnormal breathing, cardiac arrest should be assumed.
- If you are uncertain the call taker will be able to assist you.
- If there is any doubt, assume cardiac arrest and start CPR.

Alerting the emergency medical services

- If you have a mobile phone, activate speaker mode, call the local emergency number without delay.
- Assess breathing while you wait for the call to be answered.
- If you are alone and do not have a mobile phone, or there is no mobile phone network/satellite connection, you can shout for help and then continue to assess breathing.
- If you think no-one will come to help, then you will have to leave the person to alert the local emergency service. Do this as quickly as possible.
- If they remain unresponsive and are not breathing normally when you return from summoning help, immediately start CPR.

Role of the dispatcher

- Dispatchers should use standardised protocols to facilitate recognition of cardiac arrest.
- Once cardiac arrest is recognised, dispatchers should provide CPR instructions to all callers.

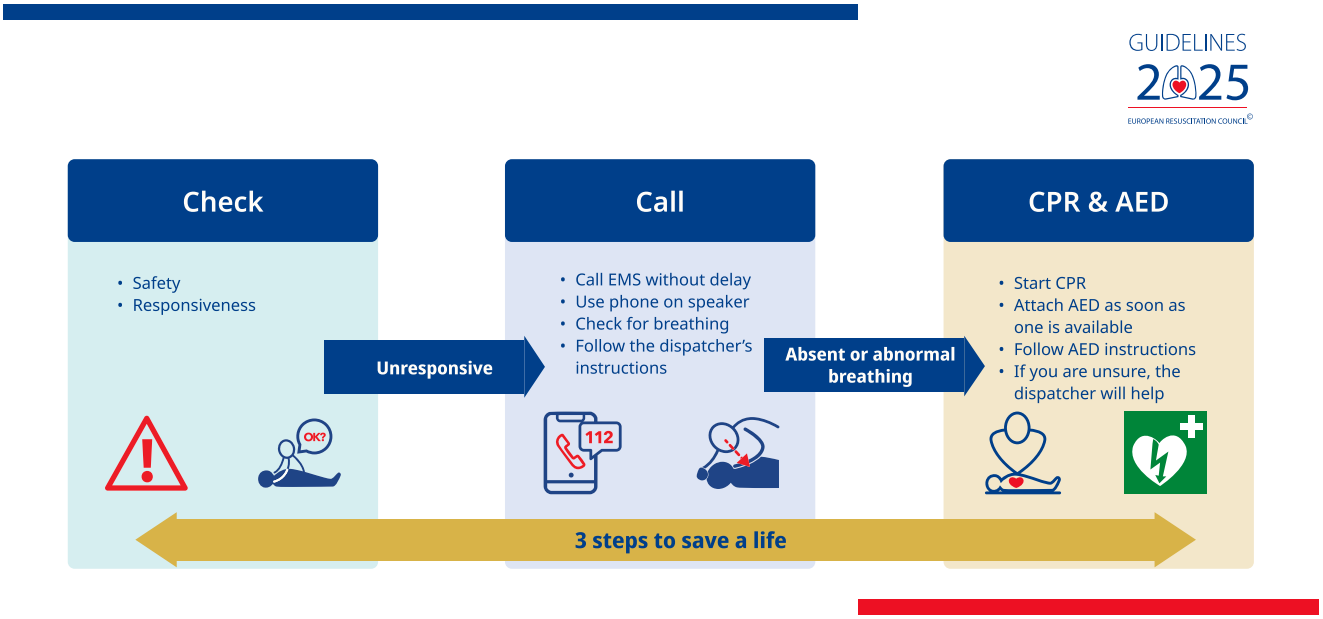

Fig. 8 – Three steps to save a life.

- Dispatchers should assume the caller does not know how to perform CPR, and provide chest-compression-only instructions. If the caller subsequently states they know how to perform rescue breaths, then dispatchers should facilitate 30:2 CPR.
- Once CPR is underway, dispatchers should ask if there is an 'AED' or 'defibrillator' at the scene.
- If no AED is available at the scene, and more than one bystander is present, dispatchers should guide bystanders to the nearest AED.
- As soon as an AED is available at the patient, dispatchers should instruct the bystander to activate the AED and to follow the AED instructions.
- Where first responder systems have been implemented, dispatchers should activate registered community volunteer responders to the incident and to retrieve a nearby AED.

High quality chest compressions

- Commence chest compressions as soon as possible.
- Place the heel of one hand on the lower half of the sternum ('in the centre of the chest').
- If you are unable to adequately visualise the sternum due to clothing, it is reasonable to displace or remove such garments to identify the correct anatomic landmark.
- Place the heel of your other hand on top of the first hand.
- Interlock your fingers of the hands to ensure that pressure is not applied over the ribs.
- Keep your arms straight.
- Position your shoulders vertically above the persons chest.
- Compress to a depth of at least 5 cm, but not more than 6 cm.
- Compress the chest at a rate of 100–120 min^{-1} with as few interruptions as possible.
- Allow the chest to recoil completely after each compression; avoid leaning on the chest.
- CPR is most effective when performed on a firm surface. However, rescuers should not move a person from a 'soft' surface e.g. bed to the floor. Start CPR on the bed and, if needed, compress the chest deeper to compensate for the soft mattress.

Rescue breaths

- If you have been trained to provide rescue breaths, alternate 30 chest compressions with 2 effective rescue breaths.
- When providing rescue breaths, deliver just enough air to make the chest start to rise; avoid excessive ventilation.
- If you are unable to ventilate the chest after 2 attempts, consider foreign body airway obstruction.[73]
- If you have not been trained to provide rescue breaths, perform continuous chest compressions without interruptions (Fig. 9).

Using an automated external defibrillator (AED)

- All laypersons and healthcare professionals should be encouraged to use automated external defibrillators (AED).

How to find an AED

- Ensure that AED locations are indicated by clear signage.
- Signage should state that AEDs can be used by anyone and that no training is needed.
- AED locations may also be identified using electronic mapping systems available on some mobile phone and computer applications.
- The local emergency service should be able to direct callers to the nearest available AED.

When and how to use an AED

- Use an AED as soon as it is available.
- Open the AED case (if present). Some AEDs automatically turn on when opened. If not, identify the power button and turn it on.

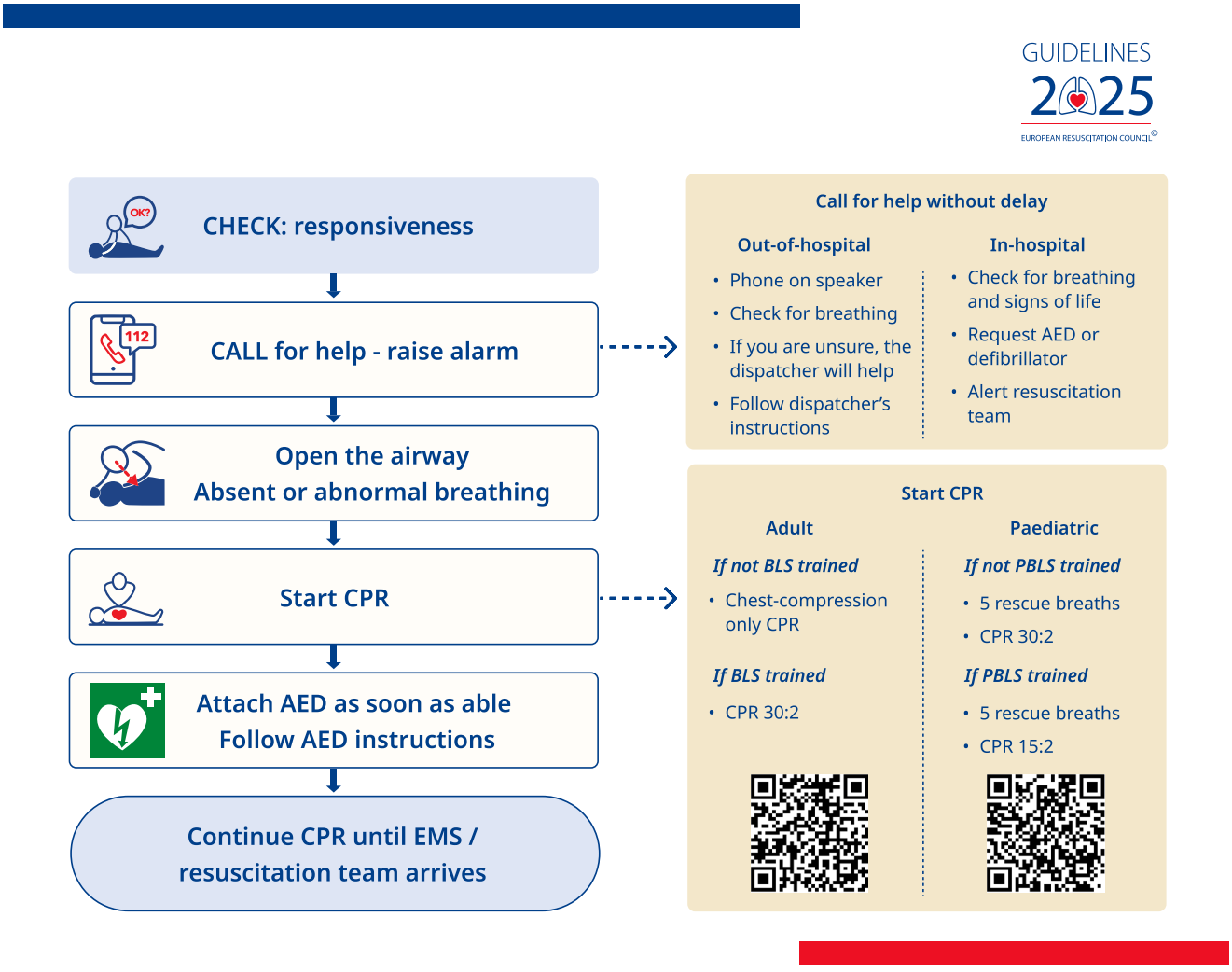

Fig. 9 – ERC Basic Life Support algorithm.

- Follow the audio/visual prompts from the AED.
- Attach the electrode pads to the person's bare chest according to the position shown on the AED.
- If more than one rescuer is present, continue CPR while the defibrillation pads are being attached.
- Ensure that nobody touches the person whilst the AED is analysing the heart rhythm.
- If a shock is indicated, ensure that nobody is touching the person.
- Some AEDs (fully automatic AEDs) will deliver a shock automatically, while others (semi-automatic AEDs) will require the rescuer to press the shock button to deliver the shock.
- After the shock has been delivered, immediately restart chest compressions.
- If no shock is indicated, immediately restart CPR chest compressions.
- Continue to follow the AED instructions.
- Usually, the AED will instruct the rescuer to perform CPR, then, after a set time interval the AED will instruct the rescuer to pause CPR to undertake rhythm analysis.

Where to place AEDs

- AEDs should be placed in clear sight.
- AED cabinets should be unlocked and readily available 24 h a day, 7 days a week, 365 days per year.
- Locations with a high population flow, such as airports, shopping centres and train stations should have on-site AEDs that are readily available for public use.
- Communities are encouraged to deploy AEDs in public spaces, particularly those with a higher incidence of cardiac arrest.
- AEDs should be registered with the local emergency service, especially if they are linked to AED registries and first responder programs.

Safety

- Ensure the safety of yourself, the person in cardiac arrest, and any bystanders.
- Lay people should start CPR for presumed cardiac arrest without concerns of harm to patients not in cardiac arrest.
- The risk of infection to rescuers performing CPR is low.

- The risk of harm to rescuers, from accidental shock during AED use, is low.
- The risk of physical injury to the rescuer, from performing CPR, is low.
- Consider the wellbeing of layperson and bystanders – offer them psychological support.

Adult advanced life support

The ERC adult Advanced Life Support (ALS) Guidelines 2025 provide insight on the prevention of cardiac arrest and advanced treatments for cardiac arrest out-of-hospital and in-hospital.[66] (Fig. 10).

Prevention of in-hospital cardiac arrest

The ERC recommends:

- Shared decision making and advanced care planning which integrates resuscitation decisions with emergency care treatment plans to increase clarity of treatment goals and also prevent inadvertent deprivation of other indicated treatments, besides CPR. These plans should be recorded in a consistent manner.
- Hospitals use a track and trigger early warning score system for the early identification of patients who are critically ill or at risk of clinical deterioration.
- Hospitals train staff in the recognition, monitoring and immediate care of the acutely ill patient.
- Hospitals empower all staff to call for help when they identify a patient at risk of physiological deterioration. This includes calls based on clinical concern, rather than solely on vital signs.
- Hospitals should have a clear policy for the clinical response to abnormal vital signs and critical illness. This may include a critical care outreach service and, or emergency team (e.g. medical emergency team, rapid response team).
- Hospital staff should use structured communication tools to ensure effective handover of information.
- Patients should receive care in a clinical area that has the appropriate staffing, skills, and facilities for their severity of illness.
- Hospitals should review cardiac arrest events to identify opportunities for system improvement and share key learning points with hospital staff.
- Hospitals should participate in national cardiac arrest audit as a benchmark for local performance.

Prevention of out-of-hospital cardiac arrest

- Coronary heart disease (CHD) is the leading cause of sudden cardiac arrest (SCA), responsible for 80 % of cases, particularly in older patients. Non-ischaemic cardiomyopathies contribute to 10–15 % of SCA cases. In younger individuals, the main causes of SCA include inherited heart diseases, congenital heart defects, myocarditis, and substance misuse. In these patient groups, risk stratification is possible, and preventive treatments may be effective.

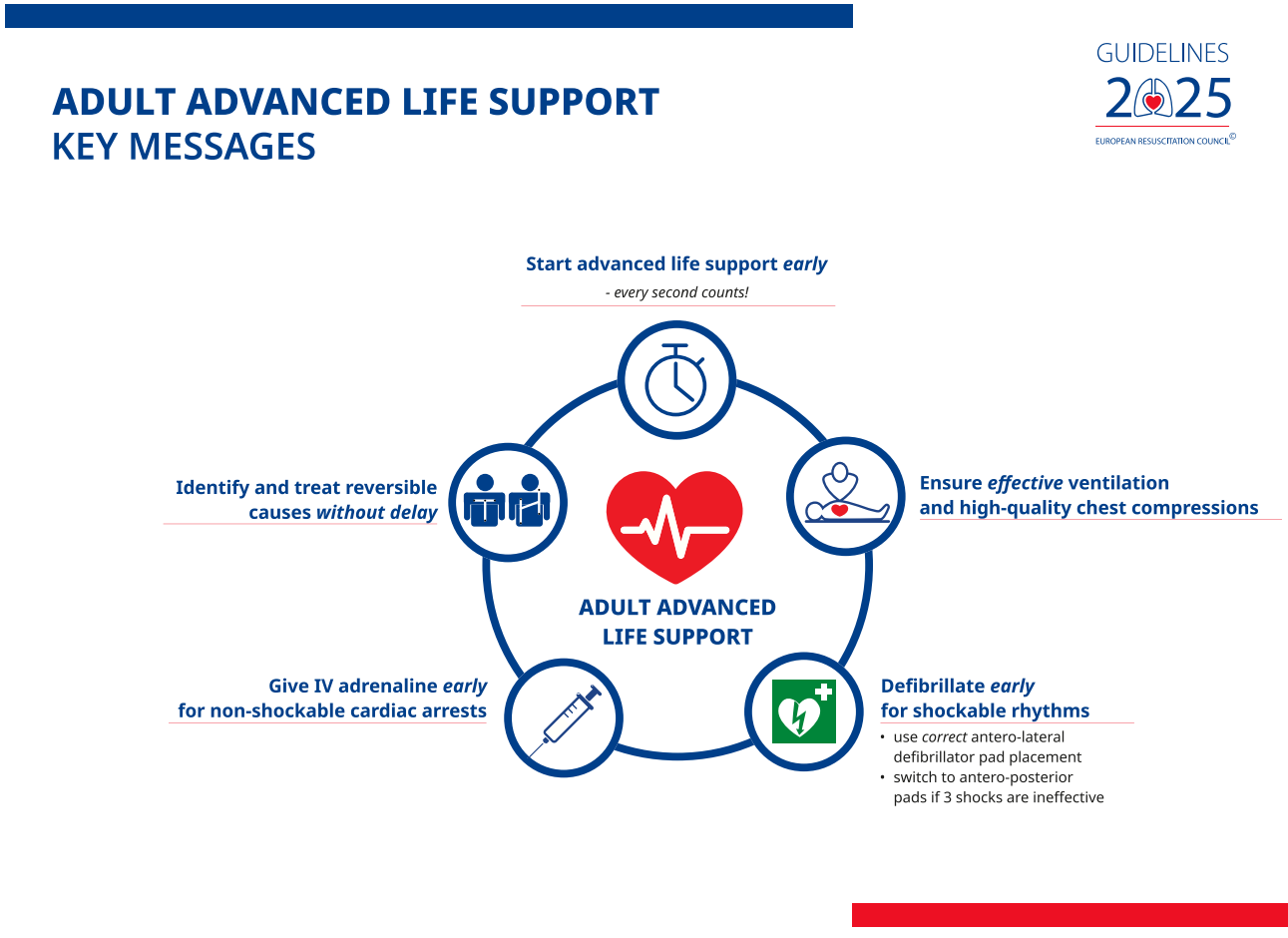

Fig. 10 – Key messages adult Advanced Life Support.

- Predicting SCA is challenging because most cases happen in individuals with undiagnosed heart disease. As a result, systems should emphasise detection of early warning signs, implementation of an efficient EMS system, and focus on the prevention of cardiovascular disease (CVD) risk factors. Symptoms such as chest pain, syncope (especially during exercise, while sitting or supine), palpitations, dizziness or sudden shortness of breath that are consistent with cardiac ischaemia or an arrhythmia should be investigated.
- Overtly healthy young adults who have SCA can also have preceding signs and symptoms (e.g. syncope/pre-syncope, chest pain and palpitations) that should alert healthcare professionals to seek expert help to prevent cardiac arrest.
- Young adults presenting with characteristic symptoms of arrhythmic syncope should have a specialist cardiology assessment, which should include an electrocardiogram (ECG) and in most cases echocardiography, 24-h ECG monitoring and an exercise test.
- Systematic evaluation in a clinic specialising in the care of those at risk for SCA is recommended in family members of young victims of SCA or those with a known cardiac disorder resulting in an increased risk of SCA.
- Identification of individuals with inherited conditions and screening of family members can help prevent deaths in young people with inherited heart disorders.
- Follow current European Society of Cardiology (ESC) guidelines for the diagnosis and management of syncope and arrhythmias.

Treatment of in-hospital cardiac arrest

- Start ALS as early as possible.
- Hospital systems should aim to recognise cardiac arrest, start CPR immediately, defibrillate rapidly (<3 min) for shockable rhythms, give adrenaline rapidly for non-shockable rhythms, and identify and treat reversible causes.
- All hospital staff should be able to recognise cardiac arrest rapidly, call for help, start CPR and defibrillate (attach an AED and follow the AED prompts, or use a manual defibrillator).
- Hospitals should adopt a standard 'Cardiac Arrest Call' telephone number (2222).
- Hospitals should have a resuscitation team that immediately responds to IHCAs.
- The hospital resuscitation team should include team members who have completed an accredited adult ALS course that incorporates teamwork and leadership training.
- Resuscitation team members should have the key skills and knowledge to manage a cardiac arrest including manual defibrillation, advanced airway management, intravenous access, intra-osseous access, and identification and treatment of reversible causes.
- The resuscitation team should meet at the beginning of each shift for introductions and allocation of team roles.
- Hospitals should standardise their resuscitation equipment.
- Termination of resuscitation rules (TOR) should not be used as a sole strategy for terminating an in-hospital resuscitation attempt.

Treatment of out-of-hospital cardiac arrest

- Start ALS as early as possible – EMS systems should be organised to provide a rapid ALS response with sufficient qualified personnel. This may include a prehospital critical care team and take into account which interventions can be provided on scene.
- Adults with non-traumatic OHCA should be considered for transport to a cardiac arrest centre according to local protocols.
- EMS may consider implementing criteria for the withholding and termination of resuscitation (TOR) following local validation of the TOR criteria, taking into consideration specific local legal, organisational and cultural context.
- Emergency medical systems should monitor staff exposure to resuscitation and low exposure should be addressed to increase EMS team's experience in resuscitation (Fig. 11).

Debriefing

Use data-driven, performance-focused debriefing of rescuers to improve future CPR quality and patient outcomes.

ALS in low-resource settings

- ALS guidelines may have to be adapted according to resources and in low-resource settings there may need to be a greater focus on prevention, early first aid, and basic life support measures.
- Rescuers should be aware that even in high-income settings, ALS may be constrained by limited resources.
- A two-tiered approach incorporating basic and advanced interventions may be the safest and most effective.

CPR-induced consciousness

- Cardiopulmonary resuscitation induced consciousness (without ROSC) is uncommon but increasingly reported. Rescuers may consider using sedative or analgesic drugs (or both) in small doses to prevent pain and distress to patients who are conscious during CPR.
- Neuromuscular blocking drugs alone should not be given to conscious patients.
- The optimal drug regimen for sedation and analgesia during CPR is uncertain. Regimens may be based on those used in critically ill patients and according to local protocols such as small doses of fentanyl, ketamine and/or midazolam.

Defibrillation

Automated external defibrillation (AED) versus manual defibrillation during ALS

- Manual defibrillators should only be used by rescuers who can quickly and accurately identify a cardiac arrest rhythm (within 5 s) and, if needed, deliver a safe shock with minimal interruption (less than 5 s) of chest compressions.
- Advanced life support providers must be proficient in using both an AED and a manual defibrillator.
- If an AED is already in use when ALS providers arrive, they should follow its shock prompts. When possible, they should transition to a manual defibrillator during a 2-min CPR cycle.

Defibrillation strategy

- Continue CPR while a defibrillator is retrieved and pads applied. High quality CPR improves the chances of successful defibrillation.
- Give a shock as early as possible when appropriate.
- Deliver shocks with minimal interruption to chest compressions and minimise the pre-shock and post-shock pause. This is achieved by continuing chest compressions during defibrillator charging, delivering defibrillation with an interruption in chest compressions of less than 5 s and then immediately resuming chest compressions.

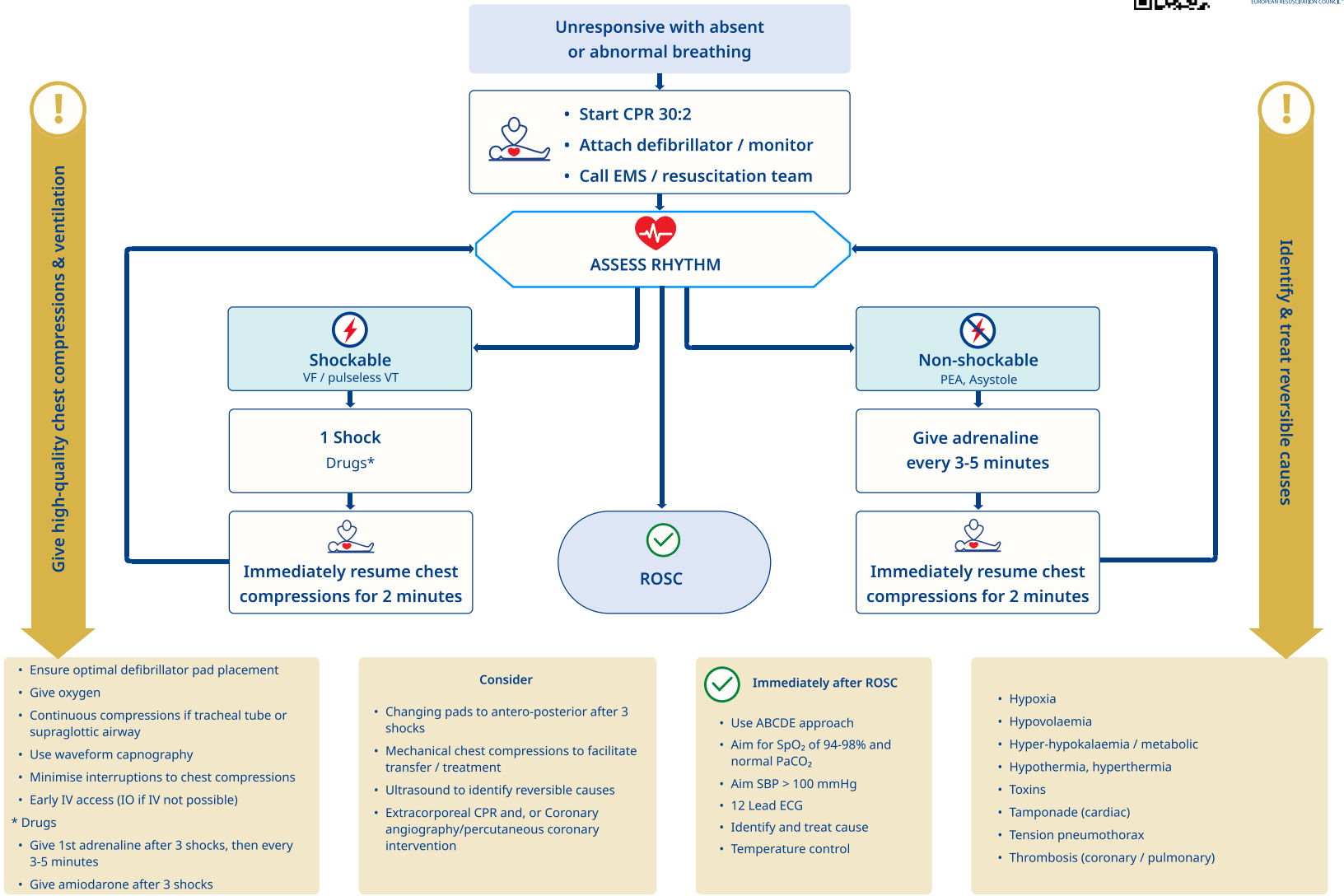

Fig. 11 – Adult Advanced Life Support algorithm.

- Immediate defibrillation of VF of any amplitude (even fine VF) should be attempted.
- Immediately resume chest compressions after shock delivery. If there is a combination of clinical and physiological signs of return of spontaneous circulation (ROSC) such as return of consciousness, purposeful movement, arterial waveform or a sharp rise in end-tidal carbon dioxide (ETCO2), consider stopping chest compressions for rhythm analysis, and if appropriate, a pulse check.
- When using a defibrillator that displays the ECG with the motion artefact caused by chest compressions removed, the underlying cardiac arrest rhythm may guide the decision to perform a rhythm and pulse check every two minutes. If asystole is displayed there would be no need to pause chest compressions for a rhythm check.

Safe and effective defibrillation

- Minimise the risk of fire by taking off any oxygen mask or nasal cannula or bag mask and by placing them at least 1 m away from the patient's chest. When using a mechanical ventilator, oxygen exhaust from ventilation circuits should be directed away from the chest. A self-inflating bag or the ventilator circuits should remain attached to a supraglottic airway or tracheal tube.
- Charging the defibrillator in anticipation of each rhythm check may minimise hands-off time prior to shock delivery and is an acceptable alternative strategy if delivered without prolonging peri-shock pauses.
- A shock with a manual defibrillator can be safely delivered without interrupting mechanical chest compression.
- Do not defibrillate during manual chest compressions (even when wearing clinical gloves), as that practice is not safe to the rescuer.

Defibrillation pads and paddles

- There is insufficient evidence to recommend a specific pad or paddle size for optimal external defibrillation in adults.
- When available, defibrillation pads are preferable to paddles as they offer practical benefits for routine monitoring and defibrillation. Pads enable the operator to stand clear during defibrillation and minimise pre- and post-shock pauses to chest compressions by enabling hands-free operation. Better contact with the chest wall may also reduce the risk of arcing and subsequent fires.
- When using defibrillation paddles, apply firm force to both defibrillation paddles to optimise skin contact, minimise transthoracic impedance and reduce the risk of electrical arcing.
- Antero-lateral pad position is the position of choice for initial pad/-paddle placement. In particular, ensure that the apical (lateral) pad is positioned correctly (i.e. below the armpit in the mid-axillary line).
- Consider an antero-posterior pad position for vector change defibrillation following three failed shocks in cases of refractory shockable rhythms. The anterior pad is placed to the left of the sternum, avoiding as much breast tissue as possible. The posterior pad is placed at the same height, centred just medial to the left scapula.
- In patients with an implantable pacemaker/defibrillator (ICD), place the pad more than 8 cm away from the device, or use an alternative pad position. Consider an alternative pad position when the patient is in the prone position (bi-axillary), or in a refractory shockable rhythm.

Energy levels and number of shocks

- Use single shocks followed by a 2-min cycle of chest compressions.
- The use of up to three stacked shocks may be considered only if initial ventricular fibrillation/pulseless ventricular tachycardia (VF/pVT) occurs during a witnessed, monitored cardiac arrest with a defibrillator immediately available, e.g. during cardiac catheterisation or in a high dependency area. (For the purposes of adrenaline and amiodarone administration after three failed shocks, the initial three stacked shocks should be counted as the initial shock).
- Energy levels:
  - For biphasic waveforms (rectilinear biphasic or truncated exponential biphasic, but not pulsed biphasic), defibrillation shock energy levels for the first shock is at least 150 J.
  - For pulsed biphasic waveforms, deliver the first shock at 130–150 J.
- If the first shock is not successful and the defibrillator is capable of delivering shocks of higher energy, it is reasonable to increase the energy for subsequent shocks.
- If the rescuer is unaware of the recommended energy settings of the defibrillator, for an adult use the highest energy setting for all shocks.
- Use standard energy levels in obese patients.

Refractory ventricular fibrillation

- Consider escalating the shock energy, after a failed shock.
- For refractory VF, defined as continuous VF after three consecutive shocks, and having ensured correct antero-lateral pad positioning, consider using a defibrillation vector change by using an alternative defibrillation pad position (e.g. antero-posterior). After a failed third shock, prepare to place a fresh set of pads, at the time of the following rhythm check. Optimise transthoracic impedance by shaving the anticipated areas of placement for the pads (if necessary).
- Dual (double) sequential defibrillation (DSD), involves using a combination of antero-lateral and antero-posterior pad positioning, discharged in close succession and has been advocated for use in refractory shockable rhythms. Given the practical challenges of using two defibrillators to deliver DSD and the limited evidence for its efficacy the ERC does not recommend its routine use.

Ventricular fibrillation waveform analysis for optimising shock success

- Rescuers should give defibrillation shocks according to AED prompts or use a manual defibrillator for ventricular fibrillation/pulseless ventricular tachycardia (VF/pVT) according to the ALS algorithm – there is currently no role for VF waveform analysis (e.g., based on amplitude) for identifying the optimal time for defibrillation.

Patients with actively discharging implantable cardioverter defibrillators (ICD)

- Rescuers may sense a significant shock across their arms if a shock is delivered by an ICD while they are performing external chest compressions, even when wearing clinical gloves.
- If an ICD fails to terminate a shockable rhythm, conventional external shocks should be delivered, placing any defibrillation

pad/paddle more than 8 cm from the defibrillator box (as above).
- If the ICD is incorrectly detecting arrhythmias and shocking inappropriately, a magnet placed over the ICD can temporarily stop shocks but will not disable pacing (if programmed).

Airway and ventilation
- During CPR, start with basic airway techniques and progress stepwise according to the skills of the rescuer until effective ventilation is achieved.
- Give the highest feasible inspired oxygen during CPR.
- Start effective ventilation breaths as soon as possible ensuring the rate and tidal volume are appropriate to prevent both inadequate ventilation (hypoventilation) and excessive ventilation (hyperventilation).
- Deliver effective bag-mask ventilation breaths by optimising mask seal and airway patency and if necessary and feasible, use a two-person technique for bag-mask ventilation.
- Give each inspiratory breath over 1 s to achieve a visible chest movement.
- When using a supraglottic airway (SGA), an i-gel is preferred to a laryngeal tube.
- Tracheal intubation should only be attempted by rescuers with a high success rate and with the use of continuous waveform capnography. The expert consensus is that a high tracheal intubation success rate is over 95 % within two attempts at intubation.
- Aim for less than a 5-s interruption in chest compression for tracheal intubation.
- Use direct or video laryngoscopy for tracheal intubation according to local protocols and rescuer experience. In settings where video laryngoscopy is immediately available, it is preferable to use video laryngoscopy instead of direct laryngoscopy.
- A sustained $ETCO_2$ trace on waveform capnography must be used to exclude oesophageal placement of the tracheal tube. It can also confirm proper ventilation with an SGA and a face mask.
- Once a tracheal tube or a SGA has been inserted, ventilate the lungs at a rate of 10 min^{-1} and continue chest compressions without pausing during ventilations. With a SGA, if gas leakage results in inadequate ventilation, pause compressions for ventilation using a compression-ventilation ratio of 30:2.
- If using mechanical ventilation, use a volume-controlled mode during chest compressions set the ventilator
  - to a tidal volume of 6–8 mL kg^{-1} (predicted body weight), or to achieve a visible chest movement, the maximum inspired oxygen,
  - a respiratory rate of 10 min^{-1},
  - an inspiratory time of 1–2 s,
  - a positive end expiratory pressure (PEEP) 0–5 cm H_2O,
  - the peak pressure alarm at 60–70 cm H_2O,
  - and the flow trigger off.

  Ensure mechanical ventilation is effective and if not, use manual ventilation.
- If standard airway management strategies (oropharyngeal airway and bag-mask/SGA/tracheal tube) fail during cardiac arrest, appropriately trained rescuers should attempt surgical cricothyroidotomy to enable oxygenation and ventilation.

Drugs and fluids

Vascular access
- Attempt intravenous (IV) rather than intraosseous (IO) access first, to enable drug delivery in adults in cardiac arrest.
- If IV access cannot be rapidly achieved within two attempts, it is reasonable to consider IO access as an alternative route for vascular access during adult cardiac arrest.

Vasopressor drugs
- Give adrenaline 1 mg as soon as possible for adult patients in cardiac arrest with a non-shockable rhythm.
- Give adrenaline 1 mg after the third shock for adult patients in cardiac arrest with a shockable rhythm.
- Repeat adrenaline 1 mg every 3–5 min whilst ALS continues.

Antiarrhythmic drugs
- Give amiodarone 300 mg IV for adult patients in cardiac arrest who are in VF/pVT after three shocks have been administered.
- Give a further dose of amiodarone 150 mg IV for adult patients in cardiac arrest who are in VF/pVT after five shocks have been administered.
- Give the first dose of amiodarone after three shocks, and the second dose after five shocks, irrespective of whether the shockable rhythms are sequential (refractory) or intermittent (recurrent).
- Lidocaine 100 mg IV may be used as an alternative if amiodarone is not available or a local decision has been made to use lidocaine instead of amiodarone. An additional bolus of lidocaine 50 mg can also be given after five defibrillation attempts.

Thrombolytic drugs
- Consider immediate thrombolytic drug therapy when pulmonary embolism is the suspected or confirmed cause of cardiac arrest.
- In select patients with suspected pulmonary embolism, consider CPR for 60–90 min after administration of thrombolytic drugs.

Fluids
- Give fluids during CPR only if cardiac arrest is caused by hypovolaemia.
- Use either isotonic saline or balanced crystalloids for fluid infusion during CPR.

Other drugs
- Do not routinely give calcium, sodium bicarbonate or corticosteroids during cardiac arrest.

ALS in highly-monitored cardiac arrest, and physiology-guided CPR
- A sudden decrease in $ETCO_2$ may indicate a cardiac arrest or very low cardiac output state.
- Consider starting chest compressions if the systolic blood pressure decreases and remains <50 mmHg despite interventions.
- In adults undergoing continuous intra-arterial blood pressure monitoring, we suggest that adrenaline is initially given in small increments (e.g., 50–100 μg IV) rather than a 1 mg bolus. If a total of 1 mg has been given with no response, ensure that there is no

extravasation and consider giving further IV adrenaline doses of 1 mg every 3–5 min.
- A pragmatic approach during physiology-guided CPR is to aim for a diastolic blood pressure of ≥30 mmHg (when using intra-arterial blood pressure monitoring) and an $ETCO_2 \geq 25$ mmHg (3.3 kPa).

Waveform capnography during advanced life support
- Use waveform capnography to confirm correct tracheal tube placement during CPR.
- Use waveform capnography to monitor the quality of CPR.
- An increase in $ETCO_2$ during CPR may indicate that ROSC has occurred. However, chest compression should not be interrupted based on this sign alone. Use a combination of clinical and physiological signs of ROSC (e.g., consciousness, purposeful movement, arterial waveform, rise in $ETCO_2$) before stopping chest compressions for rhythm analysis, and if appropriate, a pulse check.
- Do not use a low $ETCO_2$ value alone to decide that a resuscitation attempt should be stopped.

Use of ultrasound imaging during advanced life support
- Only skilled operators should use intra-arrest point-of-care ultrasound (POCUS).
- POCUS must not cause additional or prolonged interruptions in chest compressions.
- POCUS may help identify treatable causes of cardiac arrest such as cardiac tamponade and tension pneumothorax.
- Right ventricular dilation in isolation during cardiac arrest should not be used to diagnose pulmonary embolism.
- Do not use POCUS for assessing contractility of the myocardium as a sole indicator for terminating CPR.

Devices

Mechanical chest compression devices
- Consider mechanical chest compressions only if high-quality manual chest compression is not practical or compromises provider safety.
- When a mechanical chest compression device is used, minimise interruptions to chest compression during device application by using only trained teams familiar with the device.

Resuscitative endovascular balloon occlusion of the aorta (REBOA)
- The ERC does not recommend the routine use of REBOA for cardiac arrest unless being evaluated in a clinical trial.

Intra-arrest cooling
- We do not recommend intra-arrest cooling during advanced life support (unless there is severe hyperthermia).

Extracorporeal CPR
- Extracorporeal CPR (ECPR) may be considered as a rescue therapy for selected adults with IHCA and OHCA when conventional CPR is failing to restore spontaneous circulation, in settings in which this can be implemented.

Peri-arrest arrhythmias
- The 2025 ALS Guidelines and the algorithms focus on those arrhythmias that require immediate treatment before or after cardiac arrest.
- Rescuers should seek expert advice if the arrhythmia and/or life-threatening features persist.
- The assessment and treatment of all arrhythmias address the condition of the patient (stable versus unstable) and the nature of the arrhythmia. Persistent arrhythmias require careful evaluation, as they are often linked to underlying structural heart disease and may indicate unresolved issues such as myocardial ischaemia. In addition to an arrhythmia occurring immediately after ROSC, life-threatening features in an unstable patient include:
  - Shock – recognised by hypotension (e.g., systolic blood pressure <90 mmHg) along with signs of compensatory mechanisms, such as increased sympathetic activity, and evidence of inadequate organ perfusion.
  - Syncope – as a consequence of reduced cerebral blood flow.
  - Heart failure – manifested by pulmonary oedema (failure of the left ventricle) and/or raised jugular venous pressure (failure of the right ventricle).
  - Myocardial ischaemia – may present with chest pain (angina) or may occur without pain as an isolated finding on the 12-lead ECG (silent ischaemia).

Tachyarrhythmias
- Electrical cardioversion is the preferred treatment for tachyarrhythmia in the unstable patient displaying potentially life-threatening adverse signs or immediately after ROSC.
- Electrical cardioversion is recommended for stable patients with monomorphic VT who have structural heart disease or when it is unclear whether there is underlying heart muscle damage.
- Conscious patients require careful anaesthesia or sedation before attempting synchronised cardioversion – be aware of the risk of haemodynamic deterioration with anaesthesia/sedation.
- When cardioverting atrial or ventricular tachyarrhythmias, the shock must be synchronised to occur with the R wave of the ECG.
- For atrial fibrillation:
  - An initial synchronised shock at maximum defibrillator output, rather than an escalating approach, is a reasonable strategy based on current data.
- For atrial flutter and paroxysmal supraventricular tachycardia:
  - Give an initial shock of 70–120 J.
  - Give subsequent shocks using stepwise increases in energy.
- For ventricular tachycardia with a pulse:
  - Use energy levels of 120–150 J for the initial shock.
  - Consider stepwise increases in energy if the first shock fails to achieve sinus rhythm.
- If cardioversion fails to restore sinus rhythm and the patient remains unstable, give amiodarone 300 mg intravenously over 10–20 min (or procainamide 10–15 mg/kg over 20 min) and re-attempt electrical cardioversion. The loading dose of amiodarone can be followed by an infusion of 900 mg over 24 h.
- Pharmacological treatment may be considered in haemodynamically stable patients with monomorphic ventricular tachycardia if there is an increased risk with sedation or anaesthesia.
- Consider amiodarone for acute heart rate control in patients with AF and haemodynamic instability and severely reduced left ventricular ejection fraction (LVEF). For stable patients with LVEF < 40 % consider the smallest dose of beta-blocker to achieve a heart rate less than 110 min^{-1}. Add digoxin if necessary (Fig. 12).

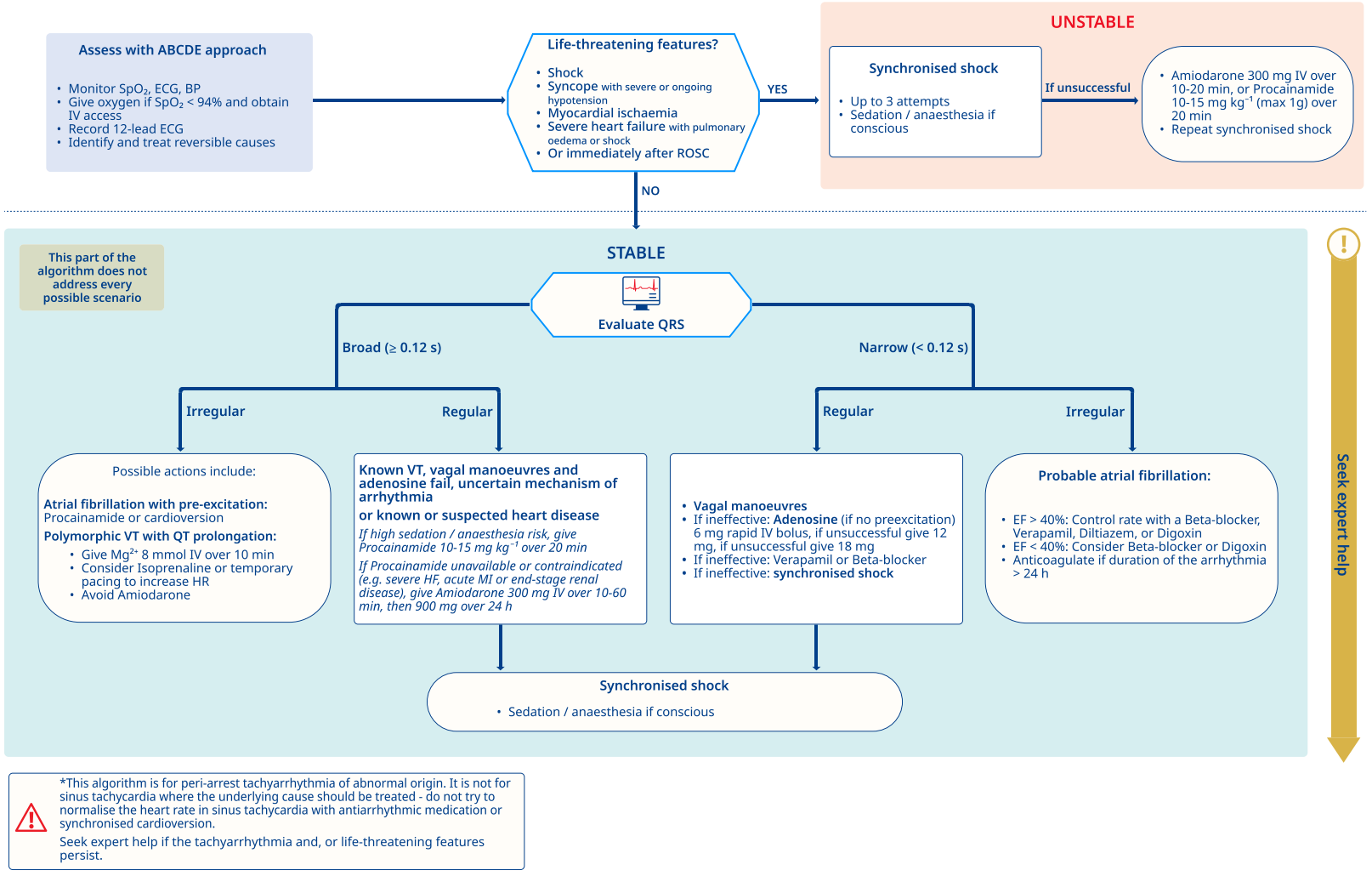

Fig. 12 – Peri-arrest Tachyarrhythmia algorithm.

Bradycardia

- If bradycardia is accompanied by adverse signs, give atropine 500 μg IV (IO) and, if necessary, repeat every 3–5 min to a total of 3 mg.
- If treatment with atropine is ineffective, consider second-line drugs. These include isoprenaline (5 μg min^{-1} starting dose), and adrenaline (2–10 μg min^{-1}).
- For bradycardia in patients with cardiac transplant or spinal cord injury, consider giving aminophylline (100–200 mg slow intravenous injection). Do not give atropine to patients with cardiac transplants – it can cause a high-degree atrioventricular block or even sinus arrest.
- Consider giving glucagon if beta-blockers or calcium channel blockers are a potential cause of the bradycardia.
- Do not give atropine to patients with high-degree atrioventricular block and wide QRS. It is ineffective and may worsen the block.
- Consider pacing in patients who are unstable, with symptomatic bradycardia refractory to drug therapies.
  - Establish early transvenous pacing in unstable patients with symptomatic bradycardia.
  - Consider transthoracic (transcutaneous) pacing as a bridge to transvenous pacing or when transvenous pacing is not readily available.
- Whenever a diagnosis of asystole is made, check the ECG carefully for the presence of P waves because, unlike true asystole, this is more likely to respond to cardiac pacing.
- If atropine is ineffective and transvenous/transcutaneous pacing is not immediately available, fist pacing can be attempted while waiting for pacing equipment (Fig. 13).

Uncontrolled organ donation after circulatory death

- When there is no ROSC, consider uncontrolled organ donation after circulatory death in settings where there is an established programme, and in accordance with local protocols and legislation

Adult special circumstances in resuscitation

The ERC Guidelines 2025 Special Circumstances in Resuscitaiton in adults cover modifications required to BLS and ALS for the prevention and treatment of cardiac arrest in special circumstances and when deviations from standard algorithms are needed.[67] (Fig. 14).

General recommendation

- Initiate resuscitation following the standard ALS algorithm in cardiac arrest.
- Always address hypoxia, hypovolaemia, electrolyte disorders, hypothermia, cardiac tamponade, tension pneumothorax, thrombosis, and toxic agents.
- Where appropriate, prioritise treating reversible causes, even if chest compressions are briefly interrupted.

Special causes

Management and prevention of cardiac arrest due to anaphylaxis

- Prompt recognition of anaphylaxis is crucial.
- Recognise anaphylaxis by the presence of airway, breathing, or circulation problems with or without skin and mucosal changes.
- Remove or stop the trigger if immediately feasible.
- Immediately inject intramuscular adrenaline 0.5 mg at first suspicion of anaphylaxis and repeat if no improvement occurs within 5 min.
- Give an IV crystalloid fluid bolus early and monitor the response.

Hyper/hypokalaemia and other electrolyte disorders

Hyperkalaemia.

- Shift potassium into cells.
  - Give 10 units soluble insulin and 25 g glucose IV for treatment of moderate and severe hyperkalaemia; follow with 10 % glucose infusion at 50 ml/hr for 5 h if pre-treatment blood glucose < 7 mmol/l.
  - Give nebulised salbutamol (10–20 mg) for moderate and severe hyperkalaemia, as an adjunct to Insulin-glucose therapy.
- Antagonise the effect of hyperkalaemia.
  - Use IV 30 mL 10 % calcium gluconate for patients with severe hyperkalaemia with ECG changes.
  - Administer IV 10 mL 10 % calcium chloride and 50 mmol sodium bicarbonate, through separate lines or with flush in between, in the treatment of hyperkalaemic cardiac arrest in all settings of severe hyperkalaemia.
- Remove potassium from the body.
  - Give sodium zirconium cyclosilicate 10 g orally.
  - Consider dialysis for patients with refractory severe hyperkalaemia.
- Consider ECPR in accordance with local protocols if initial resuscitation attempt is unsuccessful.

Hypokalaemia.

- Treatment is guided by the severity of hypokalaemia and presence of symptoms and/or ECG abnormalities.
- Where appropriate replace potassium and correct magnesium deficit concurrently.
- Give IV 20 mmol potassium chloride over 2–3 min, followed by 10 mmol over 2 min in hypokalaemia cardiac arrest then monitor K^+ level and adjust infusion rate accordingly.

Hyperthermia, malignant hyperthermia and toxin induced hyperthermia

Hyperthermia.

- Measure core temperature to guide treatment.
- Move patient to a cool environment.
- Simple external cooling may involve conductive, convective and evaporative measures.
- With heat syncope and heat exhaustion quick removal to a cool place, simple external cooling and provision of fluids are sufficient.
- With heat stroke prioritise active cooling methods that achieve the most rapid cooling rate such as application of ice, and cold-water immersion (Fig. 15).

Malignant hyperthermia.

- Stop triggering agents immediately. This includes turning off and removing vaporiser and changing the ventilator circuit.
- Give IV 2.5 mg/kg dantrolene as soon as possible.
- Start active cooling.

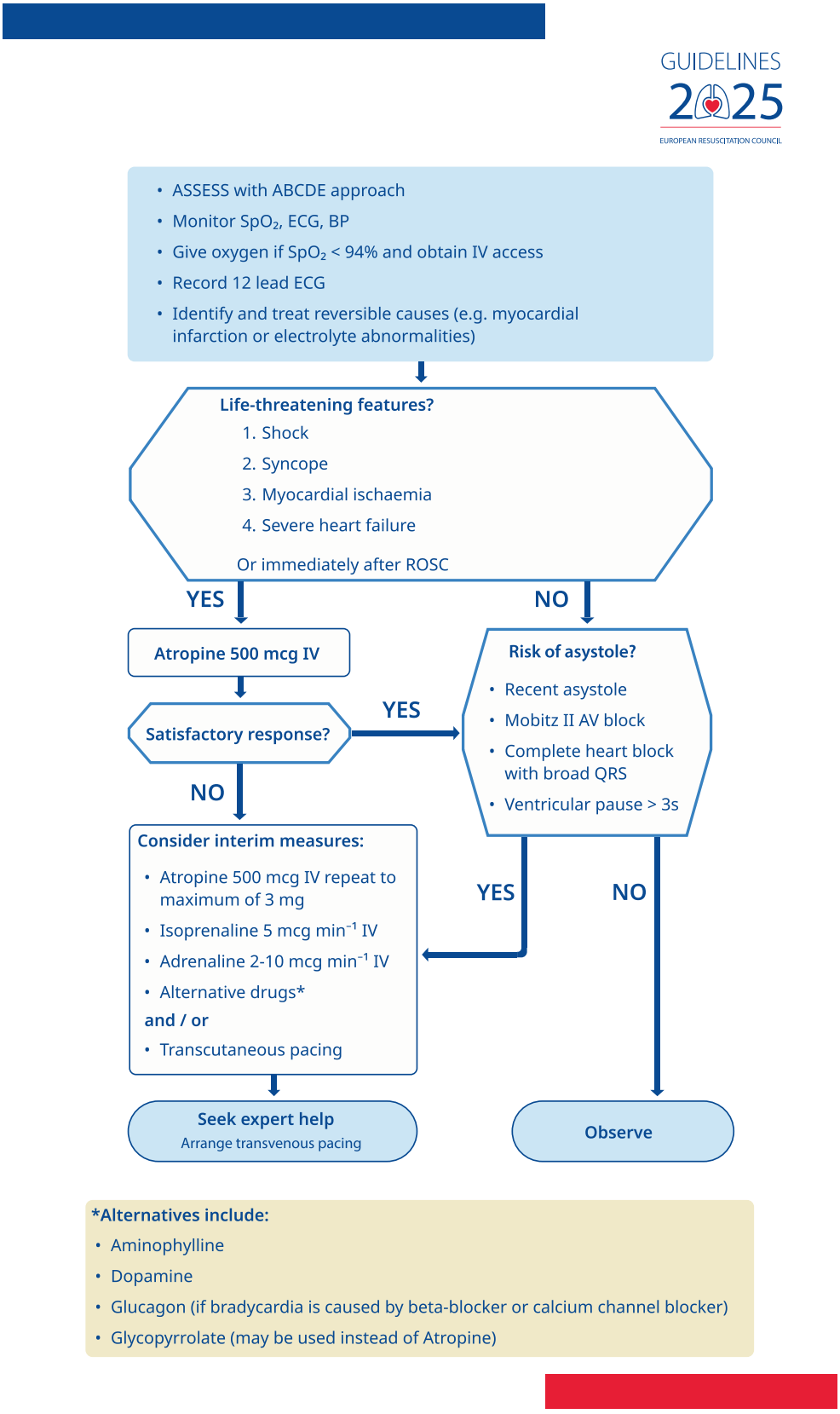

Fig. 13 – Bradycardia algorithm.

SPECIAL CIRCUMSTANCES IN ADULT RESUSCITATION
KEY MESSAGES

GUIDELINES 2025
EUROPEAN RESUSCITATION COUNCIL©

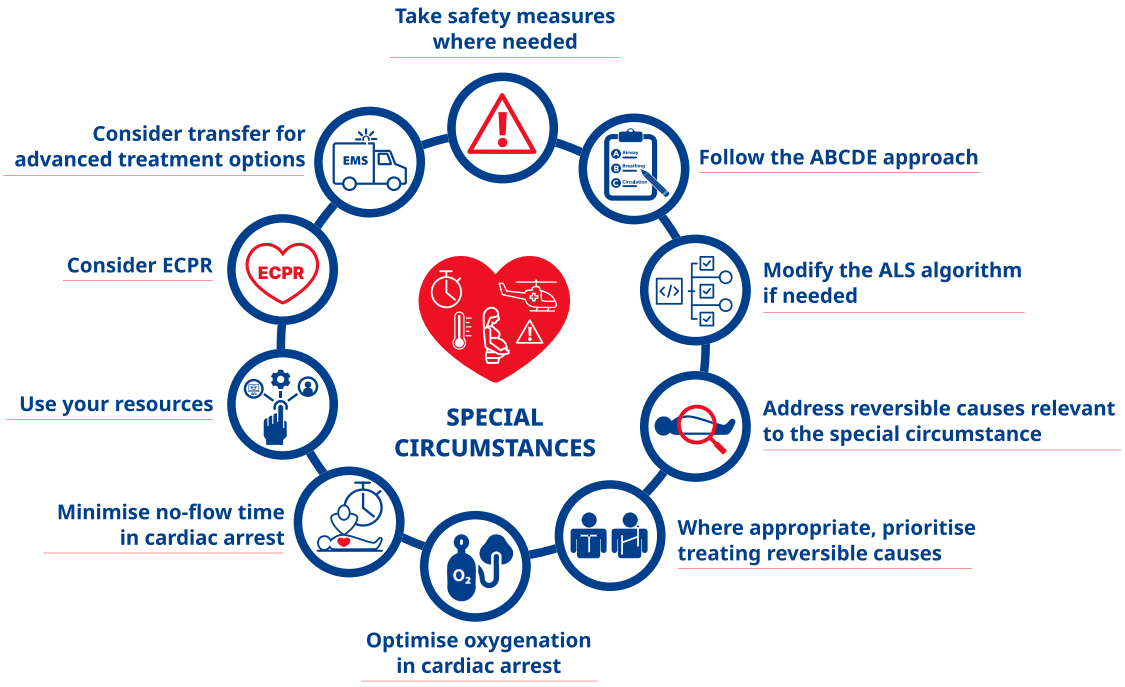

Fig. 14 – Key messages adult special circumstances.

- Give 100 % oxygen and aim for normocapnia using hyperventilation.
- Change the ventilator. If the ventilator cannot be changed, change charcoal filters.
- Contact a malignant hyperthermia centre for advice and follow-up.

Toxin-induced hyperthermia.

- Minimise exposure and absorption of the toxin.
- Use active cooling techniques. Antipyretics have no benefit as central thermoregulatory mechanisms are affected by toxins.

Accidental hypothermia and avalanche rescue
Accidental hypothermia.

- Check vital signs for up to one minute in an unconscious hypothermic patient.
- Measure core temperature with a low reading thermometer to diagnose accidental hypothermia.
- Use the Swiss Staging System if core temperature cannot be measured.
- Transfer hypothermic patients with risk factors for imminent cardiac arrest and those in cardiac arrest directly to an extracorporeal life support (ECPR) centre for rewarming.
- Delay CPR or use intermittent CPR in hypothermic arrested patients with a core temperature below 28 °C when immediate or continuous CPR is not feasible.
- Delay further defibrillation attempts if ventricular fibrillation (VF) persists after three shocks, until core temperature is >30 °C.
- Below 30 °C adrenaline will accumulate and may have more detrimental than beneficial effects. Give IV 1 mg adrenaline once to facilitate ROSC unless planning imminent initiation of ECPR. Increase administration intervals for adrenaline to 6–10 min if the core temperature is 30–35 °C.
- Consider use of a mechanical CPR device if transport is prolonged, or there are difficulties with the terrain.

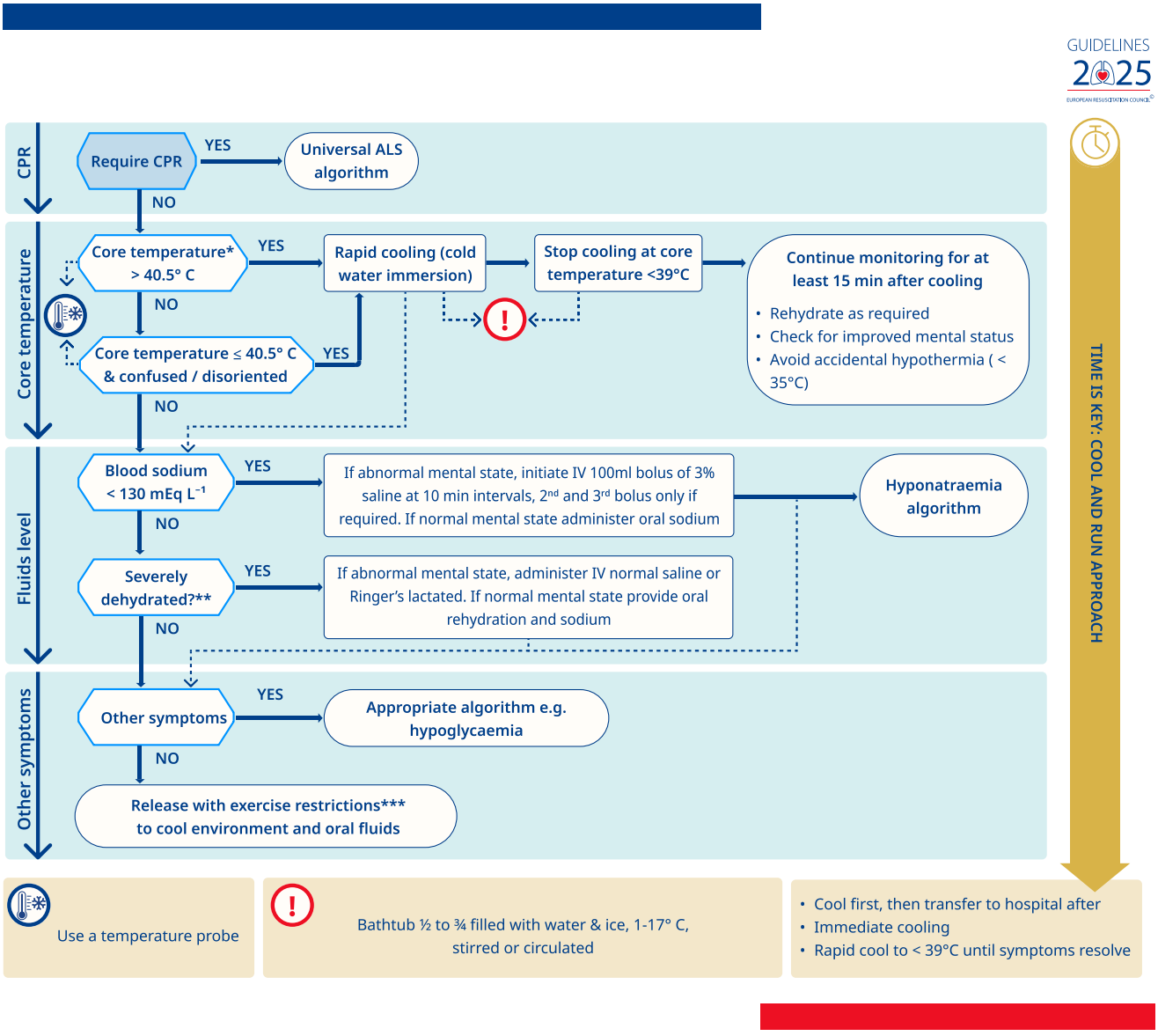

Fig. 15 – Emergency treatment of hyperthermia.

* Core temperature should be measured, e.g. tympanic, rectal, or oesophageal. ** Dry mouth, thirsty, hypotensive. *** Return to activity considerations following a diagnosis of exertional heat illness and exertional head stroke have been published recently elsewhere.

- Base in-hospital prognostication of successful rewarming on the Hypothermia Outcome Prediction after Extracorporeal Life Support (HOPE) score.
- Rewarm hypothermic arrested patients with veno-arterial extracorporeal membrane oxygenation (VA-ECMO).
- Initiate non-extracorporeal life support rewarming if an ECPR centre cannot be reached within a reasonable time (e.g. 6 h) (Fig. 16).

Avalanche rescue.

- Base initiation of CPR in cardiac arrest on core temperature, burial time, and airway patency.
- Consider proceeding according to the AvaLife algorithm, in multi-burial avalanche accidents with BLS providers only and insufficient numbers of rescuers.

Thrombosis

Pulmonary embolism.

- Consider pulmonary embolism in all patients with sudden onset of progressive dyspnoea and absence of known heart or pulmonary disease.
- Obtain 12-lead ECG (exclude acute coronary syndrome, look for right ventricle strain)
- Identify haemodynamic instability and high-risk pulmonary embolism.
- Perform bedside echocardiography.
- Initiate anticoagulation therapy (heparin 80 IU/kg IV) during diagnostic process, unless signs of bleeding or absolute contraindications.
- Confirm diagnosis with computed tomographic pulmonary angiography.

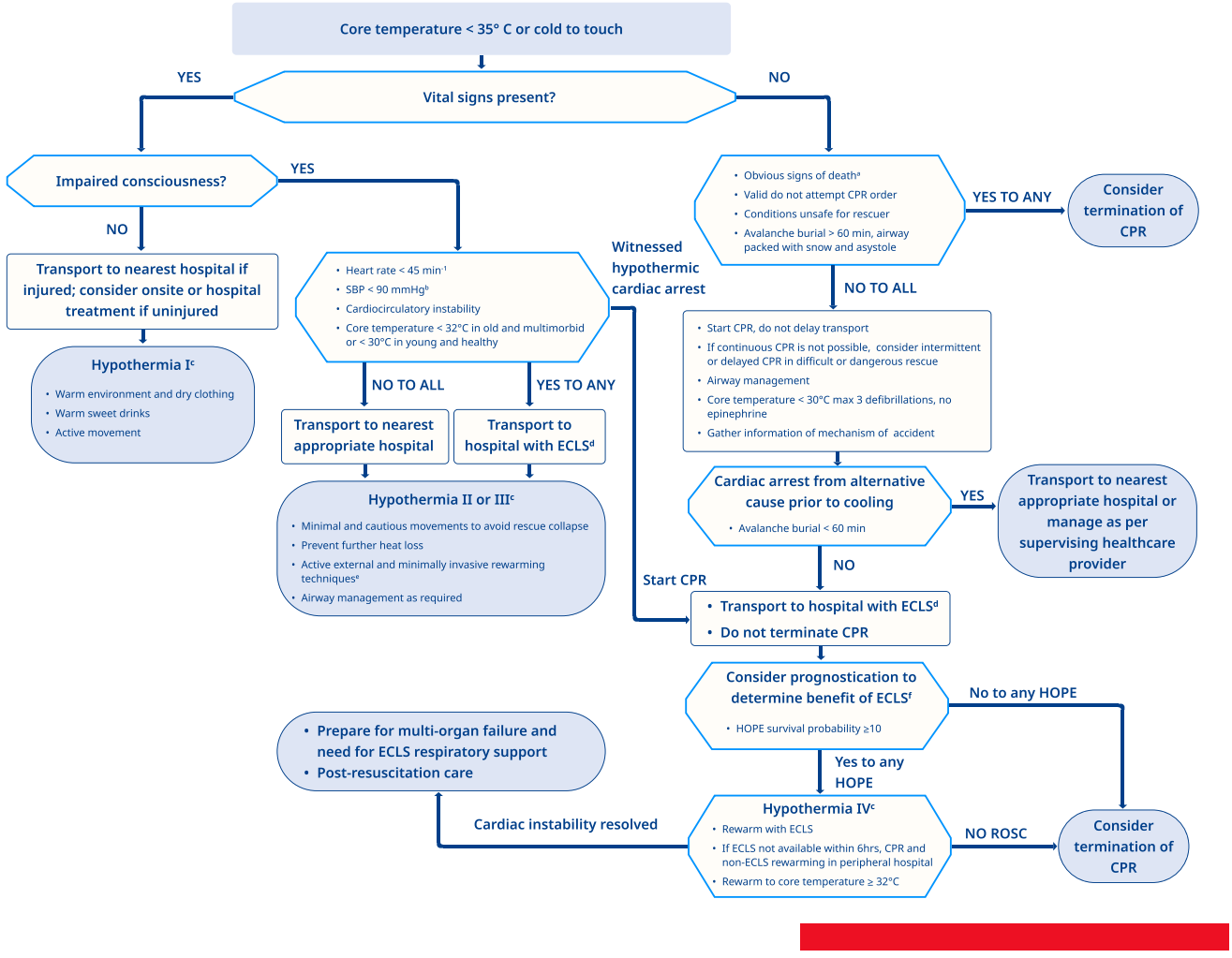

Fig. 16 – Emergency treatment of accidental hypothermia.

[a] Decapitation; truncal transection; whole body decomposed or whole body frozen solid (chest wall not compressible). [b] Systolic blood pressure <90 mmHg is a reasonable prehospital estimate of cardiocirculatory instability but for in-hospital decisions, the minimum sufficient circulation for a deeply hypothermic patient (e.g., <28 C) has not been defined. [c] Swiss staging of accidental hypothermia. [d] Direct transport to an ECLS centre is recommended in an arrested hypothermic patient. In remote areas, transport decisions should balance the risk of increased transport time with the potential benefit of treatment in an extra corporal life support centre. Transfer should be commenced if such a centre can be reached within 6 h. [e] Warm environment, chemical, electrical, or forced air heating packs or blankets, and warm IV fluids (38–42 C). In case of cardiac instability refractory to medical management, consider rewarming with extra corporal life support. [f] If the decision is made to stop at an intermediate hospital to measure serum potassium, a hospital enroute to an extra corporal life support centre should be chosen. The HOPE score should not be used in children, consider expert consultation instead.

- Consider surgical embolectomy or catheter-directed treatment as alternative to rescue fibrinolytic therapy in rapidly deteriorating patients.

Cardiac arrest due to pulmonary embolism.

- Low $ETCO_2$ values (<1.7 kPa/13 mmHg) while performing high quality chest compressions may support a diagnosis of pulmonary embolism, although it is a non-specific sign.
- Use fibrinolytic drugs for cardiac arrest when pulmonary embolism is the suspected cause of cardiac arrest.
- Use fibrinolytic drugs or surgical embolectomy or percutaneous mechanical thrombectomy for cardiac arrest when pulmonary embolism is the known cause of cardiac arrest.
- Consider ECPR as a rescue therapy for selected patients with cardiac arrest when conventional CPR is failing in settings in which it is implemented.

- Set-up a multidisciplinary team for making decisions on management of high-risk pulmonary embolism depending on local resources.

Coronary thrombosis.

- Enhance health education to recognise symptoms and minimise delays in seeking medical care.
- Promote BLS training for likely rescuers of high-risk groups.
- Strengthen regional networks to ensure timely percutaneous coronary intervention (PCI).
- Transfer the patient to a centre with PCI capability and activate existing STEMI networks in case of ST-elevation or suspected ongoing ischaemia.
- In patients with sustained ROSC and ST-elevation on ECG:
  - Perform coronary angiography (and PCI if required) within 120 min of diagnosis.
  - Consider fibrinolysis in pre-hospital and non-PCI-capable settings if greater delay is expected unless traumatic cardiac arrest, then transfer immediately to a PCI centre.
- In patients with sustained ROSC and no ST-elevation on ECG:
  - Consider immediate coronary angiography (and PCI if required) if the patient is haemodynamically unstable or shows signs of ongoing ischaemia.
  - In stable patients without ischaemic signs, emergent cardiac catheterisation laboratory evaluation should not be systematic and can be delayed if there is no estimated high probability of acute coronary occlusion.
  - Assess for non-coronary-causes if the clinical context suggests an alternative aetiology of the arrest.
  - Unless on-going resuscitation is considered futile, transfer patients without sustained ROSC with ongoing CPR, to a PCI centre for consideration for angiography or ECPR depending on available resources and team expertise.

Toxic agents

- Ensure your personal safety, as direct skin contact (e.g., mouth to mouth ventilation) might transmit toxic agents.
- Assess all patients in cardiac arrest for potential intoxication.
- Reduce absorption, consider using specific treatment measures such as antidotes, decontamination and enhanced elimination.
- Administer antidotes, where available, as soon as possible.
- Be prepared to continue resuscitation for a prolonged period of time, as the toxin concentration may fall as it is metabolised or excreted during extended resuscitation measures.
- Consult regional or national poison centres for information on treatment of the poisoned patient.

Traumatic cardiac arrest

- Traumatic cardiac arrest (TCA) is different from cardiac arrest due to medical causes; this is reflected in the treatment algorithm.
- The response to traumatic cardiac arrest is time critical and success depends on a well-established chain of survival, including focused pre-hospital and specialised trauma centre care.
- Early and aggressive management of reversible causes (e.g. haemorrhage control, airway management, chest decompression) is essential for survival.
- Ultrasound aids in identifying the cause of cardiac arrest and guides resuscitative interventions (Fig. 17).

Special settings

Cardiac arrest in the catheterisation laboratory

- Promote adequate training of the staff in technical skills and ALS, and consider periodic emergency drills.
- Ensure emergency equipment is readily available and functional.
- Plan elective procedures carefully to minimise potential complications and promote the use of safety checklists.
- Consider echocardiography in case of haemodynamic instability or suspected complication.
- Resuscitate according to the ALS algorithm, BUT modify:
  - Apply 3 consecutive shocks in case of shockable rhythm
  - Consider external or transvenous pacing for extreme bradycardia.
- Consider, in selected cases depending on clinical context, team expertise and availability:
  - Mechanical CPR, if manual compression is not feasible or safe for the provider.
  - Extracorporeal CPR in selected patients with refractory cardiac arrest, especially if it allows for critical procedures to correct reversible causes.
  - Circulatory support devices, for selected patients in cardiogenic shock after achieving ROSC (Fig. 18).

Drowning

- Rescuers and first responders should prioritise their safety and use the safest rescue technique.
- Bystanders should call for professional help and use rescue techniques with which they feel confident, based on their competencies.
- First responders should use rescue material and flotation devices they are trained to use.
- Spine immobilisation in water should not delay removing the victim from the water when resuscitation is required.
- Start with 5 ventilations using 100 % inspired oxygen when available, continue with standard CPR protocol.
- Airway and ventilation equipment can be used when the provider is trained appropriately.
- Increase ventilation pressure gradually when a high inspiration pressure is needed, in order to avoid stomach inflation.
- Consider ECPR if initial resuscitation is unsuccessful, in accordance with local protocols.
- Follow the recommendations for hypothermia.

Cardiac arrest in the operating room (OR)

- Prevent and mitigate the risk of cardiac arrest through preoperative screening and identification of high-risk patients, clear surgical communication about potential critical procedures, advanced monitoring and continuous presence of an anaesthesiologist during patient instability.
- Start chest compressions if the systolic blood pressure suddenly decreases below 50 mmHg, in association with fall in $ETCO_2$, despite appropriate interventions.
- Inform the surgeon and the operating room team of the cardiac arrest.

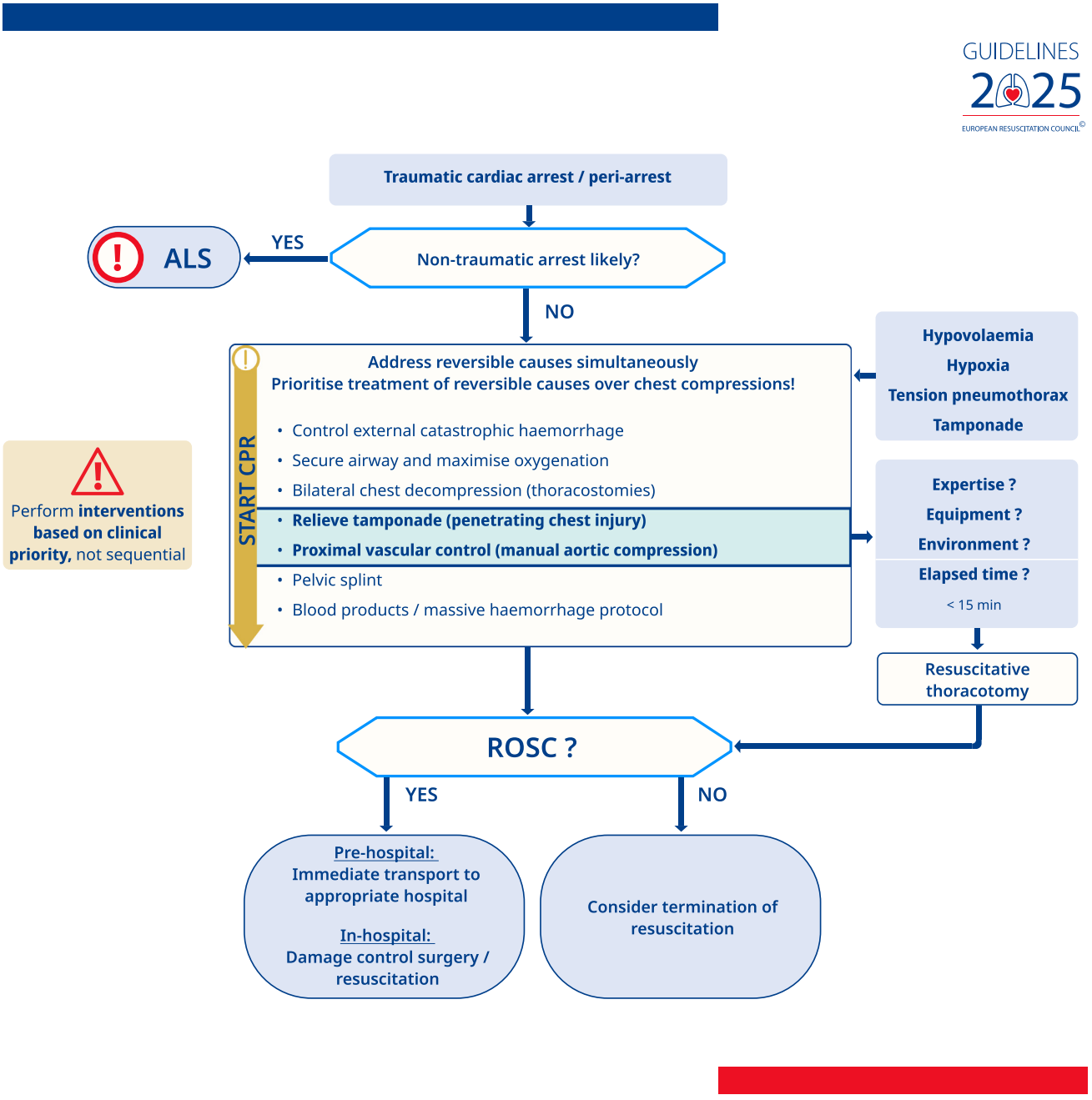

Fig. 17 – Traumatic cardiac arrest algorithm.
This algorithm should be used to guide the management of traumatic cardiac arrest and peri-arrest trauma patients with impending circulatory collapse. In contrast to the sequential ALS algorithms, it is a framework for context-sensitive decisions on clinically prioritised interventions. The aim is to treat the most urgent, reversible cause based on individualised treatment (e.g. patients with a cardiac tamponade need urgent thoracotomy; patients with pelvic fracture in haemorrhagic shock but with a stable airway may benefit more from immediate application of a pelvic binder and rapid transfer without airway intervention).

- Initiate high-quality chest compressions and adjust the height of the operating table to improve work efficiency.
- Ensure the airway is secure, review the $ETCO_2$ tracing, and deliver effective ventilation, administering 100 % oxygen. Exclude unrecognised oesophageal intubation.
- Use ultrasound to guide resuscitation addressing the reversible causes.
- Exclude tension pneumothorax.
- Consider early ECPR as therapy for selected patients when conventional CPR is failing.

GUIDELINES 2025
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1. Prevent & be prepared

Promote adequate training of the staff in technical skills & ALS

Ensure emergency equipment is functional and readily available

Plan elective procedures carefully and use safety checklists

2. Detect and react

Check patient's status and monitored vital signs regulary

Consider echocardiography if haemodynamic instability or complication

In case of cardiac arrest, call for help & activate the resuscitation team

3. Resuscitate and treat possible causes

VF / pVT cardiac arrest

↓

Defibrillate
(apply up to 3 consecutive shocks)

↓

No ROSC

↓

Asystole / PEA

↓

Consider **external or transvenous pacing** in extreme bradycardia

↓

No ROSC

↓

Continue CPR according to the ALS algorithm

- Check & correct reversible causes, including **ultrasound & angiography**
- Consider **mechanical CPR** to facilitate chest compression
- Consider **ECPR** in refractory cardiac arrest
- Consider **circulatory support devices** in case of shock after ROSC

Fig. 18 – Treatment of cardiac arrest in catheterisation laboratory.

- Trained healthcare professionals may consider open chest cardiac compression in specific cases as an alternative, if ECPR is unavailable.
- Human factors are crucial to improve survival of intraoperative cardiac arrest – ensure familiarity with equipment, assign strategies and roles during surgical team time outs and include perioperative cardiac arrest in multidisciplinary and interprofessional team training, in-situ simulation, and ALS courses.

Local anaesthetic systemic toxicity
- Stop local anaesthetic if possible.
- Hyperventilate the patient to increase plasma pH if metabolic acidosis is present
- Give a lower adrenaline dose ($\leq$1 μg kg^{-1} instead of 1 mg IV bolus).
- Give an initial IV bolus of 20 % lipid emulsion at 1.5 mL kg^{-1}over 1 min, followed by an infusion at 0.25 mL kg^{-1} min^{-1} but do not exceed a maximum cumulative dose of 12 mL kg^{-1} IV 20 % lipid emulsion.
- If ROSC has not been achieved at 5 min, double the rate of lipid infusion and give a maximum of two additional lipid boluses at 5-min intervals until ROSC has been achieved.
- Consider prolonged resuscitation (>1 h) and ECPR.
- Treat seizures by administering benzodiazepines.

Cardiac surgery
- Confirm cardiac arrest by clinical signs and pulseless pressure waveforms.
- Consider ultrasound to identify reversible causes.
- Provide up to 3 consecutive shocks in VF/pVT
- Use epicardial pacing at maximum output in asystole or extreme bradycardia.
- Perform re-sternotomy up to 10 days post-surgery within 5 min regardless of the patient's location.
- Provide internal cardiac compressions once the chest is reopened.
- Reduce IV adrenaline dose (0.05–0.1 mg).
- Consider ECPR for prolonged resuscitation or minimally invasive cases where reopening may be delayed (Fig. 19).

Left ventricular assist device (LVAD) patients.
- Immediately activate specialised teams for unresponsive LVAD patients.
- Start CPR while simultaneously attempting to restore device function if multiple rescuers are available.
- Consider delaying CPR for up to 2 min to attempt device restoration if a single rescuer is present.
- Troubleshoot device issues as a priority, following relevant protocols.

Cardiac arrest in sports
- Screening as primary prevention plays an important role but remains controversial.
- All sports and exercise facilities should undertake a risk assessment which considers the likelihood and consequence of sudden cardiac arrest and put in place mitigation strategies to reduce the risk.
- Gain immediate and safe access to the field of play.
- Awareness programs in sport events have proven to be feasible to raise awareness amongst target groups not yet involved with cardiac arrest.

Emergency medical services
- Healthcare professionals should provide resuscitation at the scene rather than undertake ambulance transport with ongoing resuscitation, unless there is an appropriate indication to justify transport (bridging to in-hospital treatment).
- Consider mechanical CPR for transport with ongoing resuscitation.
- Consider obtaining invasive arterial blood pressure to guide resuscitation and post-resuscitation care already in the prehospital setting if it is feasible.
- EMS systems should use registry and data provided from equipment data (e.g. defibrillators) for debriefing and continuous quality improvement.

Inflight cardiac arrest and microgravity resuscitation
Inflight cardiac arrest.
- Healthcare professional help should be sought (in-flight announcement).
- The rescuer should kneel in the leg-space in front of the aisle seats to perform chest compressions if the patient cannot be transferred within a few seconds to an area with adequate floor space (galley).
- Overhead-CPR is a possible option in limited space environments.
- Airway management should be based on the equipment available and the expertise of the rescuer.
- If the planned route leads over an area where no airport can be reached for a longer period of time with high possibility of ROSC during an ongoing resuscitation, consider an early diversion.
- Consider risks of diversion if ROSC is unlikely and give appropriate recommendations to the flight crew.
- If CPR is terminated (no ROSC) there is no medical need for flight diversion – follow airline policy.

Microgravity resuscitation.
- Airway management, defibrillation and IV/IO access are similar to terrestrial ALS, but only once the patient is secured.
- Consider mechanical CPR.
- Consult telemedicine support during cardiac arrest in low earth orbit if feasible and manpower allows.
- The crewmember with the highest medical qualification should decide on termination of resuscitation, consulting telemedicine support.

Cruise ship
- Use all healthcare resources immediately (personnel, equipment).
- Activate helicopter emergency medical service if close to the coastline.
- Consider early telemedicine support.
- Have all equipment needed for ALS available on board.
- In case of insufficient number of healthcare professionals to treat cardiac arrest, call for further medical staff via an on-board announcement.

GUIDELINES 2025
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1. Prevent & be prepared

- Ensure adequate training of the staff in technical skills and ALS
- Ensure availability and functioning of emergency equipment
- Use safety checklists
- Identify and manage deterioration in the post-operative cardiac patient

2. Detect cardiac arrest and activate cardiac arrest protocol

- Confirm cardiac arrest by clinical signs and pulseless waveforms
- Call for help and activate cardiac arrest protocol
- Ensure airway patency and breathing
- Deliver 100% oxygen
- Stop syringe drivers
- Consider echocardiography to early identify possible reversible causes

3. Resuscitate and treat possible reversible causes

ASSESS RHYTHM

VF/pVT	Asystole / extreme bradycardia	PEA
Defibrillate (apply up to 3 consecutive shocks)	Pace - if wires are available	Provide high-quality CPR

Start basic life support and address reversible causes

Amiodarone 300 mg IV	Consider external pacing if wires are not available	If paced, turn off pacing to exclude underlying VF

No ROSC
- Continue advanced life support
- Prepare & perform early resternotomy (<5 min)
- Consider circulatory support devices and ECPR

Fig. 19 – Post-cardiac surgery cardiac arrest algorithm.

Special patient groups

Asthma and chronic obstructive pulmonary disease

- Treat life threatening hypoxia with 100 % oxygen.
- Check for evidence of (tension) pneumothorax.
- Provide tracheal intubation (because of high inflation pressures).
- Consider manual decompression and disconnection from ventilator to manage dynamic hyperinflation.
- Consider ECPR in accordance with local protocols if initial resuscitation efforts are unsuccessful.

Cardiac arrest in haemodialysis patients

- Assign a trained dialysis nurse or technician to operate the dialysis machine.
- Stop dialysis and return the patient's blood volume with a fluid bolus.
- Disconnect from dialysis machine (unless defibrillation-proof) and beware of wet surfaces.
- Leave dialysis access open and use for drug administration.
- Dialysis may be required in the early post resuscitation period.

Table 3 – Modifications to advanced life support in obstetric patients.

ALS during pregnancy	Rationale
Detection of cardiac arrest: unconscious + abnormal breathing = suspected cardiac arrest	*No change*
Call for help – "maternal arrest team"	Consider pregnancy in any collapsed woman of childbearing age. Call maternal cardiac arrest team (including an obstetrician and neonatologist)
Manual (left) uterine displacement throughout	Relieve aortocaval compression to improve cardiac output as early as possible and maintain it throughout resuscitation. Establish manual left uterine displacement when two or more team members are available—one performing manual left uterine displacement, the other performing CPR.
Chest compression quality parameters and ventilation-compression-ratio	*No change*
Airway management	Aspiration and failed intubation risk are both increased. Use a stepwise approach (bag-mask, tracheal tube or supraglottic airway if tracheal intubation fails), according to rescuer skills. Try to achieve a ramped position. Intubation should be performed by an experienced person. Equipment considerations: – Short-handled laryngoscope for large breasts – video laryngoscope as standard for intubation – Smaller tracheal tube with guidance
Defibrillation – Shock energy	*No change*
Pad position	No change: ensure defibrillation pads are placed beneath, not over, enlarged breast tissue
Fetal monitoring	Remove internal & external fetal monitors before defibrillation
Identify common and reversible causes	4Hs, 4Ts and 4Ps – Pre-eclampsia and eclampsia; Puerperal sepsis; Placental and uterine complications; Peripartum cardiomyopathy
Medications	
Vascular access early	Consider IV/IO access above the diaphragm if possible.
Dosage and time of adrenaline, amiodarone and lidocaine	*No change*
Calcium chloride	10 ml iv calcium chloride 10 %: for Mg overdose, low calcium or hyperkalaemia
Magnesium	2 g iv: for polymorphic VT 4 g iv: for eclampsia
Tranexamic acid	1 g iv: for haemorrhage
Resuscitative Hysterotomy (Perimortem Caesarean section)	In patients >20 weeks' gestation or fundus above umbilicus. Resuscitative hysterotomy is a time-sensitive intervention. Preparation to perform should be undertaken early. Resuscitative hysterotomy should be performed as soon as possible at the site of cardiac arrest by a skilled team.
Post-resuscitation care	Stabilise mother to stabilise fetus and prepare for major obstetric haemorrhage.

Resuscitation in obese patients

- Obese patients should receive standard resuscitation treatment – no deviation from standard BLS and ALS is needed.

Resuscitation in patients with pectus excavatum

- Consider reduced chest compression depth of 3–4 cm.
- In the case of a Nuss bar correction, substantially increased force is required to deliver effective chest compressions.
- Consider early implementation of ECPR if chest compressions are ineffective.
- Use antero-posterior pad placement for defibrillation using standard energies.

Cardiac arrest in pregnancy

- Consider pregnancy in any collapsed woman of childbearing age.
- Pregnant and peripartum women can deteriorate to cardiac arrest anywhere and medical facilities and services must be prepared for such events.
- Obstetric-specific early warning systems enable early recognition of deteriorating pregnant patients.
- In obstetric cardiac arrest, follow the specific additions to the general ALS algorithm.
- Relieve aortocaval compression as early as possible and maintain it throughout resuscitation. Manual left uterine displacement in maternal cardiac arrest is suggested due to practicalities.
- Seek additional pregnancy-specific causes of cardiac arrest to the 4Hs and 4Ts: The 4Ps, which are pre-eclampsia and eclampsia, puerperal sepsis, placental and uterine complications and peripartum cardiomyopathy.
- Resuscitative hysterotomy is a time-sensitive intervention. Preparation to perform the procedure should be undertaken early.
- Resuscitative hysterotomy should be performed as soon as possible at the site of cardiac arrest by a skilled team.
- Post-resuscitation care in pregnant and postpartum women requires a multidisciplinary approach (Table 3).

Adult post resuscitation care

The European Resuscitation Council (ERC) and the European Society of Intensive Care Medicine (ESICM) have collaborated to produce these post-resuscitation care Guidelines for adults.[68] (Fig. 20)

Immediate post-resuscitation care

- Post-resuscitation care is started immediately after sustained ROSC, regardless of location.

Diagnosis of cause and complications of cardiac arrest

- Identify early non-coronary causes using transthoracic echocardiography and/or a whole body computed tomography (CT) scan (including head, neck, chest, abdomen, pelvis, and CT pulmonary angiography) at hospital admission, before or after coronary angiography if indicated.
- Prioritise immediate coronary angiography for patients with clear ST-elevation on the ECG or other high suspicion of coronary occlusion (e.g. haemodynamic and/or electrical instability). Perform a head-to-pelvis CT scan (including CT pulmonary angiography) if coronary angiography fails to identify causative lesions.
- If there are signs or symptoms pre-arrest suggesting a non-coronary cause (e.g. headache, seizures or neurological deficits, shortness of breath or documented hypoxaemia in patients with known respiratory disease, abdominal pain), perform a whole body CT-scan (including CT pulmonary angiography).

Airway and breathing

Airway management after return of spontaneous circulation

- Airway and ventilation support should continue after ROSC is achieved.
- Patients who have had a brief period of cardiac arrest and an immediate return of normal cerebral function and are breathing normally, may not require airway or ventilatory support but should be given supplemental oxygen via a facemask if their arterial blood oxygen saturation is less than 94 %.
- Patients who remain comatose following ROSC, or who have another clinical indication for sedation and mechanical ventilation, should have their trachea intubated if this has not been done already during CPR.
- Tracheal intubation (with or without drugs) should be performed only by experienced operators who have a high success rate.
- Correct placement of the tracheal tube must be confirmed with waveform capnography.
- In the absence of personnel experienced in tracheal intubation, it is reasonable to retain or insert a supraglottic airway (SGA) or maintain the airway with basic techniques until personnel skilled in drug-assisted tracheal intubation are available.
- Post ROSC patients may require drug assisted tracheal intubation – the same level of care should be provided as for any other critically ill patient with a physiologically or anatomically challenging airway in terms of skills of the provider, monitoring, and choice of drugs for induction, and maintenance of sedation.

Control of oxygenation

- Immediately after ROSC, use 100 % (or the maximum available) inspired oxygen until the arterial oxygen saturation (SpO_2) can be measured and titrated reliably with pulse oximetry or the partial pressure of arterial oxygen (PaO_2) can be measured.
- As soon as SpO_2 can be measured reliably or arterial blood gas values are obtained, titrate the inspired oxygen to achieve an arterial oxygen saturation of 94–98 % or arterial partial pressure of oxygen (PaO_2) of 10–13 kPa (75–100 mmHg). Be aware that pulse oximetry can overestimate the true oxygen saturation in people with darker skin tones and low-flow states will cause low signal quality.
- Avoid hypoxaemia (PaO_2 < 8 kPa or 60 mmHg) following ROSC.
- Avoid hyperoxaemia following ROSC.

Control of ventilation

- Obtain arterial blood gases and use end tidal CO_2 in mechanically ventilated patients.
- Target normocapnia (a partial pressure of carbon dioxide of 35–45 mm Hg or approximately 4.7–6.0 kPa) in adults with ROSC after cardiac arrest.

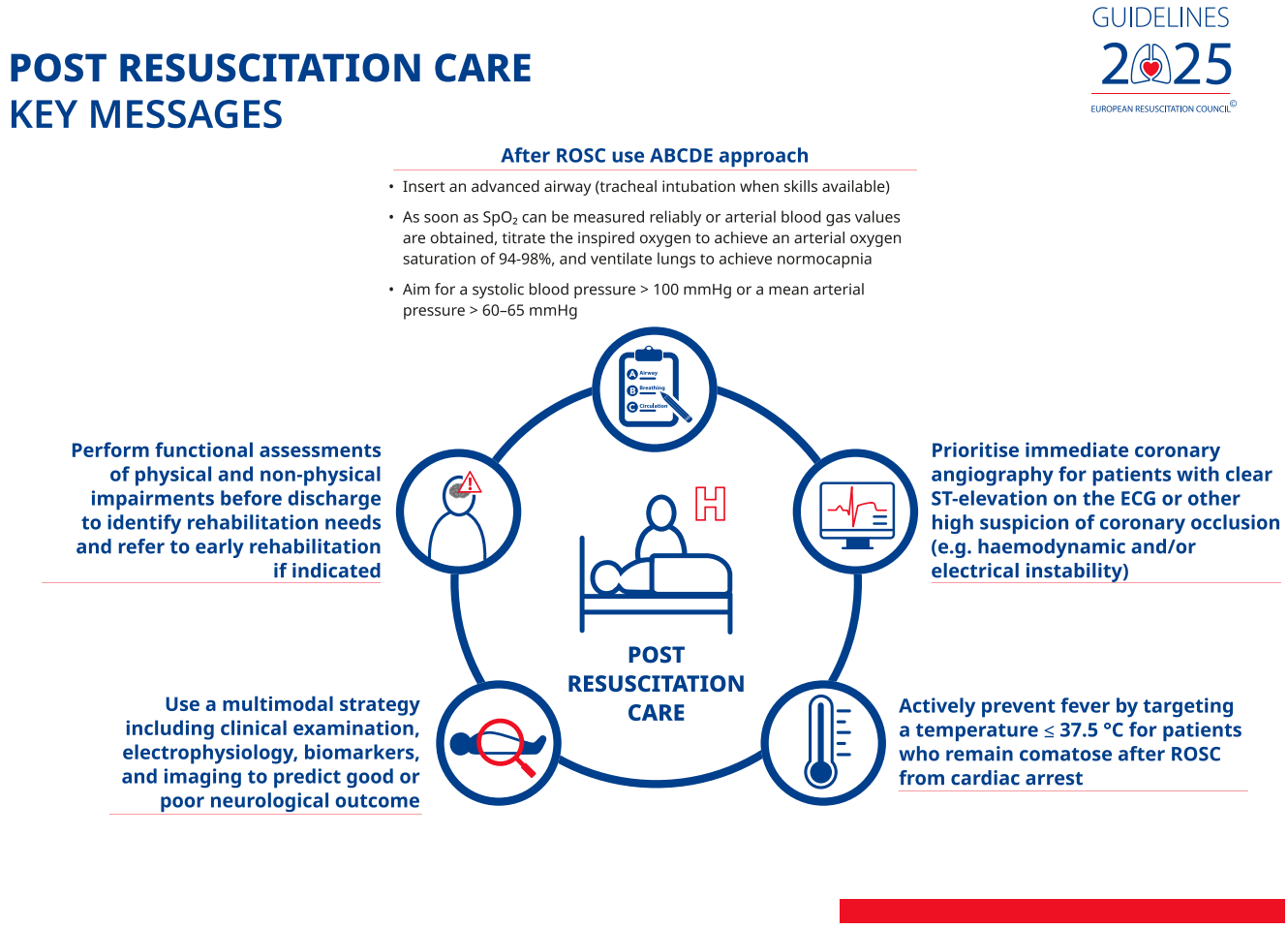

Fig. 20 – Key messages adult post resuscitation care.

- In patients with accidental hypothermia or treated with hypothermia monitor $PaCO_2$ frequently as hypocapnia may occur.
- In hypothermic patents use consistently either temperature or non-temperature corrected blood gas values.
- Use a lung protective ventilation strategy aiming for a tidal volume of 6–8 mL kg^{-1} ideal body weight.

Circulation

Coronary reperfusion

- Emergent cardiac catheterisation laboratory evaluation (and primary percutaneous coronary intervention (PPCI) if required) should be performed in adult patients with ROSC after cardiac arrest of suspected cardiac origin with persistent ST-elevation on the electrocardiogram (ECG).
- In patients with ROSC after out-of-hospital cardiac arrest (OHCA) without ST-elevation on the ECG, cardiac catheterisation laboratory evaluation should be delayed unless the clinical context suggests a high likelihood of acute coronary occlusion.

Haemodynamic monitoring and management

- All patients should be monitored with an arterial line for continuous blood pressure measurements, and it is reasonable to monitor cardiac output in haemodynamically unstable patients.
- Perform echocardiography as soon as possible in all patients to detect any underlying cardiac pathology and quantify the degree of myocardial dysfunction.
- Avoid hypotension and target a mean arterial pressure (MAP) > 60–65 mmHg after cardiac arrest.
- Maintain perfusion with fluids, noradrenaline and/or dobutamine, depending on individual patient need for intravascular volume, vasoconstriction or inotropy.
- Do not give steroids routinely after cardiac arrest.
- Avoid hypokalaemia and hyperkalaemia, which are associated with ventricular arrhythmias.
- In select patient populations (e.g. Glasgow Coma Scale score ≥8 on hospital arrival, with ST-elevation myocardial infarction (STEMI) and <10 min cardiac arrest) consider mechanical

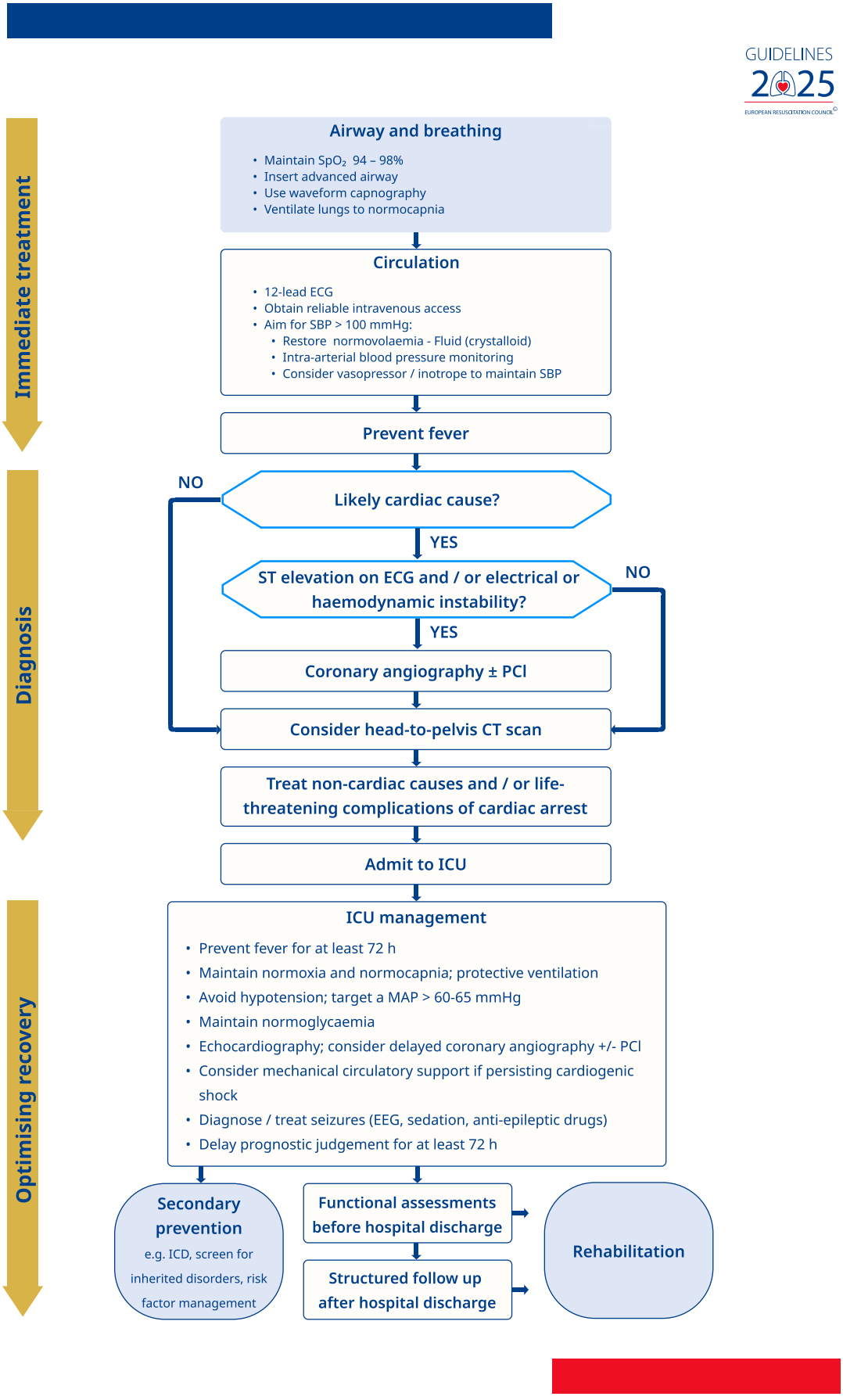

Fig. 21 – Post-resuscitation care for unconscious patients.

circulatory support (such as intra-aortic balloon pump, left-ventricular assist device or veno-arterial extra corporal membrane oxygenation) for persisting cardiogenic shock from left ventricular failure if treatment with fluid resuscitation, inotropes, and vasoactive drugs is insufficient. Left-ventricular assist devices or arterio-venous extra corporal membrane oxygenation should also be considered in haemodynamically unstable patients with acute coronary syndromes (ACS) and recurrent ventricular tachycardia (VT) or ventricular fibrillation (VF) despite optimal therapy.

Post-ROSC arrhythmias

- In patients with arrhythmia immediately after ROSC, follow the ALS Guidelines for peri-arrest arrhythmia.
- In patients with arrhythmia after ROSC, treat any potential underlying causes, such as coronary occlusion or electrolyte disorders.
- In patients with no arrhythmia after ROSC, do not routinely give anti-arrhythmic drug prophylaxis (Fig. 21).

Disability (optimising neurological recovery)

Control of seizures

- Use electroencephalography (EEG) to diagnose electrographic seizures in patients with sub-clinical convulsions and to monitor treatment effects.
- Use levetiracetam or sodium valproate as first-line antiepileptic drugs in addition to sedative drugs to treat seizures after cardiac arrest.
- Do not use seizure prophylaxis in post-cardiac arrest patients.
- Attempt a wake-up trial in patients with myoclonus and benign EEG background (days after arrest).

Temperature control

- Actively prevent fever by targeting a temperature $\leq$37.5 °C for patients who remain comatose after ROSC from cardiac arrest.
- Comatose patients with mild hypothermia (32–36 °C) after ROSC should not be actively warmed to achieve normothermia.
- We recommend against the routine use of prehospital cooling with rapid infusion of large volumes of cold intravenous fluid immediately after ROSC.
- Use surface or endovascular temperature control techniques when temperature control is used in comatose patients after ROSC.
- When a cooling device is used, we suggest using a temperature control device that includes a feedback system based on continuous temperature monitoring to maintain the target temperature.
- Prevent active fever for 36–72 h in post-cardiac arrest patients who remain comatose.

Other therapies to improve neurological outcome

- There is insufficient evidence to recommend the use of any specific drug therapy for comatose survivors of cardiac arrest.

General intensive care management

- Do not use prophylactic antibiotics routinely in patients following ROSC. However, it is reasonable to have a low threshold for giving antibiotics when there is any clinical suspicion of pneumonia.
- Use short acting sedative agents when treating post-cardiac arrest patients receiving mechanical ventilation – this may enable earlier clinical examination that is less confounded by sedation when assessing neurological recovery.
- We do not recommend systematic use of neuromuscular blocking drugs in comatose post-cardiac arrest patients.
- In patients with critical hypoxaemia and acute respiratory distress syndrome (ARDS) following cardiac arrest, the use of a neuromuscular blocker may be considered.
- Patients should be nursed 30° head-up.
- It is reasonable to start gastric feeding at low rates (trophic feeding) and increase as tolerated.
- Given the high incidence of upper gastrointestinal ulceration in post-cardiac arrest patients and the use of anticoagulant and antiplatelet drugs both pre and post arrest, use stress ulcer prophylaxis in post-cardiac arrest patients, especially in those with coagulopathy.
- Anticoagulation of post-cardiac arrest patients should be individualised and be based on general ICU recommendations.
- Use standard glucose management protocols for adults with ROSC after cardiac arrest.

Predicting neurological outcome

General recommendations

- In patients who are comatose after resuscitation from cardiac arrest, neurological prognostication should be performed using clinical examination, electrophysiology, biomarkers, and imaging, to both inform the patient's relatives and to help clinicians to target treatments based on the patient's chances of achieving a neurologically meaningful recovery.
- No single predictor is 100 % accurate. Use multimodal neuroprognostication strategies.
- When predicting poor neurological outcome, a high specificity and precision are desirable, to avoid falsely pessimistic predictions. When predicting good outcome, the aim is to identify those patients with a better potential for recovery. Since the consequence of a false prediction in this setting is less severe, the predictive performance of the test is not as critical. Both predicting good and poor outcome are important, to reduce prognostic uncertainty.
- The clinical neurological examination is central to prognostication. To avoid falsely pessimistic predictions, clinicians should exclude potential residual effects of sedatives and other drugs that may confound the results of the tests.
- Index tests for neurological prognostication are aimed at assessing the severity of hypoxic-ischaemic brain injury. Neurological prognosis is one of several aspects to consider in discussions about an individual's potential for recovery.

Clinical examination

- Perform a daily neurological examination in patients who are unconscious after cardiac arrest.
- Clinical examination is prone to interference from sedatives, opioids or neuromuscular blocking drugs. Potential confounding from residual sedation should always be considered and excluded.
- Consider neurological prognostication in patients who are not awake and obeying commands (Glasgow coma scale motor score < 6) at 72 h or later after ROSC.

- In unconscious patients at 72 h or later after ROSC, the following tests may predict a poor neurological outcome:
  - The bilateral absence of the pupillary light reflex.
  - The bilateral absence of corneal reflex.
  - The presence of myoclonus within 96 h and, in particular, status myoclonus within 72 h.
- We also suggest recording the EEG in the presence of myoclonic jerks to detect any associated epileptiform activity or to identify EEG signs such as background reactivity or continuity, suggesting a potential for neurological recovery.

Neurophysiology

- Perform EEG from day 1 after ROSC to predict outcome and detect subclinical seizure activity in comatose patients. Routine EEG or continuous EEG monitoring may be used.
- Suppressed background with or without periodic discharges and burst suppression on EEG ('highly malignant' patterns) are accurate indicators of a poor prognosis. We suggest using these EEG patterns after 24 h from ROSC.
- The bilateral absence of somatosensory evoked cortical N20 potentials indicates poor prognosis after cardiac arrest.
- Always consider the EEG and somatosensory evoked potentials (SSEPs) results in the context of clinical examination findings and other tests. Always consider using a neuromuscular blocking drug when performing SSEP.

Biomarkers

- Use serial measurements of neuron specific enolase (NSE) to predict outcome after cardiac arrest. Increasing values between 24 h and 48 h or 72 h in combination with high values at 48 h and 72 h indicate a poor prognosis.

Imaging

- Use brain imaging studies to predict poor neurological outcome after cardiac arrest. Ensure that the images are evaluated by someone with specific experience in these studies.
- Where specialist neuroradiology expertise is unavailable, consider telemedicine consultation for brain imaging interpretation.
- Use presence of generalised brain oedema, manifested by a marked reduction of the grey matter/white matter ratio on brain CT, or extensive diffusion restriction on brain MRI to predict poor neurological outcome after cardiac arrest.
- Repeat the brain CT if the patient is unconscious at the time of prognostication (72 h–96 h after ROSC) and the first brain CT does not show signs of hypoxic ischaemic brain injury (HIBI).

Multimodal prognostication

- Once major confounders have been excluded, start the prognostication assessment with an accurate clinical examination.
- In an unconscious patient at $\geq$72 h from ROSC, in the absence of confounders, poor outcome is likely when two or more of the following predictors are present: no pupillary and corneal reflexes at $\geq$72 h, bilaterally absent N20 somatosensory evoked potential (SSEP) wave at $\geq$ 24 h, highly malignant EEG at >24 h, neuron specific enolase (NSE) > 60 $\mu g\ L^{-1}$ at 48 h and/or 72 h, status myoclonus $\leq$72 h, or a diffuse and extensive anoxic injury on brain CT/MRI. Most of these signs can be recorded before 72 h from ROSC, however, conclusions on prognosis will be made only at the time of clinical prognostic assessment at $\geq$72 h.

Withdrawal of life-sustaining therapy

- Separate discussions around withdrawal of life-sustaining therapy and the assessment of prognosis for neurological recovery; withdrawal of life-sustaining therapy decisions should consider aspects other than brain injury such as age, co-morbidity, general organ function and the patients' preferences.
- Allocate sufficient time for communication around the level-of-treatment decision within the team and with the families.
- After a decision on withdrawal of life-sustaining therapy, use a structured approach to shift from curative to end-of-life palliative care and consider organ donation.

Rehabilitation and follow-up after cardiac arrest

- Implement early mobilisation, delirium management and ICU diaries during hospitalisation.
- Provide information to patients and co-survivors.
- Perform functional assessments of physical and non-physical impairments before discharge to identify rehabilitation needs and refer to early rehabilitation if indicated.
- Provide cardiac rehabilitation as indicated by the cause of the cardiac arrest.
- Organise a follow-up of cardiac arrest survivors within three months after hospital discharge; screening for cognitive, physical, emotional problems, fatigue, and impact on life roles.
- Invite co-survivors to the follow-up; ask about emotional problems and impact on life roles
- Undertake specialist referral and further rehabilitation as indicated (Fig. 22).

Organ donation

- We recommend that all patients who have restoration of circulation after CPR and who subsequently progress to death be evaluated for organ donation.
- In comatose ventilated patients who do not fulfil neurological criteria for death, if a decision to start end-of-life care and withdrawal of life support is made, organ donation should be considered for when circulatory arrest occurs.
- All decisions concerning organ donation must follow local legal and ethical requirements.
- Cardiac arrest registries should report if organ donation after initial resuscitation from cardiac arrest occurred.

Investigating unexplained cardiac arrest

- Diagnostic testing of patients with unexplained cardiac arrest includes blood sample collection for toxicology and genetic testing, data retrieval from cardiac implantable electronic devices and wearable monitors, repeated 12 lead ECG and continuous cardiac monitoring, cardiac MRI, sodium channel blocker tests, and exercise testing.
- A confirmed diagnosis of a heritable condition should prompt targeted genetic testing.
- Long-term follow-up of patients after unexplained cardiac arrest patients is recommended because of the high risk of recurrence of arrhythmia.

Cardiac arrest centres

- Adult patients with non-traumatic OHCA should be considered for transport to a cardiac arrest centre according to local protocols.
- Adult patients with non-traumatic OHCA should be cared for at a cardiac arrest centre whenever possible.

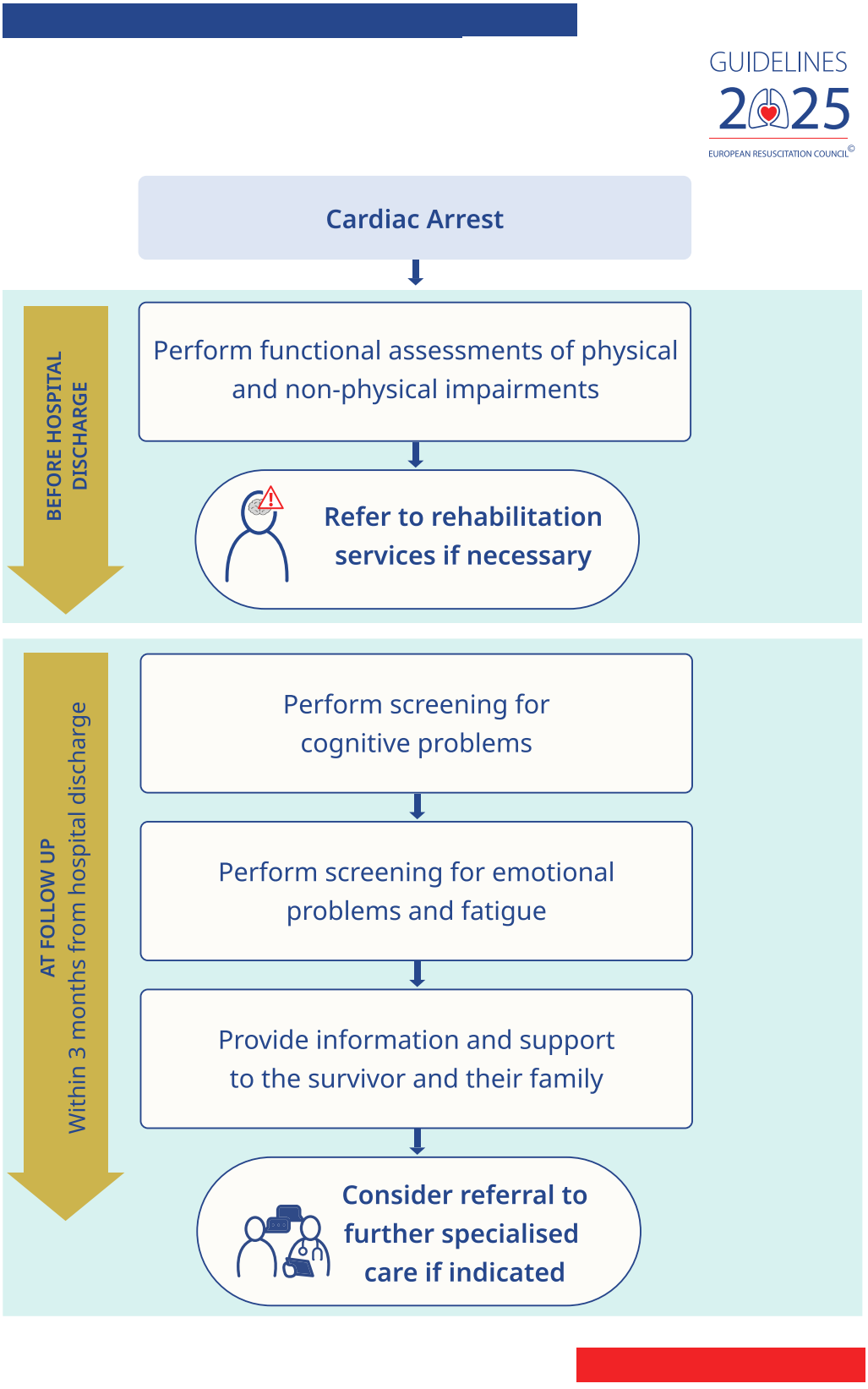

Fig. 22 – Recommendations for in-hospital functional assessments, follow-up and rehabilitation after cardiac arrest.

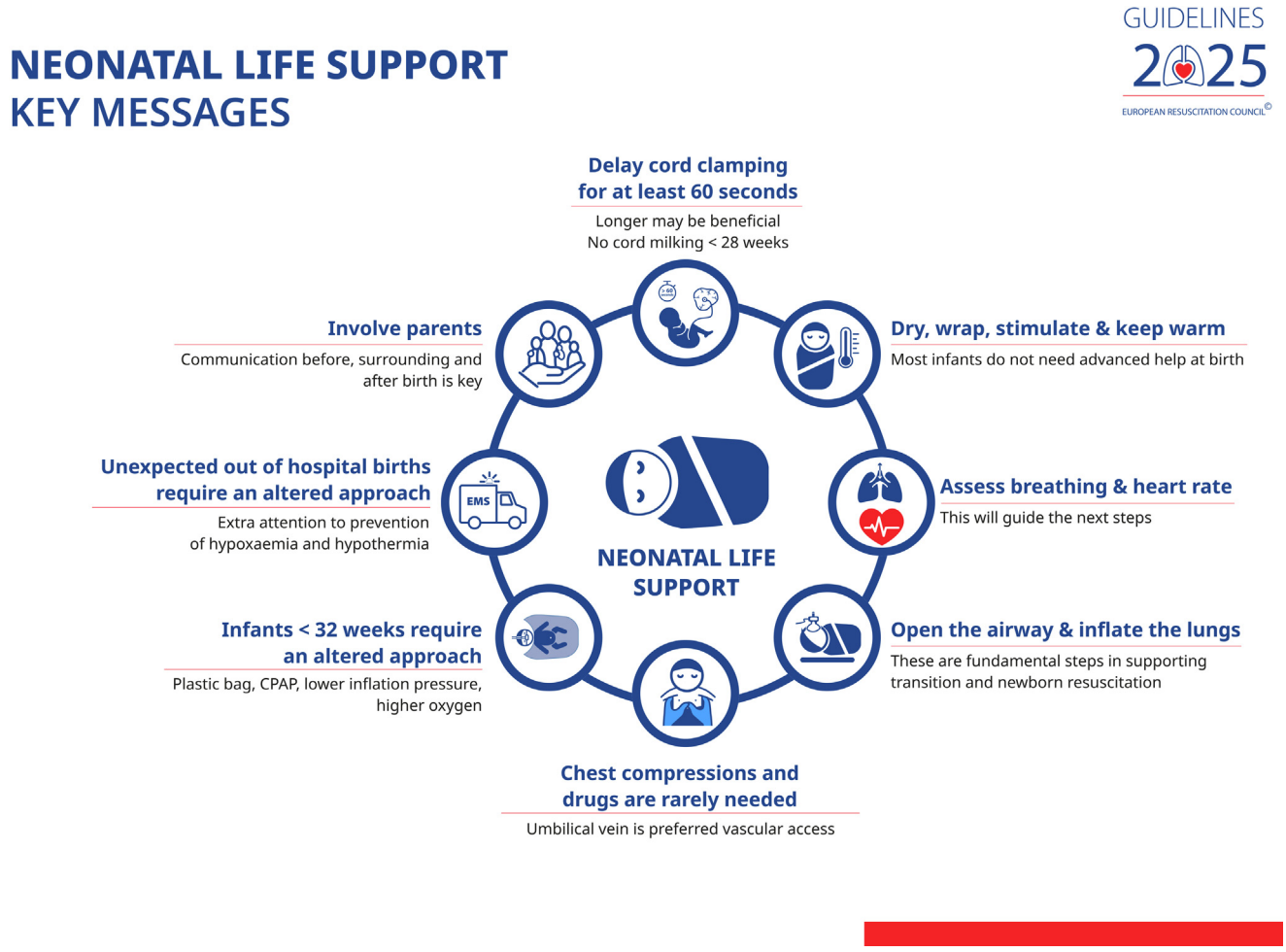

Fig. 23 – Key messages Neonatal Life Support.

- Healthcare networks should establish local protocols to develop and maintain a cardiac arrest network.

Newborn life support

The ERC Guidelines 2025 Newborn Resuscitation and Support of Transition of Infants at Birth cover the management of the term and preterm infant.[69] (Fig. 23).

Factors before birth

Staff attending births in hospitals

Any infant may develop problems during birth. Local guidelines should indicate who should attend births taking into consideration identified risk factors.

As a guide:

- An interprofessional team with appropriate experience and training in NLS proportionate to the expected risk should attend the birth.
- Neonatal staffing levels should acknowledge the potential need to deliver unexpected support in the delivery area.
- A process should be in place for rapidly mobilising extra team members with adequate resuscitation skills for any birth.

Telemedicine

- Consider the use of collaboration through telemedicine, as it facilitates providing remote advice.

Equipment and environment

- Regularly check all equipment to ensure it is ready for use.
- Ensure that equipment is easily accessible and organised in a standardised way.
- Consider human factor elements when organising equipment to maximise efficiency and minimise time delays.
- Resuscitation should take place in a warm, well-illuminated, draught-free area with a flat resuscitation surface and an external heat source, e.g. a radiant heater (see thermal control).

Briefing

- Team briefing is important and should be performed before birth.
- The purpose of briefing is to:
  - Review available clinical information.
  - Assign roles and tasks.
  - Check equipment and presence of personnel.
  - Prepare the family.
- Use a checklist and/or cognitive aid to facilitate all of the above, reduce mental load, and enhance safety.

Education

- Institutions or clinical areas where births may occur should provide sufficient opportunities and resources for healthcare professionals involved in neonatal resuscitation to receive regular training, maintaining up-to-date knowledge as well as technical and non-technical skills.
- The content and organisation of such training programmes may vary according to the needs of the providers and the local organisation.
- Undertake training at least once per year to prevent skill decay, preferably supplemented with more frequent short-duration booster sessions (e.g. every 3–6 months). For more information on training see ERC Guidelines 2025 Education for Resuscitation.

Thermal control

Standards

- Maintain the temperature of newborn infants between 36.5 °C and 37.5 °C.
- Monitor the infant's temperature regularly or continuously after birth.
- Record the admission temperature as a prognostic and quality indicator.
- Rewarm infants who are hypothermic after birth; avoid hyperthermia.
- In appropriate circumstances, therapeutic hypothermia may be considered after resuscitation (see post-resuscitation care).

Environment

- Protect the infant from draughts. Ensure windows are closed and air-conditioning appropriately programmed.
- In infants >28 weeks, keep the delivery area at 23–25 °C.
- In infants ≤28 weeks, keep the delivery area at >25 °C.

Newborn infants ≥32 weeks

- Dry the infant immediately after birth and remove wet towels.
- Cover the infant's head with a hat, and the body with dry towels.
- If no intervention is required, place the infant skin-to-skin with mother or let mother do that herself, and cover both with towels.
- Ongoing careful observation of mother and infant is required, especially in more preterm and growth-restricted infants to ensure they both remain normothermic.
- Consider the use of a plastic bag/wrap if skin-to-skin care is not possible.
- Place the infant on a warm surface using a preheated radiant warmer, if support of transition or resuscitation is required.

Newborn infants <32 weeks

- Dry the infant's head and cover with a hat.
- Put the infant's body in a plastic (polyethylene) bag or wrap without drying.
- Use a preheated radiant warmer.
- Consider the use of additional measures during delayed cord clamping to ensure thermal stability (e.g., increasing room temperature, warm blankets, and thermal mattress).
- Be careful to prevent hypothermia during skin-to-skin care during assisted transition, especially in the more preterm and/or growth restricted infants.
- Consider the use of heated humidified respiratory gases for infants receiving respiratory support.
- Be aware of the risk of hyperthermia when multiple heat-preservation interventions are used simultaneously, especially while using a thermal mattress.

Management of the umbilical cord

- Ideally, delayed cord clamping is performed in all births, after inflation of the lungs and before uterotonics are given.

Cord clamping

- Discuss the options for managing cord clamping and the rationale with parents and team before birth.
- Perform thermal management, tactile stimulation and initial assessment during delayed cord clamping.
- Newborn infants without need for support: facilitate at least 60 s of delayed cord clamping.
- Newborn infants in need of resuscitation: clamp the cord <30 s to minimise any delay to necessary interventions.
- If stabilisation with intact cord can be safely undertaken, longer delayed cord clamping is preferred, especially in infants <34 weeks.

Cord milking

- Do **not** milk the cord in preterm infants <28 weeks.
- Consider intact cord milking as an alternative in infants ≥28 weeks, but only if delayed cord clamping cannot be performed (Fig. 24).

Initial assessment

- Perform initial assessment as soon as possible after birth, ideally during delayed cord clamping, drying and wrapping to:
  - Identify the need for support and/or resuscitation.
  - Aid decisions relating to the appropriateness and duration of delayed cord clamping.
- Assess:
  - Breathing.
  - Heart rate (HR).
  - Muscle tone.
- Provide thermal management and tactile simulation during delayed cord clamping and assessment.
- Reassess breathing and HR frequently to assess any response and determine if further interventions are required.

Breathing

- Note presence or absence of breathing.
- If present, note the rate, depth, symmetry and work of breathing.

Heart rate

- Initial HR assessment can be performed with a stethoscope.
- Continuous HR assessment methods (pulse oximetry, electrocardiography (ECG)) are preferred when interventions are indicated or during stabilisation of preterm newborns.

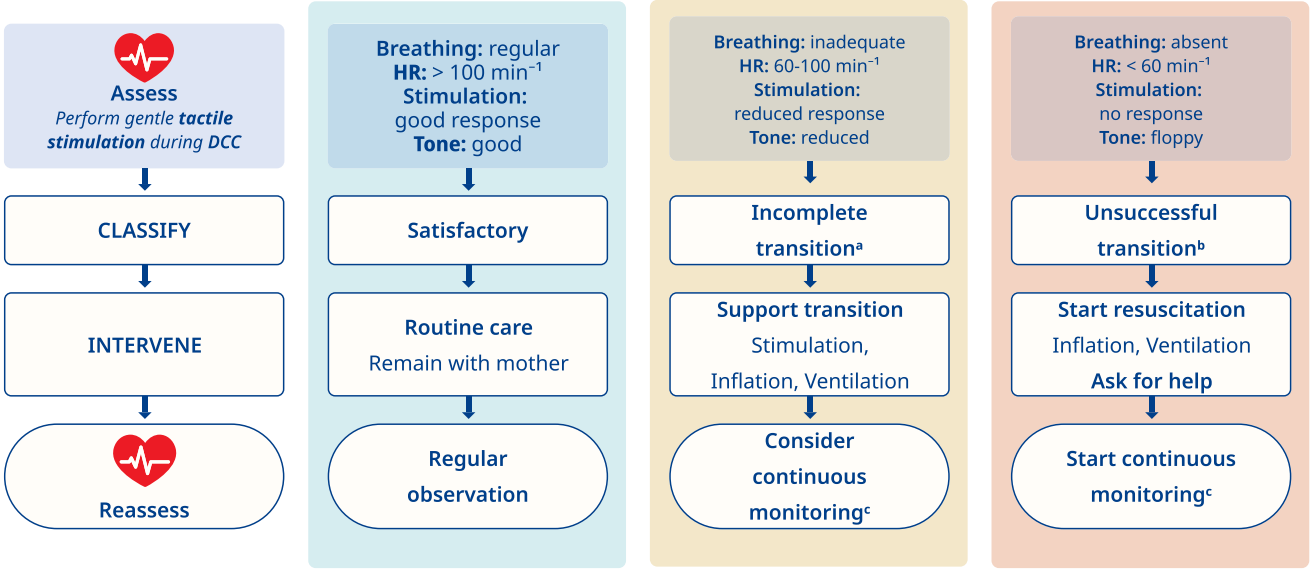

Fig. 24 – Initial assessment and interventions.
[a] Slow HR may indicate hypoxia, so airway and breathing require support. Ventilatory support will likely be adequate for a higher HR and adequate transition. [b] HR suggestive of significant hypoxia, so airway and breathing support required urgently. [c] SpO_2 +/- ECG.

- Do not interrupt resuscitation to place pulse oximetry or ECG.

Response to tactile stimulation
- Gently stimulate the newborn infant by drying them, rubbing the soles of the feet or the back.
- Avoid more vigorous methods of stimulation, especially in preterm infants.

Muscle tone & colour
- A very floppy infant is likely to need breathing support.
- Hypotonia is common in preterm infants.
- Do not use colour to assess oxygenation.
- Interpret pallor within clinical context, as it may have several causes such as acidosis, asphyxia, blood loss, or chronic anaemia.

Classification according to initial assessment
- Based on the initial assessment, further actions can be implemented guided by the NLS algorithm.

Newborn life support
- Ensure the airway is open and the lungs are inflated.
- Do not undertake subsequent interventions before the airway is open and the lungs have been inflated.
- Following initial assessment, start respiratory support if the infant is not breathing regularly or the HR is <100 min^{-1} (Fig. 25).

Airway
- Assess the effect of each airway technique by observing for chest movement and assessing HR.

Position
- Place the newborn infant on their back with the head supported in a neutral position.
- Gently push the lower jaw forwards with pressure from behind (jaw thrust) to open the airway.

Two-person method
- Use the two-person method of airway support (jaw thrust) as this approach is more effective than single person jaw thrust.

Suction
- Do not routinely suction meconium or amniotic fluid from infant's' airways because it delays initiating ventilation.
- Consider physical airway obstruction if lung inflation is unsuccessful despite alternative airway opening techniques.
- Perform suction under direct vision.

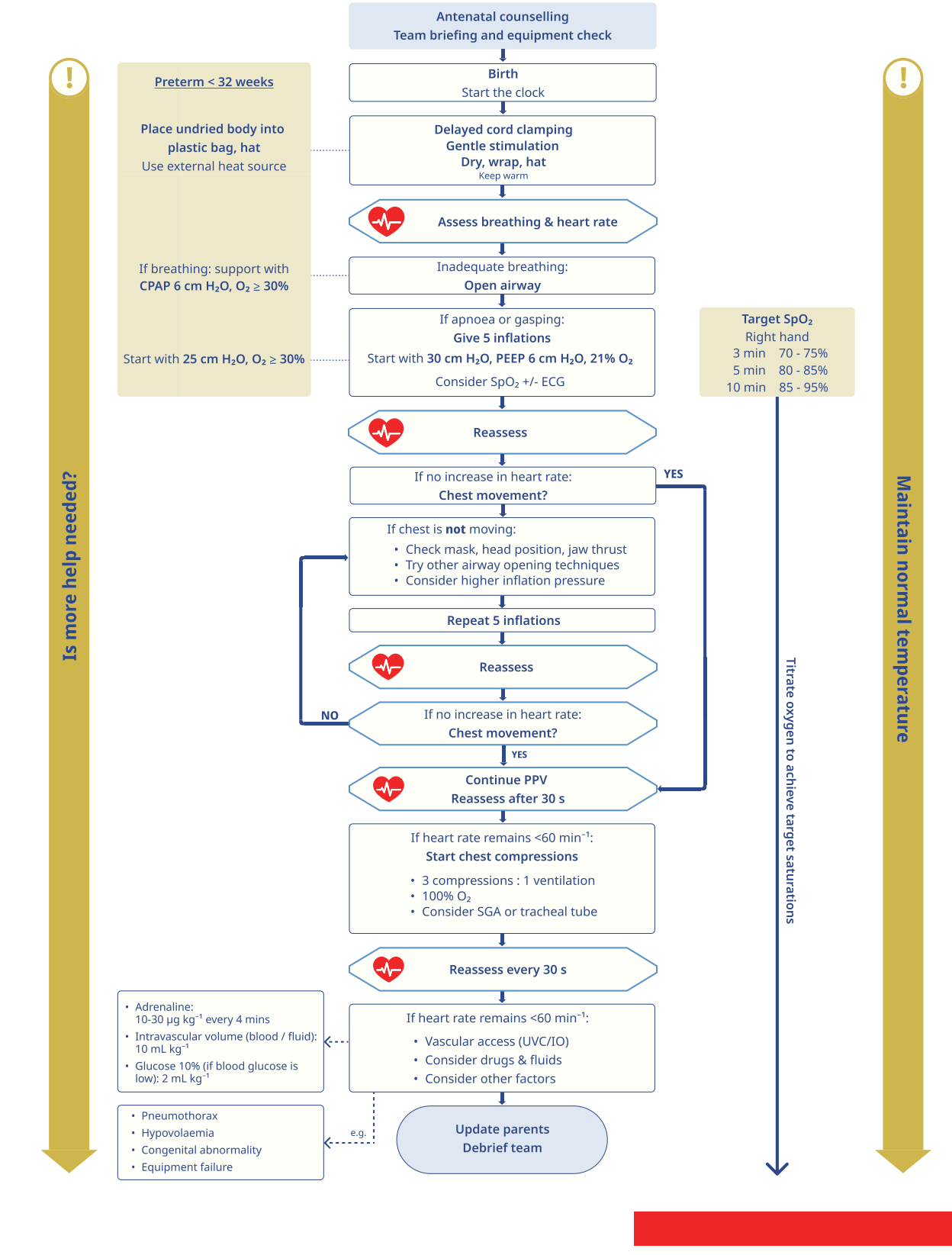

Fig. 25 – Neonatal life support algorithm.

- Rarely, with no response to inflations and no chest wall movement, an infant may require tracheal suctioning to relieve an airway obstruction below the vocal cords.

Airway devices

- Use airway devices only if competent personnel are available and trained in the appropriate equipment; if not continue with mask ventilation and call for help.

Supraglottic airway devices. Consider using an appropriate size supraglottic airway device (SGA) (see manufacturers guidelines):

- When facemask ventilation is ineffective.
- As an alternative for facemask ventilation if SGA size permits.
- When a more definitive airway is required as an alternative to tracheal intubation.
- Where tracheal intubation is not possible or deemed unsafe because of congenital abnormality, a lack of equipment, or a lack of skill.
- When chest compressions are performed.

Nasopharyngeal and oropharyngeal airway devices.

- Consider nasopharyngeal or oropharyngeal airway devices, especially when facemask ventilation may be difficult (e.g. micrognathia).
- Use oropharyngeal airway devices with caution in infants <34 weeks. They might contribute to airway obstruction.

Tracheal tube. Consider tracheal tube placement:

- When equipment and skills permit.
- When facemask or SGA ventilation are ineffective.
- With prolonged ventilation.
- When suctioning the lower airways (removal of presumed tracheal blockage).
- When chest compressions are performed.

When performing tracheal intubation:

- Have a range of different sized tubes available.
- Use video laryngoscopy or, if unable, direct laryngoscopy.
- Use exhaled CO_2 detection and clinical assessment to confirm tracheal intubation.
  - Be aware that exhaled CO_2 detection may be false negative in low or no cardiac output states at birth.
- Use appropriate imaging to confirm correct tube position.
- If available, respiratory function monitoring may be used to help confirm tube position within the airway and assist adequate ventilation (expired tidal volume 4–8 mL kg^{-1} with minimal leak).

Breathing

- Inflate the lungs when the newborn infant is not breathing using a facemask or nasal interface.
- Nasal interface used to provide positive pressure ventilation (PPV) may vary: single or binasal prongs, short or long prongs, or nasal mask.

Assisted ventilation

Lung inflation.

- If apnoeic, gasping or not breathing effectively, start PPV as soon as possible to inflate the lungs – ideally within 60 s.
- Apply appropriately fitting nasal interface or a facemask connected to a device for providing positive pressure ventilation.
- Give 5 inflations with an inflation time of up to 2–3 s:
- Infants <32 weeks: starting inflation pressure 25 cm H_2O.
- Infants ≥32 weeks: starting inflation pressure 30 cm H_2O.
- Consider pulse oximetry ± ECG.

Assessment.

- During lung inflations look for chest movement.
  - Visible chest movement during inflations indicates a patent airway and delivered volume.
  - Failure of the chest to move may indicate that the airway is not open, or that insufficient inflation pressure/volume is delivered.
- After lung inflations check HR
  - An increase in HR within 30sec of positive pressure ventilation, or a stable HR > 100 min^{-1}, usually confirms adequate ventilation/oxygenation.
  - HR < 100 min^{-1} or decreasing usually suggests continued hypoxia and almost always indicates inadequate ventilation.

If there is a HR response.

- Continue uninterrupted positive pressure ventilation until the infant begins to breathe adequately and the HR > 100 min^{-1}.
- Aim for a positive pressure ventilation rate of 30 ventilations min^{-1} with an inflation time of approximately 1 s.
- Adapt inflation pressure based on clinical observation (chest movement and HR)
- Reassess breathing and HR every 30 s, until the newborn infant is deemed stabilised.
- Consider inserting SGA or tracheal tube if apnoea continues.

If there is no HR response. If there is **no** HR response **and** the chest is not moving with inflations:

- Call for help.
- Recheck equipment.
- Perform airway opening technique of choice.
- If the airway opening techniques are ineffective in inflating the lungs, increase inflation pressure.
- Repeat inflations after every airway opening technique or after increasing inflation pressure.
- Re-assess chest movement and HR after inflations until visible chest movement **or** HR response.
- Reduce inflation pressure when chest movement is seen and there is clinical improvement.
- If being used, check with a respiratory function monitor that expired tidal volume is within target range (4–8 mL kg^{-1}, depending on gestational age).

Without adequate lung inflation, chest compressions will be ineffective:

- **Confirm effective ventilation** through observed chest movement or other measures of respiratory function.
- **Then** progress to chest compressions, if the HR remains <60 min^{-1}.

Continuous positive airway pressure and positive end-expired pressure

- Use either nasal interface or a facemask as device-patient interface to deliver continuous positive airway pressure (CPAP) or positive end-expired pressure (PEEP)
- Start with CPAP at 6 cm H_2O as initial breathing support in:
  - Spontaneously breathing infants <32 weeks with respiratory distress.

- Spontaneously breathing infants ≥32 weeks with respiratory distress requiring supplemental O_2.
- In infants needing positive pressure ventilation, start with PEEP at 6 cm H_2O.

Ventilation devices
- Use appropriately sized nasal interface or facemask to deliver CPAP or PEEP
- Ensure effective seal with minimal force on the facemask.
- Where possible, use a T-piece resuscitator capable of providing either CPAP or positive pressure ventilation + PEEP when giving ventilatory support, especially in the preterm infant.
- Self-inflating bags should be available as backup:
  - Take care not to deliver excessive volumes and pressures.
  - Be aware that CPAP might not be effectively delivered even when a PEEP valve is used.

Oxygen
- Use pulse oximetry and O_2 blenders during resuscitation or stabilisation in the delivery area.
- Check O_2 and saturations every 30 s.
- Titrate inspired O_2 to achieve target SpO_2 between the 25th and 75th percentile.
- Infants ≥32 weeks needing respiratory support:
  - Start at 21 % O_2.
- Infants <32 weeks:
  - Start at ≥30 % O_2.
  - Avoid SpO_2 < 80 % and/or bradycardia at 5 min of age.

Circulation

Chest compressions
- Start chest compressions if the HR remains <60 min^{-1} after at least 30sec of effective ventilation.
- When starting chest compressions:
  - Increase O_2 to 100 %.
  - Call for experienced help if not already summoned.
  - Anticipate the need to secure the airway and establish vascular access for medication.
- Use a 3:1 compression-to-ventilation ratio (C:V), aiming for 90 compressions and 30 ventilations (120 events) per minute.
- Use the two-thumb-hands-encircling-technique with overlapping or adjacent thumbs to deliver chest compressions.
- Compress to a depth of one-third of the anterior-posterior chest diameter.
- Allow full chest recoil between compressions.
- Re-assess HR every 30 s.
- If HR < 60 min^{-1}, secure the airway with an SGA or tracheal tube (if competent and not already done) with minimal interruptions to ongoing chest compressions.
- After tracheal intubation or, if unable, SGA placement, continue with the 3:1 C:V ratio.
- Titrate O_2 against the oxygen saturation once a reliable value is achieved.
- Discontinue chest compressions if the HR is >60 min^{-1}; check for output (e.g. auscultation, pulse check, pulse oximetry, signs of life).

Vascular access

Umbilical venous access.
- Use the umbilical vein for rapid emergency vascular access during resuscitation at birth.
- Perform emergency umbilical venous catheter placement under clean rather than sterile conditions to ensure timely vascular access is secured.
- Consider the use of emergency umbilical venous catheter until some days after birth as it may still be achievable.

Intraosseous access.
- Use intraosseous (IO) access as an alternative method of emergency vascular access for medication and fluids.
- Consider device-specific weight limitations for IO related equipment.
- Ensure there is no extravasation when administering medication and fluids.
- Do not aspirate blood; even when correctly positioned, it is often not possible.

Support of transition/post-resuscitation care.
- If venous access is required following resuscitation, peripheral access may be adequate unless multiple infusions and/or vasopressors are required in which case central access may be preferred.

Medication during resuscitation at birth

Resuscitation drugs may be considered where, despite adequate control of the airway, effective ventilation, and chest compression for at least 30sec, HR remains <60 min^{-1} and is not increasing.

Adrenaline
- Umbilical venous catheter or IO is the preferred route.
  - Give 10–30 μg kg^{-1} (0.1–0.3 mL kg^{-1} of 1:10,000 adrenaline [0.1 mg mL^{-1}]).
  - Give subsequent doses every 4 min if HR remains <60 min^{-1}.
- If no umbilical venous catheter/IO access but intubated:
  - Give intra-tracheal adrenaline at dose of 100 μg kg^{-1} (1 mL kg^{-1} of 1:10,000 adrenaline [0.1 mg mL^{-1}]).
  - If HR remains <60 min^{-1}: as soon as umbilical venous catheter/IO access is obtained, immediately give a dose via this route, irrespective of when the intra-tracheal dose was given.

Glucose
- If possible, check the blood glucose value during resuscitation.
- If blood glucose is low: give glucose 200 mg kg^{-1} (2.0 mL kg^{-1} of 10 % glucose).

Intravascular volume replacement
- Give 10 mL kg^{-1} of group O Rh-negative blood or isotonic crystalloid solution if suspected blood loss or in a newborn infant unresponsive to other resuscitative measures.

Absence of an adequate response despite appropriate resuscitation measures

- Consider other factors which may be impacting the response to resuscitation, and which require addressing such as the presence

of pneumothorax, hypovolaemia, congenital abnormalities, equipment failure.

Low resource or remote settings

- Births outside the hospital may be considered as birth in a remote or low resource setting. Moreover, not all hospitals have the same resources.
- HCPs have to adapt according to available resources. Focus needs to be on prevention or treatment of hypothermia and hypoxia within the existing possibilities.

Planned home births

- Ideally, two trained healthcare professionals (HCP) should be present at all home births.
- Have at least one HCP competent in providing inflations, PPV and CC to the newborn infant.
- Have a minimum set of equipment of an appropriate size for the newborn infant available.
- Have a clear plan of who will attend, what equipment will be available, and how transfer will be arranged if newborn support is required and agree this with parents when formulating the home birth plan.
- HCPs attending home births should have pre-defined plans for unexpected or difficult situations, including knowing how to communicate with receiving healthcare facilities for the mother and newborn infant.

Unexpected births outside the hospital

- Emergency services should be prepared and trained for such events and carry appropriate equipment, especially related to thermal care and support of airway and breathing.
- Equipment to support thermal care and oxygenation should be available.

Temperature control out of hospital

- Involved HCPs should have a heightened awareness of the increased risk of hypothermia in infants born (unexpectedly) out of hospital.
- They should perform regular temperature checks of the neonate and intervene if the temperature is too low.
- Most interventions for infants born in hospital (see temperature management) can also be applied outside the hospital.
- If possible, place compromised, preterm (<37 weeks), and/or growth restricted infants in a preheated incubator for thermal control and transport.

Post-resuscitation care

- Once effective ventilation and circulation are established, the infant should be cared for in or transferred to an environment in which close monitoring and anticipatory care can be provided.

Glucose management

- Measure blood glucose values early and regularly until they have stabilised in the normal range; especially in newborns resuscitated at birth, those at risk of hypoxic-ischaemic encephalopathy (HIE), and/or receiving intravenous glucose.
- Avoid hypoglycaemia, hyperglycaemia, and large swings in blood glucose value.

Thermal care

- Monitor the infant's temperature frequently or continuously after resuscitation.
- Maintain temperature between 36.5 °C and 37.5 °C and rewarm if the temperature is below this.

Therapeutic hypothermia

- Consider inducing therapeutic hypothermia (33–34 °C) *after* completion of resuscitation and detailed assessment of potentially eligible infants with clinical, biochemical, and (if available) neurophysiological evidence of HIE.
- Use appropriate eligibility criteria and strictly defined protocols to guide the cooling process; inappropriate application of therapeutic hypothermia may be harmful.
- Arrange safe transfer to an appropriately equipped facility where monitoring and treatment can be continued.
- Monitor (rectal) temperature during transport and, if available, apply active cooling with a servo-controlled device while transferring the infant.

Oxygenation and ventilation

- Consider additional monitoring of post-ductal oxygen saturation to identify pulmonary hypertension.
- Avoid hypoxia and hyperoxia.
- Avoid inadvertent hypocapnia during mechanical ventilation.

Documentation and prognostication

- Keep an accurate time-based record of the infant's clinical state, interventions and responses during resuscitation to facilitate retrospective review.
- Record APGAR scores.

Clinical team debriefing

- Use performance-focused, interdisciplinary/interprofessional team debriefings following resuscitation or other non-routine situations to optimise individual and team performance as well as systems issues (e.g., emergency supplies, equipment).

Communication with parents

Where intervention is anticipated

- The decision to attempt resuscitation of an extremely preterm or clinically complex infant should be taken in close consultation with the parents and senior paediatricians, midwifes, and obstetricians.
- Discuss the options, including the potential need and magnitude of resuscitation and the likely prognosis before birth, so that an individualised management plan can be agreed.
- Ensure concise and factual documentation of discussions is recorded in mother's notes before birth and in the infant's notes after birth.

For every birth

- If parents want and resources allow, enable parents to be present during the stabilisation or resuscitation.
- Consider the views of the resuscitation team, parents and circumstances.
- Ensure that parents are fully informed about the progress of the care provided to their infant.

- Identify a member of healthcare staff to support parents and be aware that witnessing the resuscitation of their infant will be distressing for them.
- Encourage parents to hold or touch their infant as soon as possible after resuscitation; this should be facilitated especially when the resuscitation was unsuccessful.
- Ensure an accurate record is kept of the resuscitation and of any subsequent parental communication.
- Provide an explanation of any procedures and why they were required.
- Facilitate further discussions later to enable parents to reflect and to aid their understanding of events.
- Provide additional support to parents following resuscitation at birth.

Discontinuing or withholding resuscitation

- Use national or regional outcomes and guidelines to interpret these recommendations
- When discontinuing, withdrawing or withholding resuscitation, care should be focused on the comfort and dignity of the infant and family and should ideally involve senior paediatric/neonatal staff.

Discontinuing resuscitation

- If the HR remains absent despite ongoing resuscitation, review clinical factors (for example potential reversible factors, gestation of the infant), effectiveness of resuscitation, and the views of other members of the clinical team about continuing resuscitation.
- If the HR of a newborn infant remains absent for more than 20 min after birth despite the provision of all recommended steps and exclusion of reversible causes, consider stopping resuscitation.
- For preterm infants (particularly extremely preterm), it may be appropriate to discontinue resuscitation earlier than 20 min. The decision should be individualised.
- Where there is partial or incomplete HR improvement despite apparently adequate resuscitative efforts, the choice is much less clear. It may be appropriate to take the infant to the intensive care unit and later consider withdrawing life sustaining treatment.
- Where life-sustaining treatment is withheld or withdrawn, infants should be provided with appropriate palliative (comfort focused) care.

Withholding resuscitation

- Decisions to withhold life sustaining treatment should be made in advance of birth together with parents in the light of regional/national evidence on outcome if resuscitation and active (survival focused) treatment is attempted.
- In situations where there is extremely high (e.g. >90 %) predicted neonatal mortality and unacceptably high morbidity in surviving infants, attempted resuscitation and active (survival focused) management is usually not appropriate.
- Resuscitation is nearly always indicated in conditions associated with lower (e.g. <50 %) neonatal mortality and what is deemed to be acceptable morbidity. This will include most infants with congenital malformations and most infants >24 weeks or above in high resource settings with access to neonatal intensive care.
- Resuscitation should usually be commenced in situations where there is uncertainty about the outcome and there has been no chance to have prior discussions with parents.
- In situations where there is high mortality (e.g. >50 %) and/or a high rate of morbidity, and where the anticipated burden of medical treatment for the child is high, parental wishes regarding resuscitation are usually supported. It may be appropriate to provide full resuscitation, to provide some measures (but withhold other interventions) or to provide comfort focused care. Provision of antenatal palliative care support can be beneficial to parents in the face of certain or uncertain poor outcomes.

Paediatric life support

The ERC Paediatric Life Support (PLS) Guidelines cover the management of critically ill infants and children, before, during and after cardiac arrest, and includes special circumstances of cardiac arrest in children.[70] (Fig. 26).

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.

Recommendations for caregivers and other untrained rescuers

- All parents and caregivers should be encouraged to learn basic recognition of critical illness and trauma 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 medical help 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.
- **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.

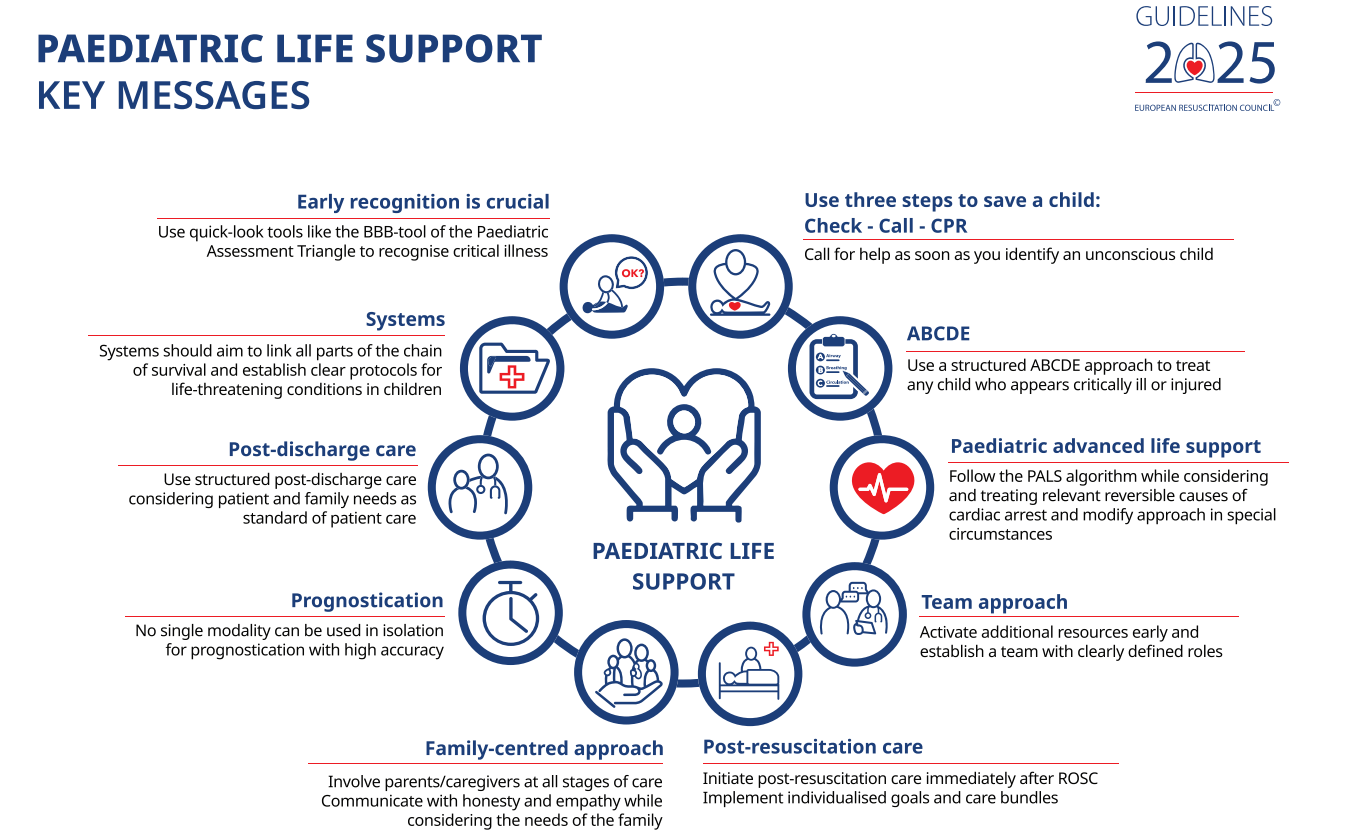

Fig. 26 – Key messages Paediatric Life Support.

- **Body colour**:
  - The child's skin is cyanosed (blue), mottled, abnormally pale or greyish. Look at the hand palms, soles of the feet and mucosal membranes especially in children with darker skin tones.
- 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 very 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.

Recommendations for healthcare professionals

- Identify children with an increased risk of 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. 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.
- 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 they wish, and 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.

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. 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 signs (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 tones or poor peripheral perfusion.
- 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.

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 (Fig. 27).

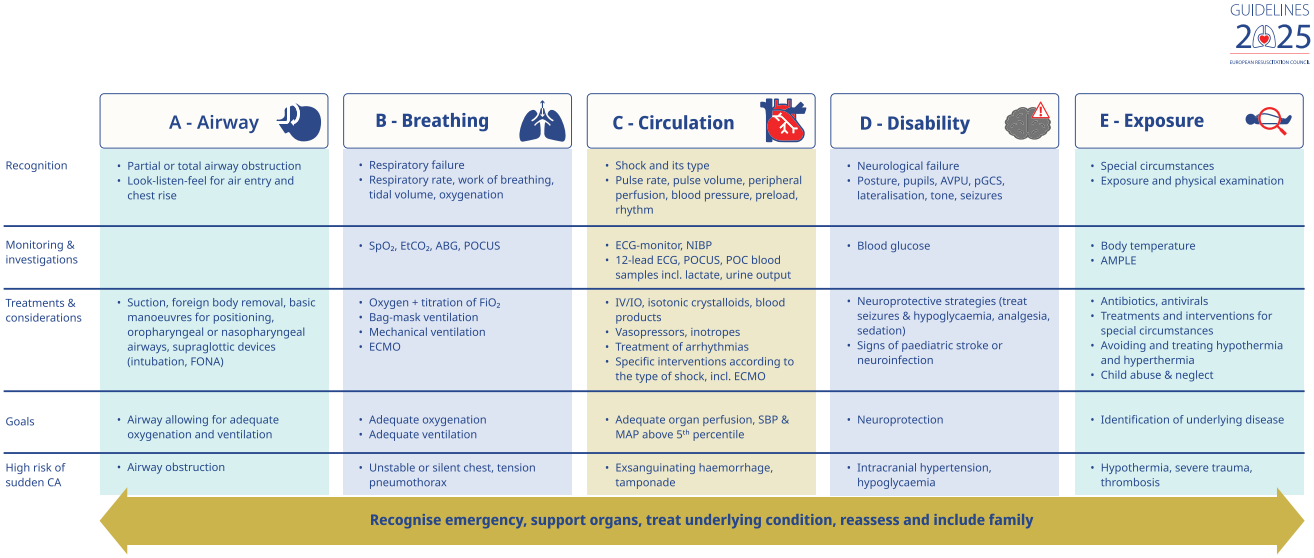

Fig. 27 – Management of critically ill/injured child using the ABCDE approach.

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 or use a SGA, 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.
  - The oral route for tracheal intubation is preferable during emergencies.
  - Use video or direct laryngoscopy for tracheal intubation depending on local protocols and rescuer experience.
  - 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. 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, provide oxygen and ventilation via bag valve mask until the tube is cleaned and replaced.
  - 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.
  - If the upper airway is not patent it may be possible to provide oxygen and bag-mask ventilation at the tracheostomy stoma site using a small face mask (or the end of an LMA used as a mask) over the stoma site.
  - 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.
- 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 movements). Avoid hyperinflation and high peak inspiratory pressure.
  - Aim for a 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 children >12 y).
- 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:
  - Use tidal volumes of 6–8 ml kg^{-1} of ideal body weight and a respiratory rate at a low-normal range for the child's age.
  - 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 settings 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.
  - 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, distributive, or dissociative (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.
  - 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.
- 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 (2 ml kg^{-1} 10 % glucose) and re-check blood glucose after 5–10 min and repeat if necessary.
- When IV glucose is not available, give glucagon as a 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).
- Protect the best interests of the child according to the local ethical and legal policies in case of a suspicion of inflicted trauma (child abuse and neglect).

Additional recommendations for time-critical interventions.

In children with **severe acute asthma** (critical asthma syndrome):

- Give 100 % oxygen.
- Give (intermittent or continuous) short acting $beta_2$-adrenergic agonists via pressurised metered-dose inhalers with spacer or by nebulisation (e.g. salbutamol 100 μg/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)
- Give inhaled ipratropium with $beta_2$-adrenergic agonists as required in the following doses: children aged from 1 month to 5 years 125–250 μg (max 1 mg day^{-1}), from 6 to 11 years 250 μg (max 1 mg day^{-1}) and from 12 to 17 years 500 μg (max 2 mg day^{-1}).
- 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 μg kg^{-1} salbutamol over 10 min, max. doses of 250–750 μg have been used) which may be followed by an infu-

sion depending on clinical severity (e.g. salbutamol 1–2 μg 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 polymerase chain reaction (PCR) if possible and start broad-spectrum antibiotics as soon as possible (within 1 h) after initial ABCDE management.
- Consider 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. use 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 h) 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 h or until the bleeding stops.

In children with **circulatory failure due to bradycardia**:
- Seek the advice of a paediatric cardiologist early.
- 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 μg 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 μg 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. If the SVT persists after the second dose, consider further doses of IV adenosine every 1–2 min increasing the dose in steps of 0.05–0.1 mg kg^{-1} until a maximum single dose of 0.5 mg kg^{-1} has been given.
  - Seek the advice of a paediatric cardiologist. Consider cardioversion or alternative medications (e.g. amiodarone), especially in children with sinus 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 a 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**:
- 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. Anticipation is important when treating seizures as several interventions may be necessary.
- Any seizure lasting 5 min or longer (status epilepticus) requires treatment with a benzodiazepine (first-line medication). Use the intravenous (IV) route if available. If an IV/IO access has not yet been established, use an alternative route (e.g. buccal, nasal, IM).
- 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 IV 20 mg kg^{-1} over 20 min, or phenobarbital IV 20 mg kg^{-1} (max 1 g) by slow injection at a maximum rate of 1 mg kg^{-1} min^{-1}, or valproic acid IV 20 mg kg^{-1} over 4 min as a second choice instead. Do not use valproic acid where there is the potential for pregnancy.
- If the seizures continue for ≥30 min despite the administration of a second-line drug (refractory status epilepticus), prepare for intubation and refer the child to the paediatric intensive care team. If you are not ready for intubation and anaesthesia, then giving another, different second line drug is an alternative.
- 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 a paediatric neurologist.
- Consider continuous EEG monitoring and brain imaging.

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

Paediatric basic life support (PBLS)

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 life** (see Fig. 8):
  - **Check** if the child reacts to non-painful stimulus.
  - **Call** the EMS immediately If the child does not react and follow the dispatcher's advice.
  - **CPR**: Start CPR immediately following the instructions of the dispatcher.
- Dispatchers should encourage bystanders to perform both ventilation and chest compressions in children of all ages. They should actively ask about signs confirming that the ventilations are effective (e.g. whether the chest is moving).
- 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.
- 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).

Recommendations for those trained in PBLS (Fig. 9)

- Ensure safety for you and the child.
- Use verbal and tactile stimulation to assess responsiveness. Do not use painful stimuli.
- Call, or have someone call, the EMS immediately, using speaker function of your mobile phone with video when possible. Follow the advice of the dispatcher who can help you to recognise if you need to start CPR. If you are trained in PBLS, check the breathing as described below, while waiting for the connection with the dispatcher.
- Use the head tilt chin lift manoeuvre to open the airway and assess breathing and look for signs of life for no longer than 10 s.
- Give five initial rescue breaths.
- Immediately proceed with 15 chest compressions.
- Continue CPR in a 15:2 compression-to-ventilation ratio if you are specifically trained in PBLS to the level of the ERC PBLS-course or equivalent, otherwise use a ratio of 30:2.
- Focus on consistently high-quality compressions and effective ventilations. Minimise chest compression pauses.
- If a second rescuer is available, they should call the EMS while the first rescuer starts CPR, and then bring and attach an automated external defibrillator (AED) as soon as possible for children of all ages. Once attached, 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.
- 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.
- Check the breathing continuously or at least every minute if the child is placed in the 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). In older children, more head tilt will be needed. 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 s, sufficient to make the chest visibly rise and then allow the chest to fall back passively while you take your next breath.
  - 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.
  - 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.

- Deliver high quality chest compressions as defined by:
- Rate of 100–120 min^{-1}.
- 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 defibrillation 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 defibrillation as follows:
  - Use the antero-posterior 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 antero-lateral for the antero-posterior or the anteroposterior position in children weighing more than 25 kg and adolescents. In the antero-lateral position one pad is placed bellow the right clavicle and the other in the left axilla. If the antero-posterior position is used in adolescents, avoid placing the defibrillation pads over breast tissue.
  - Do not touch the patient while the AED is analysing the rhythm.
  - Restart chest compressions immediately after shock delivery.

Additional considerations for PBLS

- In hospital, healthcare professionals should call for help as soon as deterioration is detected and not wait for cardiac arrest.
- They should then check for breathing and other signs of life.
- If they suspect a cardiac arrest or a critical situation, one person should call the resuscitation or emergency medical team, while the other person starts CPR as described above, using a compression-to-ventilation ratio of 15:2.
- 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 $\leq$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.

Foreign body airway obstruction

- Suspect choking due to a foreign body if the child 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 of the thorax (use gravity). Give a sharp blow between the shoulder blades. Repeat up to 5 times or until the obstruction is relieved.
  - Lean children and adolescents forward and give blows between the shoulder blades. Repeat up to 5 times.
- Give up to 5 chest/abdominal thrusts if back blows are not effective:
  - In infants:
  - 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 up to 5 times or until the obstruction is relieved.
  - In children and adolescents:
  - Stand behind the child 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 up to 5 times or until the obstruction is relieved.
  - If the child is still conscious, repeat the back blows up to 5 times 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.
- The ERC is unable to make a recommendation for or against the use of suction-based devices advertised and marketed for clearing a foreign body airway obstruction, because no high-certainty scientific evidence exists (Fig. 28).

Paediatric advanced life support (PALS)

- 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).
- 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).

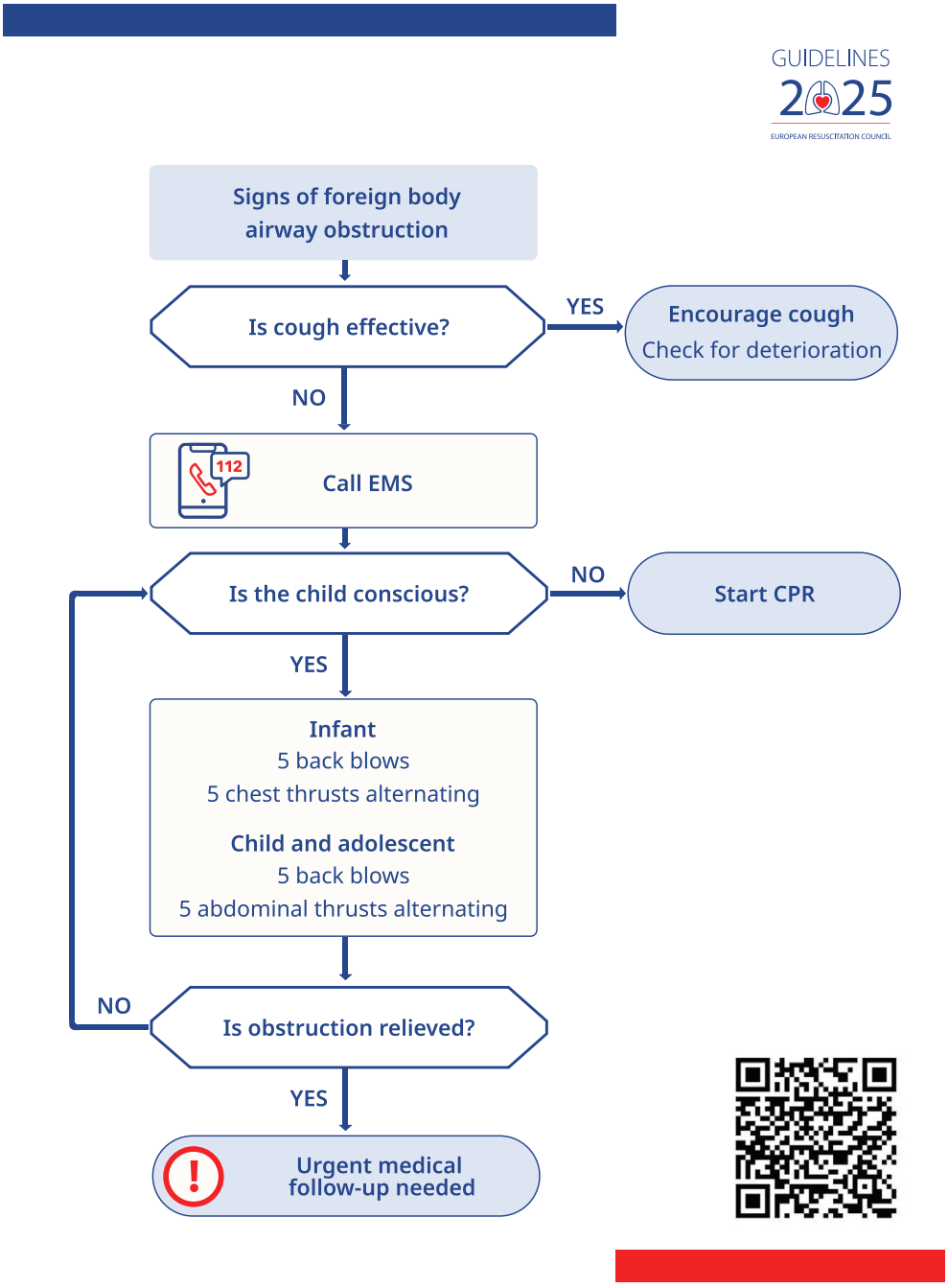

Fig. 28 – Algorithm for paediatric foreign body airway obstruction.

- 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 (Fig. 29).

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^{-1}, 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). If the rhythm has changed to an organised rhythm which could produce cardiac output, check for signs of life and feel for a central pulse (max. 5 sec).

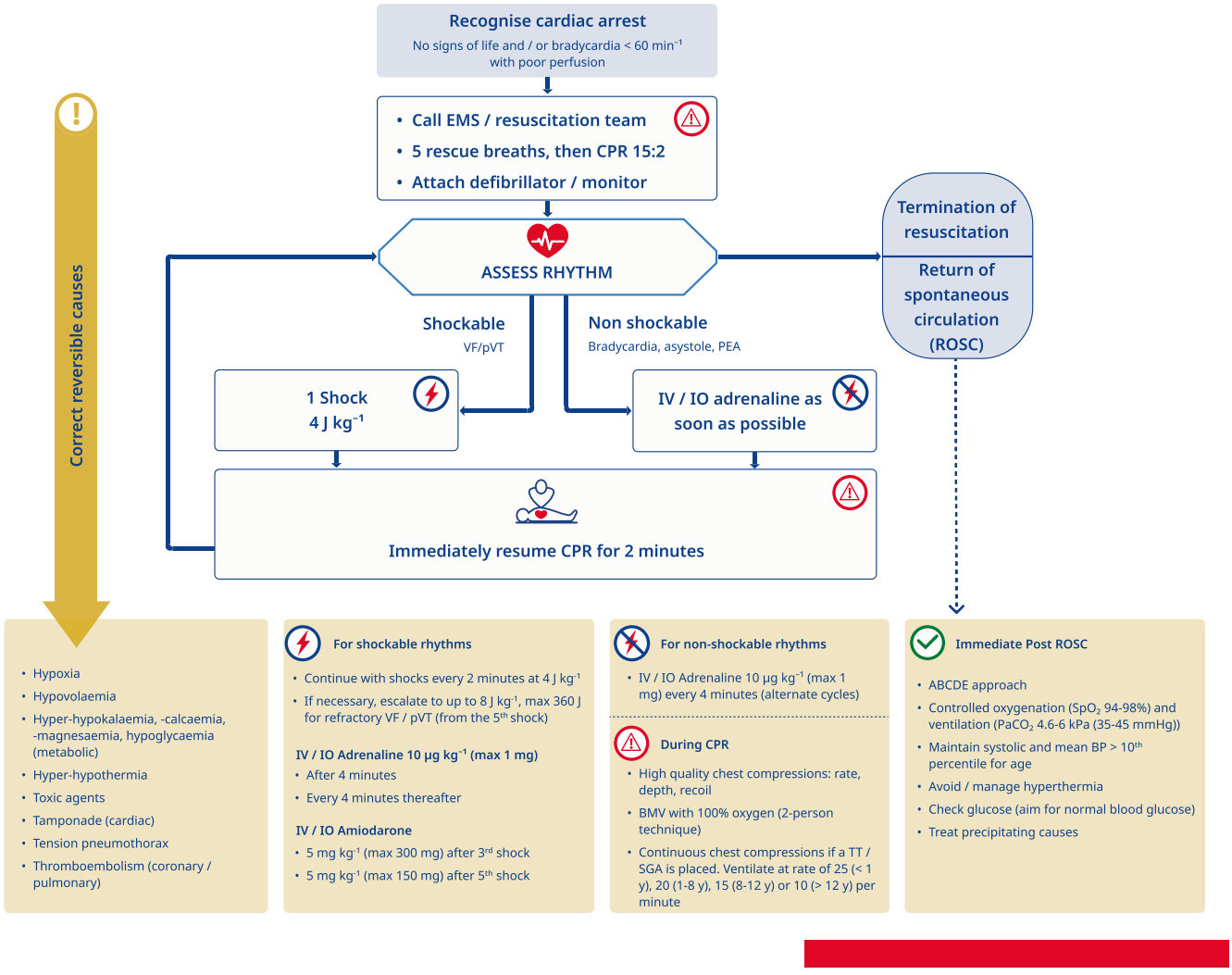

Fig. 29 – Paediatric Advanced Life Support algorithm.

- 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.

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.
- Ensure that there is no leakage of oxygen around the chest during defibrillation. In small children the self-inflating bag may be very close to defibrillation pads; direct the oxygen exhaust away from the chest or disconnect the bag, if necessary, before charging the defibrillator. 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:
  - o 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

  - o 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 μg 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^{-1}) might be used as an alternative if amiodarone is not available or a local decision has been made to use lidocaine instead of amiodarone.
- Give a second dose of adrenaline (10 μg kg^{-1}, max 1 mg) and amiodarone (5 mg kg^{-1}, max 150 mg) IV/IO immediately after the 5th shock.
- 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 ECPR.
- Criteria for withdrawing resuscitation are met.

Defibrillation during PALS

- 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.
- Defibrillation pads should be positioned either in the antero-lateral or the antero-posterior position.
  - Avoid contact between defibrillation pads as this can cause charge arcing.
  - In the antero-lateral position, one pad is placed below the right clavicle and the other in the left axilla.
  - In the antero-posterior 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 antero-posterior position in infants and children who can easily be turned onto their side for pad placement and in whom the antero-lateral position is more difficult to achieve without contact between the defibrillation pads.
  - Use the antero-lateral position in larger children as this leads to less interruption of chest compressions than the antero-posterior position. Avoid breast tissue in adolescents.
- 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 defibrillation pads or paddles on the chest. Continue chest compressions while the defibrillator is charging when using defibrillation 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.

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 moves 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 and 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.
- 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 y), 15 (>8 y), 10 (>12 y).
- 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 FiO_2 to an SpO_2 of 94–98 % after ROSC.

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 to help verify ROSC.
- **Invasive blood pressure:** If an intra-arterial line is 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 if it does not compromise the quality of chest compressions.

Table 4 – Reversible causes of cardiac arrest in PALS.

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 movement. 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 (>6.5–7 mmol/L), give 0.1 unit kg^{-1} short acting insulin (max 10 units) with 5 ml kg^{-1} 10 % glucose (max 250 ml) as an IV bolus and an IV/IO infusion of a short acting $beta_2$-adrenergic agonist (e.g. salbutamol 5 μ kg^{-1}). 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 5–10 min. Repeat if necessary.
	Other metabolic derangements History and blood analysis.	Correct calcium, magnesium and other metabolic derangements.
Hypo-or hyperthermia	***Hypothermia*** History/situation and core temperature.	Modify the PALS algorithm: • <30 °C: give a single dose of adrenaline unless planning immediate initiation of extracorporeal life support. • 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.

(*continued on next page*)

Table 4 (continued)

Consider	Identification	Treatment in cardiac arrest
Thromboembolism	History (children with indwelling central lines, cardiac conditions, cancer, recent trauma, recent surgery) and POCUS.	Consider IV thrombolysis.
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).
Toxic agents	History. Pre-arrest ECG, blood gas analysis, electrolytes.	Specific measures (safety, antidotes, decontamination, enhanced elimination). Consider ECPR.

- **Point of care blood analysis:** Check at least glucose, potassium, haemoglobin, lactate and blood gas analysis, and treat as appropriate.

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

Reversible causes of paediatric cardiac arrest

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

Cardiac arrest and its prevention in special circumstances

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

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 administration of any potential allergen, if possible.
- Immediately administer 0.01 mg kg^{-1} = 10 microg kg^{-1} (max. 0.5 mg) adrenaline (1 mg/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 1–5 years,
  - 0.3 mg at 6–12 years and
  - 0.5 mg if older than 12 years.

  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 h.
- 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.

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.
  - 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, preferably 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.
- 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.

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 person 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 a rate of at least 1 °C h^{-1}. Aim for normothermia but stop active rewarming at 35 °C to avoid overshoot hyperthermia.
  - 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 algorithm modified for hypothermic arrest if cardiac arrest occurs (see below).
- Consider ECPR if conventional CPR is failing.

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.
- Below 30 °C give a single dose of adrenaline unless planning immediate initiation of extracorporeal life support. Do not give amiodarone until the temperature is above 30 °C. Prolong the administration intervals of resuscitation drugs while the core temperature remains between 30 and 35 °C (i.e. adrenaline every 8 min, second dose of amiodarone after 8 min).
- 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 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 $\geq$30 °C and an obstructed airway).

Hyperthermia/heat stroke

- Identify patients with exertional or environmental hyperthermia or heat stroke (core temperature above 40 °C, not due to fever) 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 40 °C, start cooling aggressively preferably using immersion up to the neck 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^{-1}. 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 algorithm while continuing cooling.
- 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), replace ventilation tubing and the ventilator, cool the child actively, ensure adequate oxygenation and ventilation, correct severe acidosis and hyperkalaemia, and administer dantrolene.

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.

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.

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.
- Consider echocardiography if the expertise (e.g. a paediatric cardiologist) is available.
- 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.
- In cardiac arrest due to pulmonary thromboembolism, consider thrombolysis, e.g. IV alteplase 0.3–0.5 mg kg^{-1} (max 50 mg) over 2 min, which may be repeated after 15 min.

Toxic agents

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 trauma.
- 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).
- Take a thorough history (families, 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 toxic agents 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.

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 $mmol^{-1}$ or >7.0 mmol L^{-1} in neonates younger than 96 h):
  - Treat the underlying cause if possible.
  - Administer rapidly acting insulin with glucose 0.1 U kg^{-1} (max. 10 U) with 10 % glucose at 5 ml kg^{-1} (max. 250 ml) over 30 min followed by a glucose containing infusion. Check potassium and glucose every 15 min for 4 h.
  - 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 $beta_2$-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 μg 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 above 6.5–7 mmol L^{-1}):
  - Give 0.1 unit kg^{-1} short acting insulin (max 10 units) with 5 mL kg^{-1} 10 % glucose (max 250 ml) as an IV bolus, followed by blood potassium and glucose monitoring and a glucose containing infusion as needed. Higher concentrations of glucose solutions may be used via a central line (e.g. 2.5 ml kg^{-1} 20 % glucose or 1 ml kg^{-1} 50 % glucose).
  - Do not use calcium in children in cardiac arrest.
  - Continue high quality PALS and consider ECPR.

Other metabolic derangements

- Hypokalaemia: give 1 mmol kg^{-1} (max 30 mmol) potassium at 2 mmol min^{-1} 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^{-1}) with life-threatening symptoms or in cardiac arrest. Repeat, if necessary, until the serum potassium is >2.5 mmol L^{-1}. Follow this with an IV infusion (e.g. 0.5–1 mmol kg^{-1} h^{-1}, maximum 20 mmol h^{-1}, depending on the potassium level for 1–2 h). Consider magnesium sulphate 30–50 mg kg^{-1} IV for concurrent hypomagnesaemia.
- Hypoglycaemia: Treat hypoglycaemia < 3.9 mmol L^{-1} with symptoms, or <3.0 mmol L^{-1} 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 5–10 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.

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.

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 and/or intravenous prostacyclin.
- Consider ECPR if medical management is ineffective.

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

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.
- Start chest compression and give amiodarone after if the third stacked defibrillation attempt is unsuccessful and continue CPR for 2 min.
- 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.

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 $ETCO_2$ tracing, and deliver effective ventilation with 100 % oxygen.
- Follow the general PALS algorithm and focus initially on the most likely reversible causes: hypovolaemia (haemorrhage, anaphylaxis), hypoxia, tension pneumothorax, thrombosis (pulmonary embolism) and toxic agents (medication).
- Use POCUS, when the equipment and expertise are available, to help identify the cause and guide resuscitation, provided this does not compromise the quality of the 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 $\mu g\ kg^{-1}$ 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.

Post-resuscitation care

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

Recommendations for healthcare providers in the pre-hospital setting and limited-resource healthcare

- 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 FiO_2 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 normal respiratory frequency for the child's age and mild chest movements.
- 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 H_2O 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 that can cause sudden drops or rises in blood pressure.
- Always treat hyperthermia or fever 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 (Fig. 30).

Recommendations for healthcare providers in a hospital

- 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 SvO_2 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 h 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.
- Keep temperature control management as an integral part of post-resuscitation care for at least 24 h after cardiac arrest. Avoid fever for at least 72 h.
- 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 (e.g. paediatric neurologists, psychologists, paediatric palliative care team, social workers, and, if necessary, an interpreter) to address the needs and concerns of the child, parents, family and other caregivers.
- In case of cardiac arrest, whether fatal or not, use a standardised diagnostic protocol to identify the cause. If the cardiac arrest might have been due to an inherited condition, such as certain arrhythmias and cardiomyopathies, ensure appropriate screening of family members to prevent cardiac arrest in future patients.

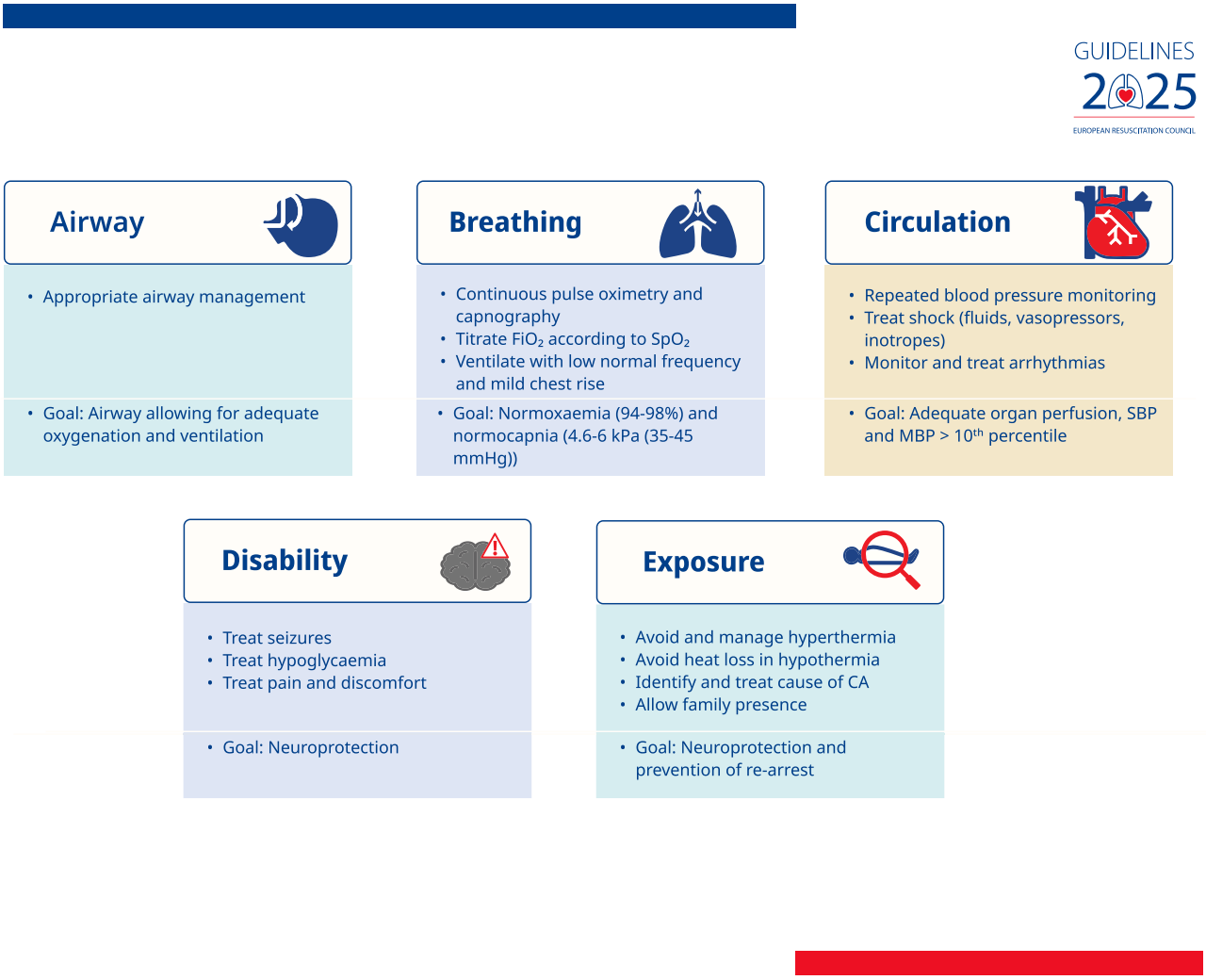

Fig. 30 – Immediate paediatric post-resuscitation care.

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).

Recommendations for healthcare professionals

- Delay prognostication in children with a decreased level of consciousness or who are sedated for at least 72 h following cardiac arrest.
- Use a multimodal approach to prognostication. Accurate prognostication for both good and poor outcomes involves:
  - o Pre-arrest: knowledge of the child's baseline health and neurological status
  - o The context of the cardiac arrest: e.g. location of the cardiac arrest, bystander BLS, first rhythm, cause of cardiac arrest and duration of the cardiac arrest.
  - o 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. 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.
- Visual aids and presentations might help parents/caregivers to understand certain specifics of prognostication enabling them to participate better in the decision making.

Post-discharge care

- 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.

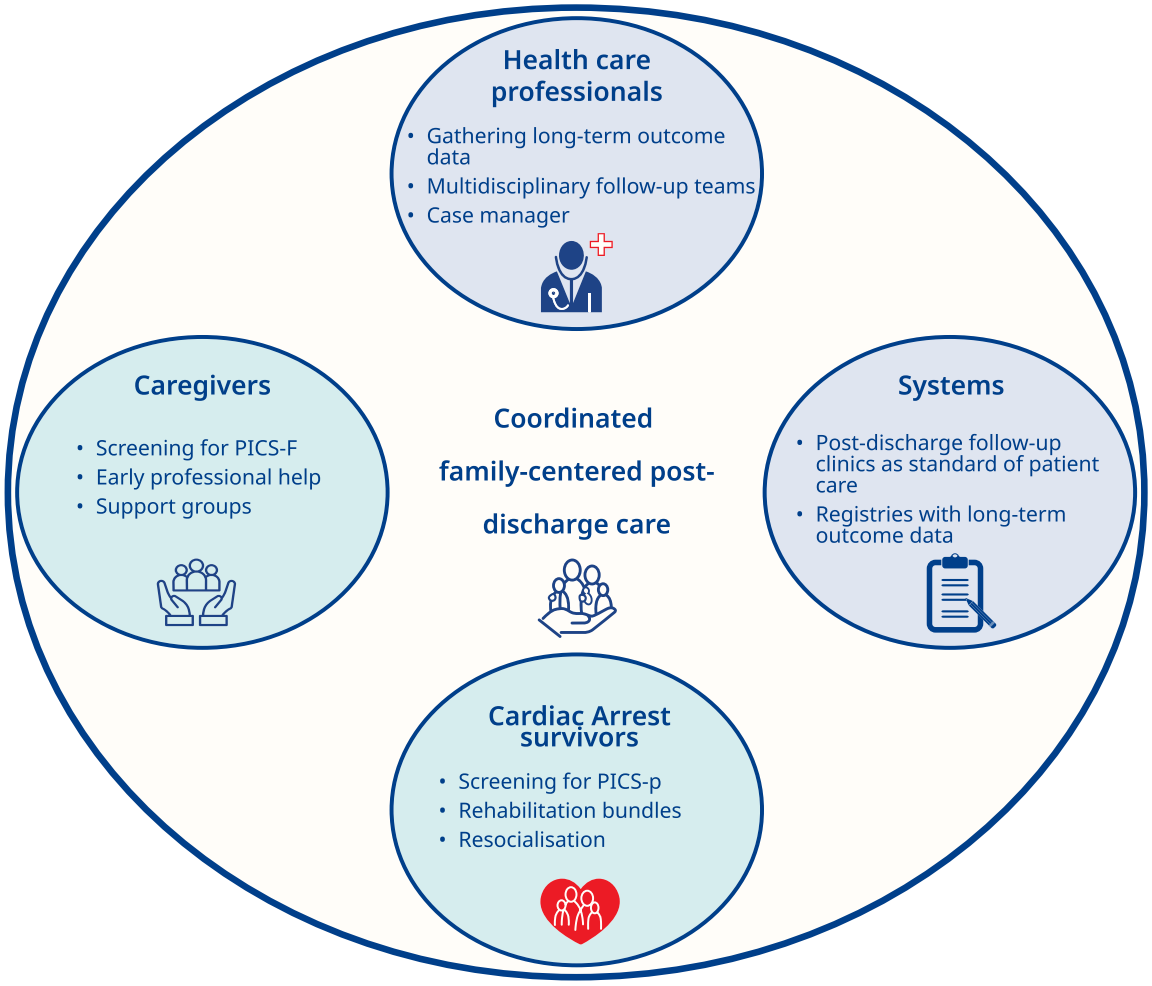

Fig. 31 – Paediatric post-discharge care.

- Seek and signpost supportive structures for patients and parents/caregivers, such as parent groups, cardiac arrest survivors' groups and bereavement groups (Fig. 31).

System-level recommendations and recommendations for implementation

Recommendations for the general public

- All parents and caregivers should be encouraged to learn the basic recognition of signs and symptoms of critical illness and trauma in children, 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 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.

Recommendations for all healthcare systems

- All systems caring for children should aim to link all parts of the chain of survival (prevention of cardiac arrest, 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 the family, siblings of children who died from sudden infant death syndrome (SIDS) and children with specific congenital abnormalities, primary arrhythmia syndromes, cardiomyopathies, channelopathies and coronary artery abnormalities. Systems should ensure that a plan is in place to care for these children.

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.

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 healthcare 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.

- 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 recommendations, for the management of perioperative cardiac arrest in every operating 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.

Recommendations for manufacturers of medical devices

- Manufacturers of AEDs and defibrillation pads should standardise pictograms for positioning the defibrillation 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 defibrillation pads).

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.
- 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.

Education of resuscitation

The ERC Guidelines in Education of Resuscitation 2025 provide guidance to citizens and healthcare professionals on how to teach knowledge, skills and attitudes of resuscitation with the goal of teaching effective resuscitation measures that will improve patient survival after cardiac arrest.[71] (Fig. 32).

Resuscitation education tailored for specific groups of life-saving rescuers

- Educate all members of the community about cardiac arrest awareness and cardiac arrest treatment and consider the diversity of the target group.
- Introduce early resuscitation training starting in early childhood education (around 4–6 years of age) and incorporate annual resuscitation training into school curricula.
- Provide all health care professionals with accredited resuscitation training.
- Tailor the required CPR training to the provider's role, their specific setting, and/or specific patient populations.
- Train emergency medical services dispatchers in cardiac arrest recognition and telephone-assisted CPR guidance.

Educational methods to teach high-quality resuscitation competencies

- Use blended and self-directed learning to provide flexibility and accessibility for all learners of resuscitation.
- Consider gamified learning as a component of resuscitation training for all types of basic and advanced life support courses.
- Use real-time CPR feedback devices to improve chest compression skill acquisition and accuracy.
- Use rapid cycle deliberate practice as an effective learning strategy to master skills rapidly.
- Use spaced learning to improve acquisition and retention of competencies.
- Use stepwise approaches for structured skill acquisition. Strict adherence to a four-step approach is not always necessary.
- HCPs should consider using cognitive aids during resuscitation training to enhance protocol adherence. Bystanders should not use them as this may delay critical actions.
- Integrate ethical training into HCP resuscitation education.
- Regardless of the rescuer's background, basic life support education should include effective chest compressions, safe use of an AED, and ventilation of the lungs.
- Teach two-person ventilation when using a self-inflating bag and mask.
- Address in BLS training barriers that rescuers might experience in performing CPR and factors increasing rescuers' willingness to perform CPR.
- Include training of team competencies in all life support courses (incl. non-technical skills and human factors during resuscitation) (Fig. 33).

Technology-enhanced learning for resuscitation

- Use online learning modalities (e.g. podcasts, videos, social media) to provide flexibility in time and location for learners and to promote asynchronous learning.
- Use augmented reality for life support training as it possibly adds value to the learning process.
- Consider applications and artificial intelligence, which might facilitate assessment and teaching during resuscitation courses.

Simulation-based resuscitation education

- Use high-fidelity manikins when training centres/organisations have the infrastructure, trained personnel, and resources available. Use low-fidelity manikins for standard advanced life support training where high-fidelity manikins are not available.

EDUCATION FOR RESUSCITATION
KEY MESSAGES

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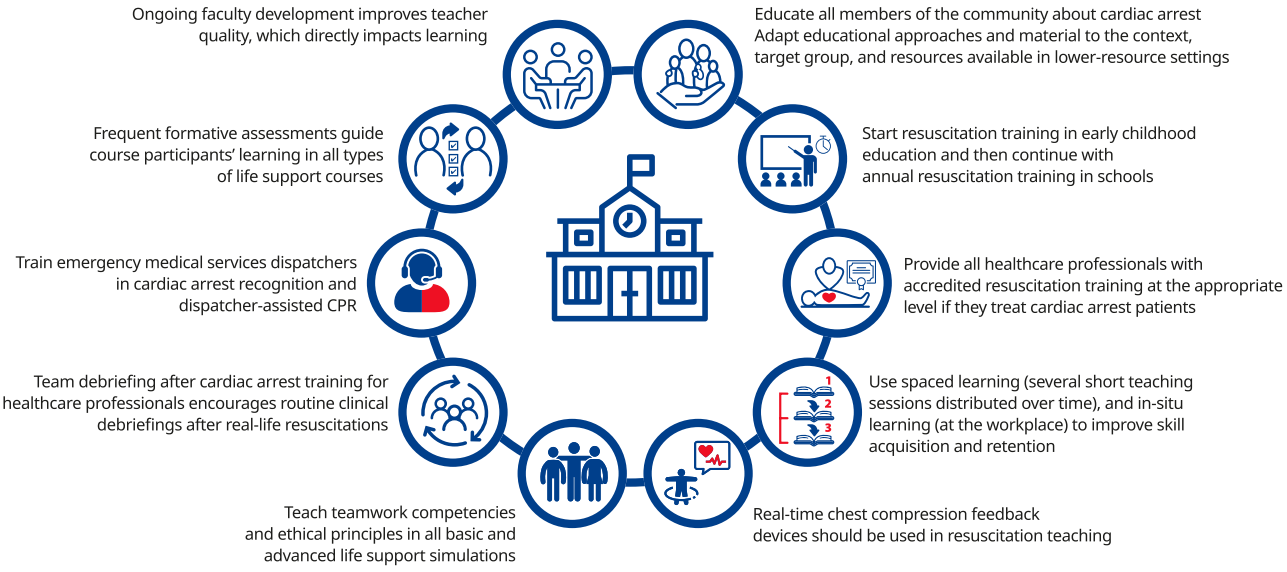

Fig. 32 – Key messages education for resuscitation.

- Use in-situ simulation (at the workplace) as an option for CPR training where resources are readily available.
- Include the teaching of teamwork competencies in basic and advanced life support simulations.
- Consider the inclusion of a CPR coach as a member of the resuscitation team during CPR simulation.
- Use debriefing scripts to support instructors during debriefing after simulation.

Assessment in resuscitation education

- Use frequent formative assessments in all life support courses to provide instructors with information for targeted feedback, to support learning, and to facilitate a summative assessment.
- Use checklists to support assessment decisions.

Feedback and debriefing in life support courses

- Ensure feedback is a two-way discussion between the giver and the recipient, driven by an authentic interest in the learner's improvement.
- Consider using a concise team debriefing after cardiac arrest training for HCPs to encourage routine clinical debriefings after real-life resuscitations.

Faculty development

- The ERC recommends faculty development programs for all instructors teaching life support courses.
- Select trainers with medical education expertise to conduct faculty development programmes.
- Implement faculty development programs that enable participants to establish a positive learning climate, practice effective educative leadership, communicate learning goals, implement robust assessment and feedback strategies, and evaluate course programs for continuous improvement.

Effect of resuscitation education on outcome

- HCPs providing advanced life support to adults should attend accredited adult advanced life support training.
- HCPs providing advanced life support for newborns and babies should attend accredited neonatal resuscitation training (NRT) courses such as Newborn Life Support.
- For HCPs providing care for newborns and babies in out-of-hospital low-resource settings, we recommend participation in the Helping Babies Breathe (HBB) support program.

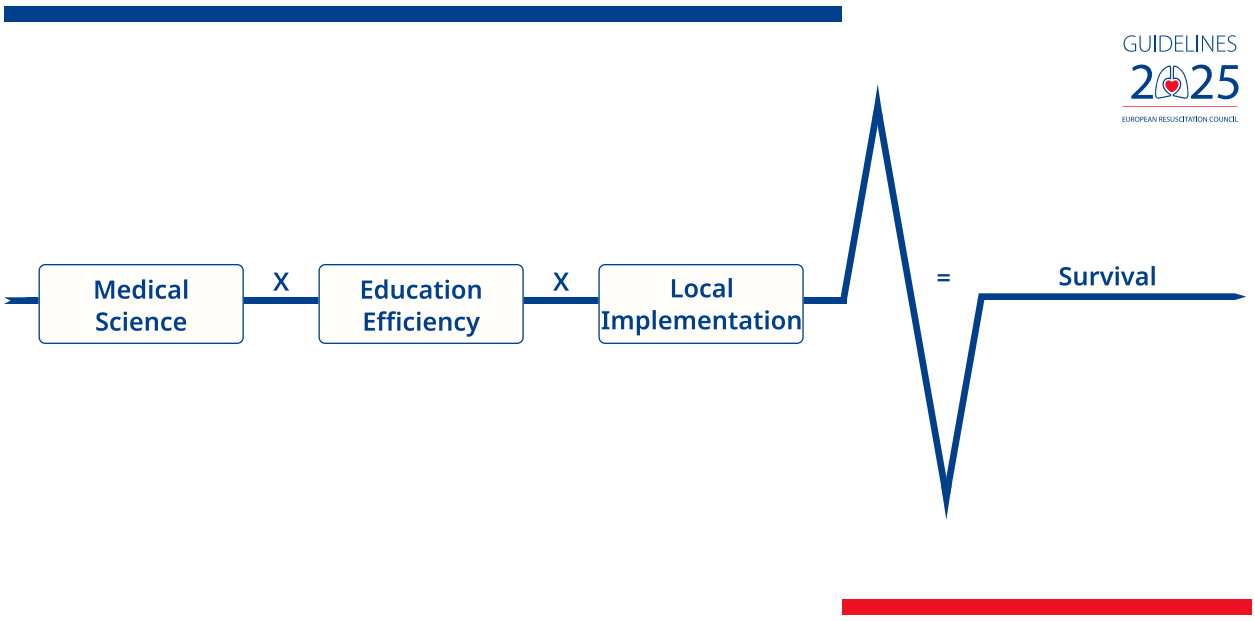

Fig. 33 – The Utstein formula of survival.

- Other accredited life support courses (e.g., paediatric life support) are recommended, even though less evidence on the effect on patient outcomes is available.

Resuscitation education in low-resource settings and remote areas

- Adapt educational approaches and materials, and awareness campaigns to the context and available resources.
- Consider distance learning, technology-enhanced learning, hybrid resuscitation training, and the use of low-cost (self-made) manikins.

Ethics in resuscitation

The ERC Ethics in Resuscitation Guidelines 2025 provide evidence-informed recommendations for the ethical, routine practice of resuscitation and end-of-life care of adults and children.[72] (Fig. 34).

Advance care planning

- Healthcare systems should offer advance care planning to all patients expressing wishes to discuss goals of care.
- Decisions of do not attempt CPR (DNACPR) are best made in the broader context of advance care planning.
- Anticipatory decisions, whether to attempt cardiopulmonary resuscitation (CPR) or not, should be taken regardless of the time of the day in all patients with a significant risk of cardiac arrest. For patients not under imminent risk, it is appropriate to plan for the discussion and decision-making to take place at daytime.
- Document decisions of DNACPR and on which of the three different grounds the decision is based: (1) CPR will not be appropriate since death is expected; (2) CPR not in a beneficial balance between the medical assessment and the patient's values; (3) or the patient does not wish to receive CPR.
- For patients with cognitive impairment, invite a substitute decision maker to ensure concordance in goals of care over time.
- Offer patient-centred education about advance care planning to patients before discussions on this topic.
- Document advance care plans in a consistent manner that is available in emergency care settings (e.g. electronic registries, standardised documentation templates).
- Use advance care planning to identify treatments and interventions that should be avoided upon hospital admission at the end of life.
- Reassess advance care plans regularly and when a patient's situation changes.
- Facilitate patient and family caregivers' understanding of their preferences, as mutual understanding can optimise the decision-making process for all involved.
- Organise local educational hubs focusing on skills and competencies when undertaking goals of care discussions.
- Communication skill training should be part of the continuous professional development of healthcare providers involved in advance care planning and end-of-life care.

Ethics of bystander and first responder involvement

- Ensure that bystanders are not forced or unduly compelled into performing CPR, respecting their personal autonomy in resuscitation decision-making, while acknowledging the 'duty to help'.
- Mitigate moral distress among bystanders and first responders by offering ethical guidance for navigating situations involving difficult or distressing interventions.

ETHICS IN RESUSCITATION
KEY MESSAGES

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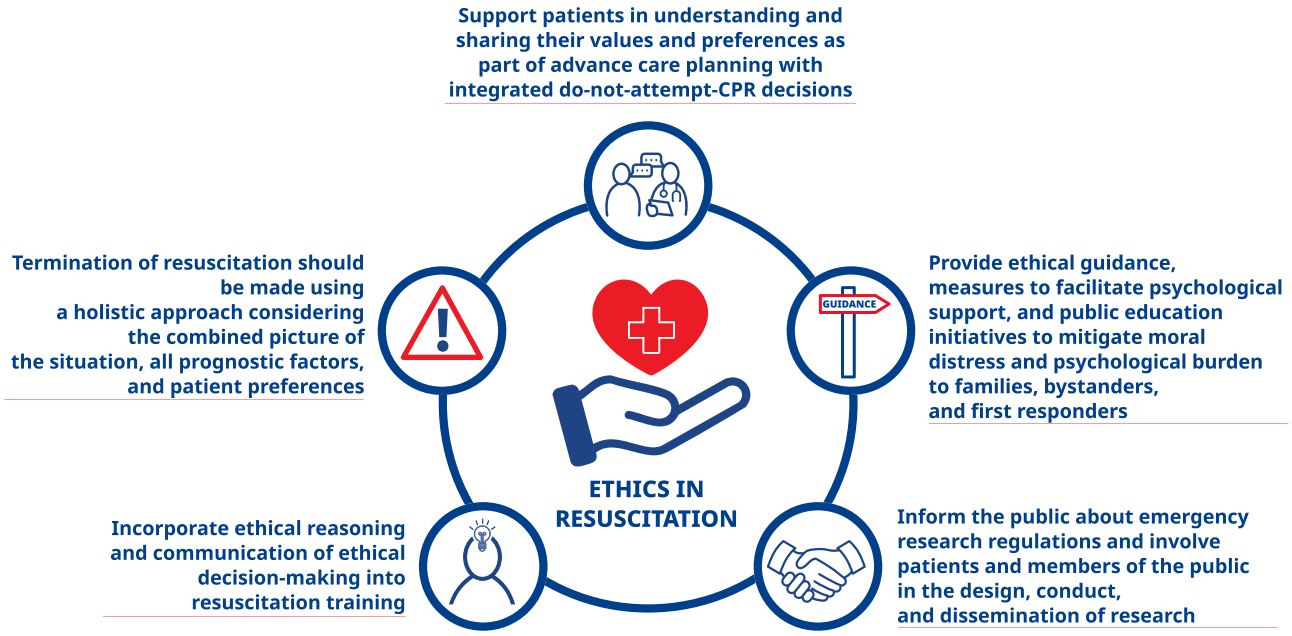

Fig. 34 – Key messages ethics in resuscitation.

- Health care systems should implement measures to facilitate psychological support for bystanders and first responders following out-of-hospital cardiac arrest (OHCA), e.g. through surveys or defusing to identify people in need of additional support and/or by providing contact information for further psychological support.
- Clarify legal and ethical protection for bystanders to reduce hesitation due to fear of liability or moral responsibility.
- Implement strategies to minimise the impact of biases in bystander intervention, ensuring that factors such as gender, cultural background, or the patient's social identity do not influence resuscitation decisions.
- Clearly articulate the ethical boundaries of bystander responsibility in OHCA response, carefully distinguishing between moral obligations and legal or medical duties and delineating how these distinctions can be navigated effectively within the context of the legal-moral duty to assist.
- Implement safeguards in bystander alert systems to protect patient autonomy and prevent unwanted or inappropriate resuscitation attempts, while also ensuring that the bystanders' autonomy is respected in their decision to intervene.

Family presence

- Resuscitation teams should offer the family of cardiac arrest patients the choice of being present during the resuscitation attempt.
- Healthcare systems should establish clear, contextualised, and culturally sensitive procedures for the involvement of family members.
- Healthcare systems should specifically train their teams to support family members during resuscitation.
- As far as reasonably practicable, healthcare systems should have a trained team member who can be designated to this task as part of the overall CPR strategy and choreography.

Termination of resuscitation (TOR)

- Make a team-based decision to terminate resuscitation based on a holistic approach considering patient values and preferences and the combined picture of prognostic factors including duration of CPR, the absence of reversible causes, and the absence of response to advanced life support.

- TOR should be carried out in a planned manner and all team members should have the opportunity to weigh in before termination.
- The team should conduct a debriefing immediately following termination.
- TOR may be considered when the patient has persistent asystole despite 20 min of advanced life support in the absence of any reversible cause when no other clinical factors suggest against.
- TOR rules may be used to aid decision-making for adult patients with OHCA following local validation and considering local values and preferences.
- TOR rules should not be used for IHCA and for paediatric patients in any setting due to insufficient evidence.
- Persistently low $ETCO_2$ is a strong prognostic marker that may be used to aid decision making in addition to other factors but should not be used in isolation.
- Other factors such as cardiac ultrasound, blood gases, and pupil reactiveness are not valid factors for termination of resuscitation (Fig. 35).

Uncontrolled organ donation after circulatory death

- Healthcare systems should assess their current policies and strategies regarding organ donation to improve organ availability while considering their sociocultural and religious context.
- Healthcare systems should invest in education and communication for both citizens and healthcare professionals.
- In healthcare systems that offer uncontrolled donation after circulatory determination of death, transparent procedures should be accessible to all those involved. These procedures should cover aspects such as donor identification, consent, organ preservation, and procurement.
- Moreover, TOR practices within these systems should be reviewed and adjusted to ensure they do not conflict with the possibility of uncontrolled organ donation after circulatory death.

Ethics of education and systems

- Establish ethical reasoning as a core competency in resuscitation education to strengthen critical thinking, ethical judgment, and decision-making that respects patient autonomy, follows medical best practices, and aligns with societal values.
- Implement simulation-based ethics training to provide healthcare professionals with hands-on experience in ethically complex resuscitation scenarios, including cases involving communication and decision-making regarding advance care planning, DNACPR decisions and TOR decisions.
- Introduce ethical preparedness education for resuscitation providers to develop strategies for managing moral distress, addressing ethical dilemmas, and overcoming institutional constraints that impact decision-making in high-pressure situations.
- Standardise institutional policies on advance care planning, DNACPR decisions, and TOR by embedding structured ethical frameworks that provide clear, legally and professionally aligned guidance for resuscitation decisions.
- Develop formal education programs to equip healthcare professionals with the skills to navigate institutional constraints, legal uncertainties, and policy inconsistencies in ethically complex resuscitation cases.
- Establish ethical oversight mechanisms within resuscitation policies to promote patient-centred, transparent, and ethically sound decision-making at institutional levels.

Cardiac arrest as a result of a suicide attempt

- In making decisions about withholding or withdrawing resuscitation in patients after attempted suicide, teams should consider various factors, such as context, patient motivations, and competing rights.
- If there is an advance directive, we still suggest initiating resuscitation until the context and background – clinical and ethical – of that advance directive is fully known.
- The response to the clinical situation should be tailored to the individual patient and not be dogmatic.
- If resuscitation likely results in significantly more harm than benefit, then the cause (being suicide) becomes irrelevant.

Resuscitation research ethics

- Systems should support the delivery of high-quality emergency research, as an essential component of optimising patient-centred cardiac arrest outcomes.
- Regulatory and procedural barriers to high-quality emergency research related to consent models should be minimised by legal improvements. For example, clear legal support for deferred consent may be extended to non-drug investigational interventions to minimise any pertinent ambiguity, while still maintaining adequate safeguards for patient and family autonomy, dignity and privacy.
- For observational research (e.g. in the context of registry data collection and/or DNA biobank data sampling and analyses) we suggest consideration of a deferred consent model, with concurrent implementation of appropriate safeguards aimed at preventing data breaches and patient reidentification.
- Researchers should involve patients, and members of the public as community advisors, throughout the research process, including design, delivery and research dissemination.
- Systems should promote education of the public regarding applicable regulations and the necessity of using deferred consent for emergency research. This initiative may enhance willingness for research participation.
- The use of a core outcome set, along with standardised corresponding terminology, should be harmonised across trials investigating clinical effectiveness.
- Communities or populations in which research is undertaken and who bear the risk of research-related adverse events, should be given the opportunity to benefit from its results.
- Researchers should comply with best practice guidance to ensure integrity and transparency of research, including study protocol registration, prompt reporting of results, allocation of authorship according to international criteria for authorship, and data sharing.
- Policies of governments, public health bodies, international societies, and non-profit organisations should aim to ensure that funding for cardiac arrest research is sufficient to effectively address the high societal burden caused by cardiac arrest-associated morbidity and mortality.
- Health authorities should augment systems' resilience to pandemic-associated (or other calamity-induced) disruption of resuscitation research by cost-effective use of available computer and telecommunication/telemedicine technology and

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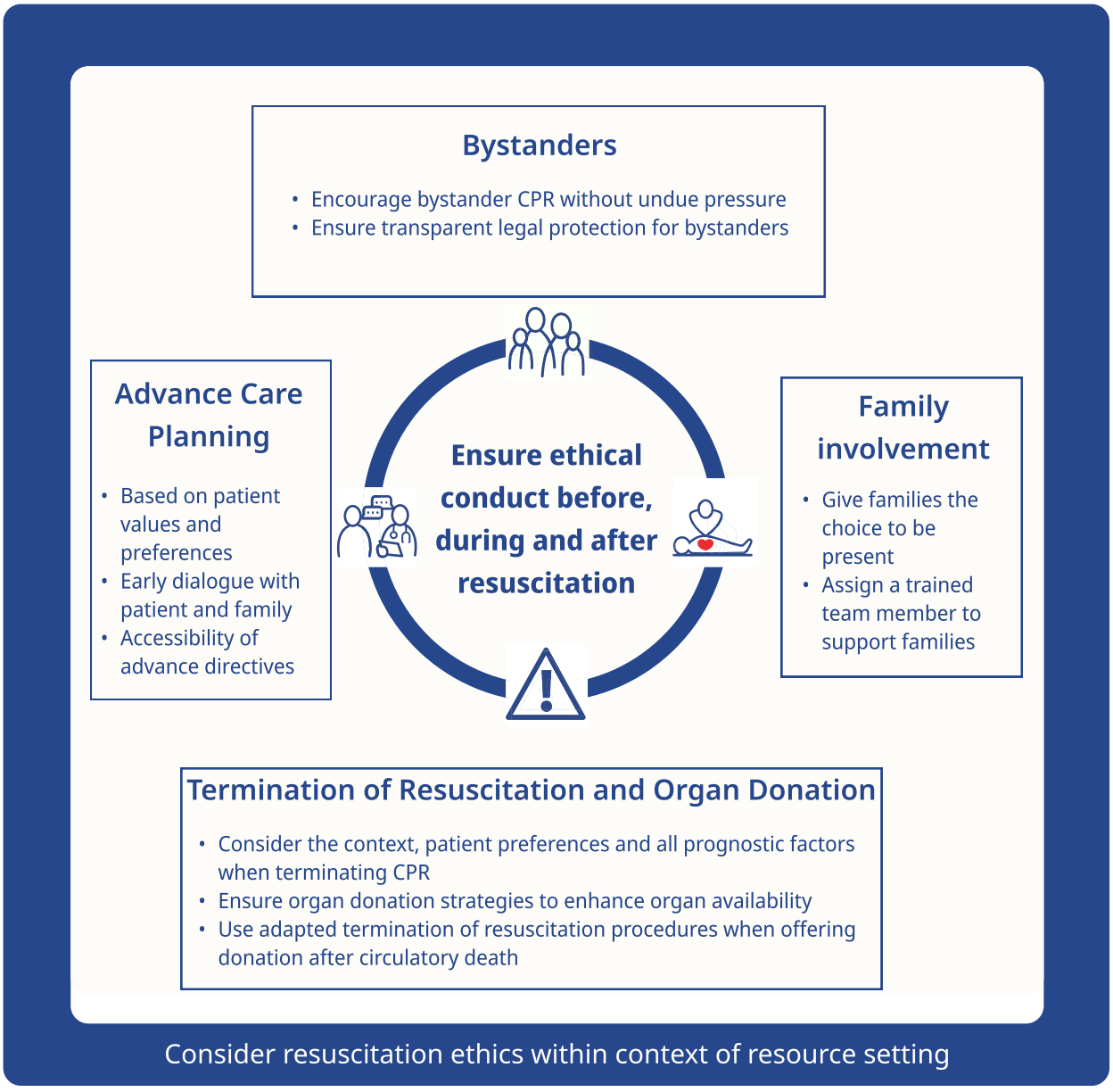

Fig. 35 – Ethical considerations before, during and after resuscitation.

infrastructure, and other occasion-specific measures, such as personal protection and widespread/prompt vaccination.

- Use of AI in research should be regulated according to rigorous ethical and scientific safeguards for beneficence, autonomy/privacy and justice. As an example, development of new AI algorithms should be based on broad datasets from the general population, rather than datasets from socioeconomically privileged groups.

First aid

The ERC First Aid Guidelines 2025 include evidence-informed first aid management of emergency medicine and trauma related to resuscitation and prevention of cardiac arrest.[73] (Fig. 36).

Implementation of first aid guidelines and considerations for different settings

Considering differences across these four essential domains will support guideline implementation:

- First aid recipient (e.g. age, sex, gender, health status, capacity to provide consent).
- First aid provider (e.g. knowledge, training/education, preparedness, familiarity, duty to respond, professional scope, capability).
- Treatment (e.g. invasiveness, skills required, technology, efficacy and effectiveness, cost).
- Setting and environment (e.g. low- or high-resource, safety, cultural norms and values, urban or remote).

Expectations of a first aid provider

As a first aid provider, you may minimise further injury, improve health and prevent death by following these three key principles:

- Check for scene safety.
- Call your local emergency number as soon as possible.
- Only use available equipment or medications you have been trained to use.

First aid courses

- First aid courses should be accessible to the widest possible audience and promote equal opportunities in both providing and receiving first aid.
- Course providers should tailor content based on the needs of participants, their context (low-resource settings, rural areas), sociocultural appropriateness and feasibility.
- Courses should teach awareness of the regional Good Samaritan laws.

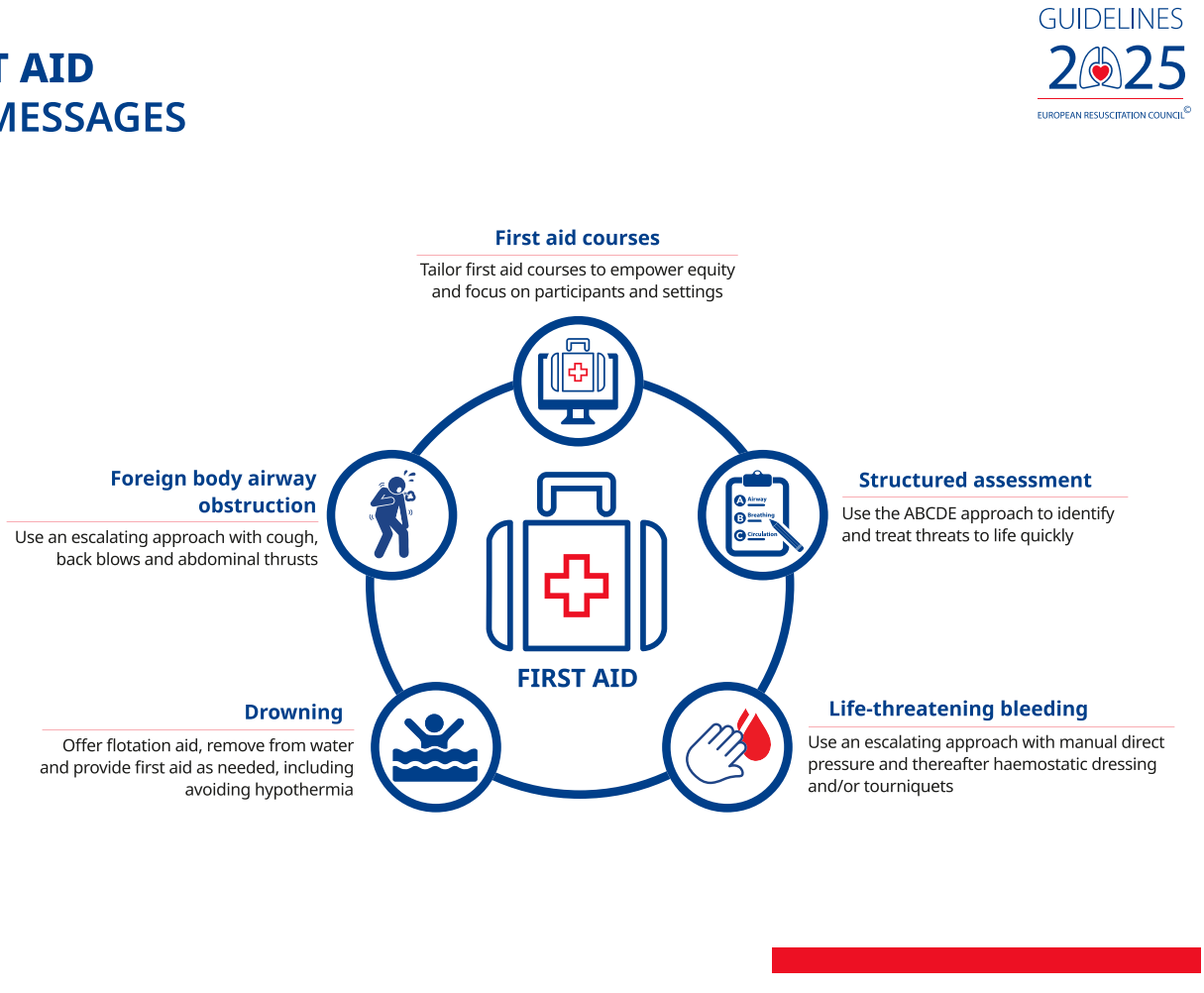

Fig. 36 – Key messages first aid.

- Courses should include measures to help bystanders, lay rescuers and professional first aid providers to overcome fear, anxiety and moral distress during and after providing first aid.

First aid kits

- All workplaces, leisure centres, public buildings, homes and cars should have first aid kits.
- Public first aid kits should meet local legal requirements, be clearly marked and readily accessible.
- The content of the kits should be based on the setting, expected risks and the users.
- All first aid kits should be inspected regularly and properly maintained.

Cardiac arrest

- If you suspect a cardiac arrest, call the emergency number (112) and follow the dispatcher instructions on how to perform cardiopulmonary resuscitation (CPR).
- Start CPR without worrying about accidentally hurting the person. It is more important to try to save their life than causing an injury.
- Continue CPR until professional help arrives and takes over or tells you to stop.

Structured first aid assessment of a person appearing ill, injured or in shock (ABCDE)

- Pay immediate attention to safety, responsiveness of the victim, and catastrophic bleeding.
- Use the ABCDE framework to structure your assessment of a person in need.

Recovery position

- Place adults and children with decreased level of responsiveness who do NOT meet the criteria for CPR into a lateral (side-lying) recovery position.
- In situations such as agonal breathing or trauma, do NOT move the person into the recovery position.

Use of a pulse oximetry and use of oxygen for acute difficulty breathing

- Give oxygen to a person with difficulty breathing and looking cyanosed (blue tinged) but only if you are trained in its use.
- Use a pulse oximeter to titrate the administered oxygen.
- Give oxygen via a simple facemask or non-rebreathing mask. Titrate flow rate to maintain an oxygen saturation of 94–98 %.
- If the person has chronic obstructive pulmonary disease, titrate the oxygen flow to maintain an oxygen saturation between 88 % and 92 %.
- In the presence of life-threatening hypoxaemia (oxygen saturation <88 %) give oxygen with a higher flow to everyone, including persons with chronic obstructive pulmonary disease having difficulty in breathing in the out-of-hospital setting.

Medical emergencies

Anaphylaxis

- Suspect anaphylaxis if someone has:
  - Stridor (which could be due to upper airway swelling), wheezing (which could be due to lower airway obstruction) or breathing difficulties.
  - Flushing, rash (hives), cold or clammy skin or is feeling faint.
  - Abdominal pain, vomiting, or diarrhoea.
  - A recent exposure to known food allergens or insect stings.
- Call your emergency number (112).
- Ensure that the person remains in a sitting or lying position.
- Give intramuscular adrenaline as soon as possible via autoinjector into the outer thigh in the recommended dose (self-administered or given by trained individuals).
  - 0.15 mg for children aged 1–5 years.
  - 0.3 mg for children aged 6–12 years.
  - 0.5 mg for adults.
- If an autoinjector is not available, use a device for intranasal administration.
- Give a second dose of adrenaline, if symptoms persist 5 min after administration.

Choking in an adult

- Suspect choking if a person is suddenly unable to speak or talk, particularly if eating.
- Ask the person – "Are you choking?"
- Encourage the person to cough.
- If unable to cough or the cough becomes ineffective, give up to 5 back blows.
- If back blows are ineffective, give up to 5 abdominal thrusts.
- If choking has not been relieved after 5 abdominal thrusts, continue alternating 5 back blows with 5 abdominal thrusts until choking is relieved, or the person becomes unresponsive.
- Call your emergency number (112).
- Do NOT use blind finger sweeps to try and remove a foreign body from the mouth or airway.
- If the person becomes unresponsive, start CPR.
- Any person successfully treated for choking with abdominal thrusts or chest compressions should be evaluated by a healthcare practitioner since complications and injuries may occur.

Asthma

- Assist persons with asthma who are having problems in using their own bronchodilator device.

Chest pain *in a responsive adult*

- Reassure the person and sit or lie them in a comfortable position.
- Encourage and assist a person with cardiac sounding chest pain in self-administering 150–500 mg of chewable aspirin as soon as possible whilst awaiting transport to hospital (but not to adults with known aspirin allergy).
- Assist a person with known angina to self-administer their own nitro-glycerine spray or tablets.
- Stay with the person until help arrives.

Hypoglycaemia (low blood sugar value)

- Suspect hypoglycaemia in someone with diabetes or chronic malnutrition and sudden impaired responsiveness or behavioural change.
- Give glucose or dextrose tablets (15–20 g), by mouth if the person is awake and able to swallow.
- If feasible, measure capillary blood sugar using a blood glucose meter and treat if low (a value less than 4.0 mmol L^{-1} or 70 mg dL^{-1}) and repeat measurement after treatment.

- If glucose or dextrose tablets are not available give other dietary sugars, such as a handful of sugary sweets or 50–100 mL of fruit juice or sugar containing soda
- If oral glucose is not available, give a glucose gel (partially held in the cheek, and partially swallowed).
- Repeat giving oral glucose if the symptoms are still present and not improving after 15 min.
- If the person has a prescribed glucagon autoinjector, this could be administered under the skin in the outer thigh (self-administered or by trained individuals). Some diabetics may have glucagon syringes for nasal use.
- For children, consider administering half a teaspoon of table sugar (2.5 g) under the child's tongue, if they are uncooperative with swallowing oral glucose.
- Call your emergency number (112) if the person is/or becomes unresponsive or the condition does not improve.
- Following recovery from symptoms (5–10 min after sugar intake) encourage the person to eat a light snack.
- For unresponsive persons, do not give oral sugar due to the risk of aspiration, instead call your local emergency number (112).

Opioid overdose

- Suspect an opioid overdose if the person is breathing is slowly, irregularly or not at all, is extremely drowsy or unresponsive, or has pinpoint (very small) pupils.
- If the person is unresponsive and not breathing normally, start CPR CPR and call your local emergency number (112).
- Administer intra-nasal naloxone, or if you are trained, use an intramuscular naloxone autoinjector.
- Reassess the person according to ABCDE.
- Follow package instructions on when to give another dose of naloxone.

The management of general intoxications and opioid overdose has been described in the ERC Guidelines 2025 Special Circumstances in Resuscitation (Fig. 37).

Stroke

- Use a stroke assessment scale to decrease the time to recognition and call for help.
- Give oxygen only if you are trained in its use and the person is showing signs of hypoxia (bluish lips and rapid breathing).

Suicidal thoughts

If you think a person might harm themselves;

- Ask the individual "Are you alright?" "How do you feel and why"?
- Ask if the person has suicidal thoughts and plans (how? where? when?).
- Summarise to the person your understanding of how and why they have certain feelings.
- If the person has made concrete threats or plans for suicide, tell them you are going to ask for help, and call your emergency number (112).
- Give hope.

Trauma emergencies

Cervical spinal motion restriction

- Suspect a cervical spine injury in a person who fell or dived from a height, was crushed by machinery or a heavy object, was involved in a road traffic, or a sporting accident.
- Minimise movement of the neck if the person is awake and alert and encourage them to self-maintain their neck in a comfortable stable position.
- Never force an uncooperative person into any position, as this may exacerbate an injury.
- In unresponsive persons lying on their back, kneel behind their head and immobilise their head and neck using head or trapezius squeeze.
- Consider the need to open the person's airway using the 'jaw-thrust' technique.
- If the person is unresponsive and is lying face-down, check if their airway is open and hold their neck in a stable position
- If you need to open their airway, ask others to help you carefully roll them as a unit onto their back whilst keeping their neck in line with their body and as stable as possible. Then apply the head or trapezius squeeze.
- First aid responders with specialised training (e.g. ski patrol, lifeguard) may consider the selective use of spinal motion restriction using their existing protocols.

Control of life-threatening bleeding

- Apply firm direct manual pressure to the bleeding injury.
- Apply a standard or haemostatic dressing directly to the bleeding injury and then apply firm direct manual pressure on top of the dressing.
- Once bleeding is under control, apply a pressure dressing.
- Apply a tourniquet as soon as possible for life-threatening extremity bleeding that is not controlled by direct manual pressure.
- Write the time of application on the tourniquet.

Open chest wounds

- Leave an open chest wound exposed to freely communicate with the external environment.
- Do not apply a dressing or cover the wound.
- If necessary, control localised bleeding with direct pressure.
- If you are trained and the equipment is available, apply a specialised non-occlusive or vented dressing, ensuring a free outflow of air when breathing out.
- Observe the wound for air flow obstruction due to bleeding or clotted blood.

Concussion

- Suspect concussion if a person has difficulties with thinking/remembering, displays physical symptoms (headache, change in vision, dizziness, nausea or vomiting, seizures, sensitivity to light/noise), emotional changes or changes in behaviour (increased sleepiness, reduction in normal activities, loss of responsiveness, confusion).
- Remove the person from physical activities.
- Refer to a healthcare professional for further advice and assessment.

Preservation of an amputated body part

- Manage any severe bleeding first (see 'Control of life-threatening bleeding').
- Retrieve the body part as quickly as possible and keep it cold without freezing.
  - Wrap the part in a sterile dressing or a clean cloth moistened with saline or water.

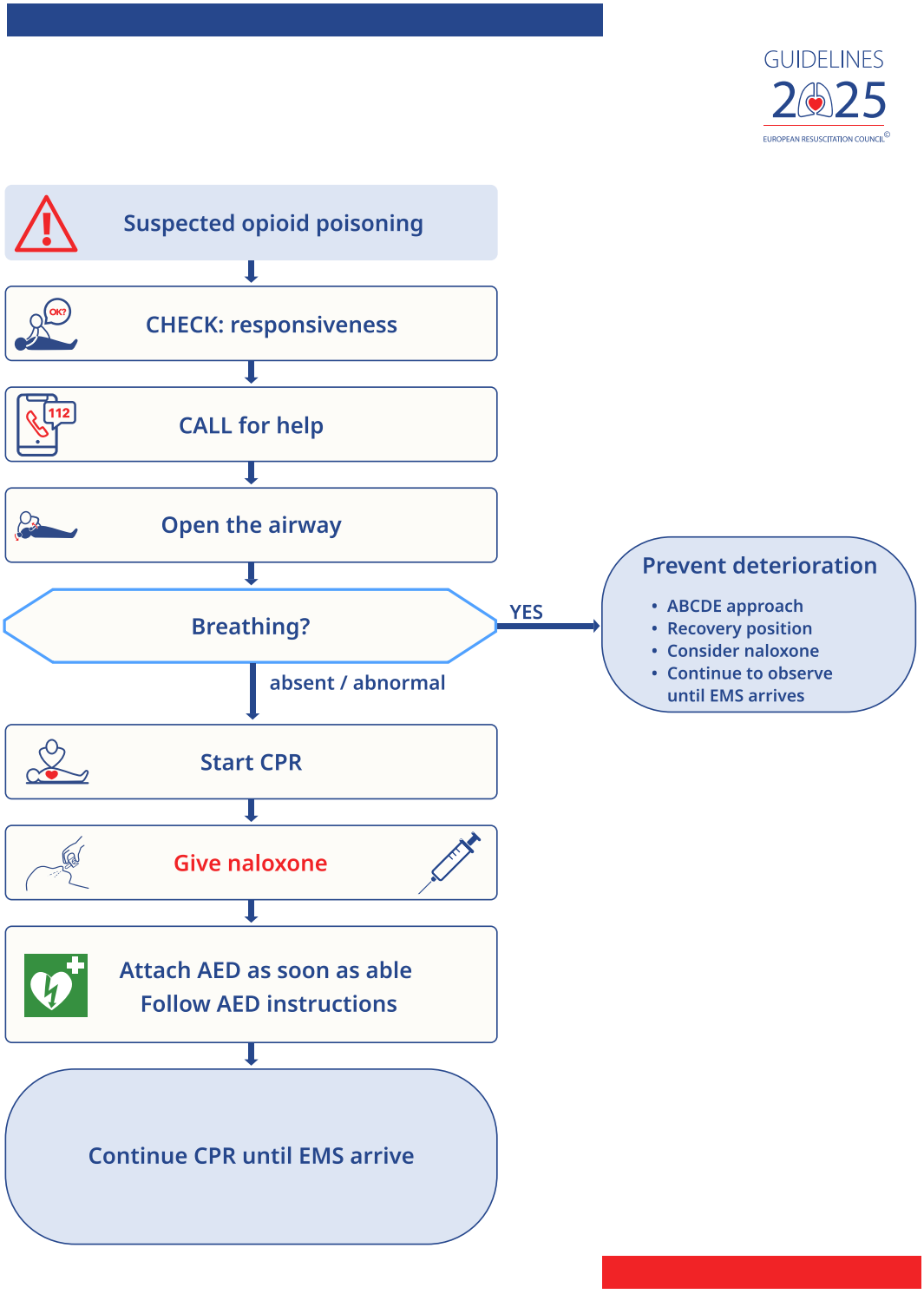

Fig. 37 – Order of actions for opioid overdose.

- o Place the wrapped part in a clean watertight plastic bag or container.
- o Put the watertight bag or container holding the body part, inside another bag containing ice or ice-water. If ice is unavailable, you can use a cooler with instant cold packs.
- Keep the part always cooled. Avoid direct contact with ice or freezing. Label the container with the person's name and time the part was stored.
- Transport the part with the injured person to the same hospital as quickly as possible.

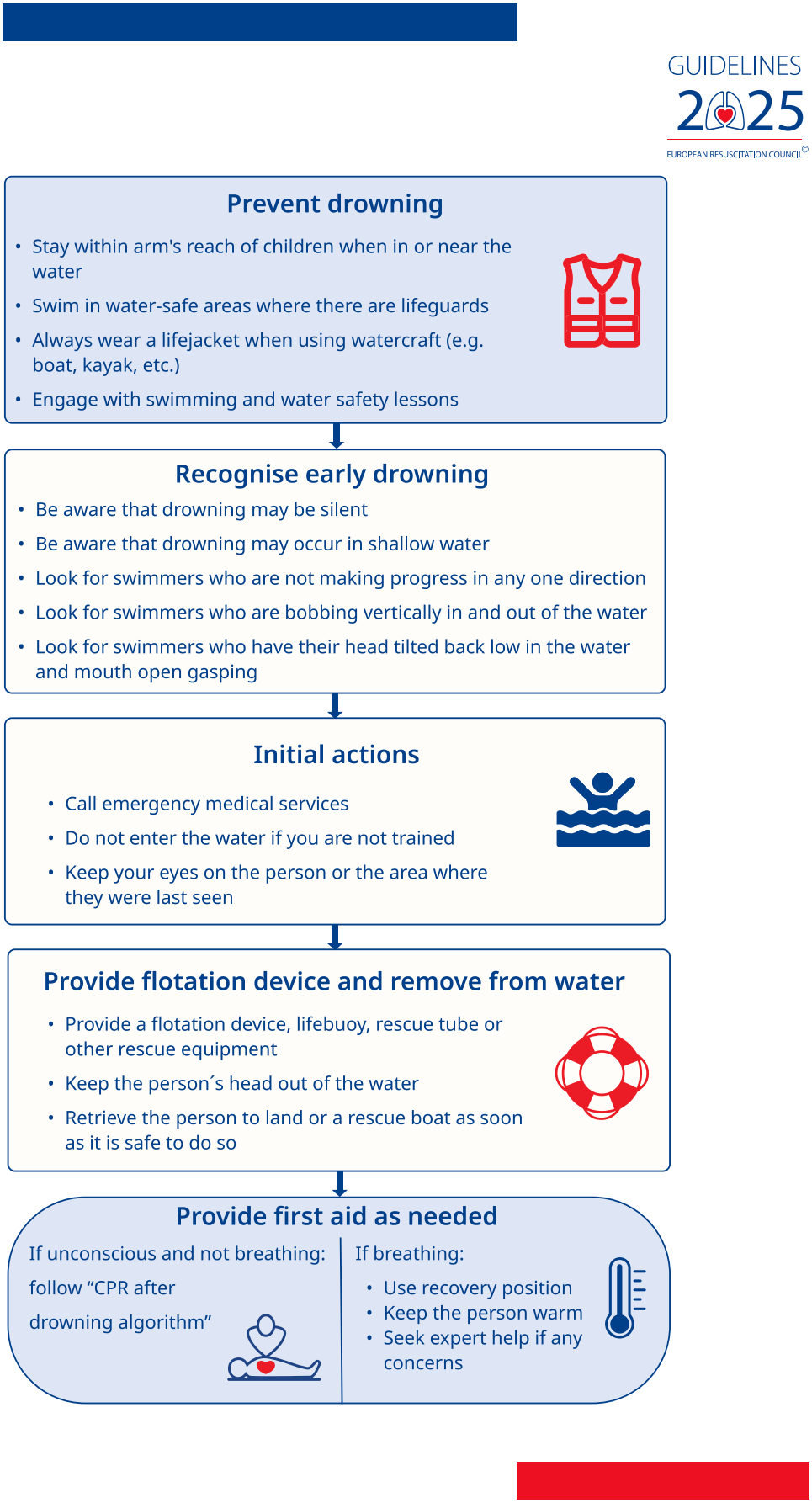

Fig. 38 – First aid in drowning.

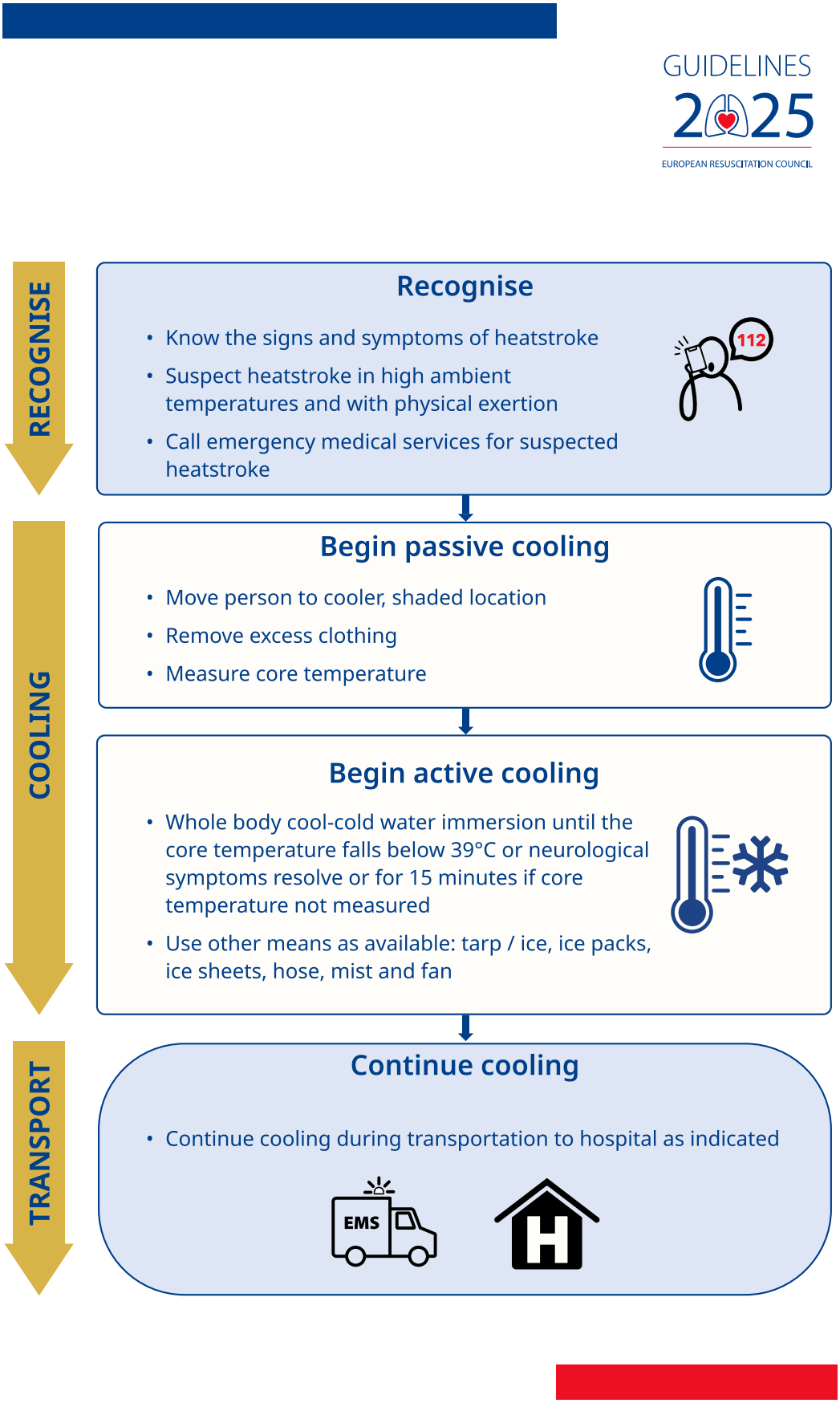

Fig. 39 – Management of heatstroke and exertional hyperthermia.

Environmental emergencies

Drowning

- Do not enter the water as you might risk drowning yourself if you are not trained in water rescue.
- If the person is awake and responsive, stay on land and reach out to the person through floatation devices, lifebuoy, rescue tube or other rescue equipment.

Trained first aiders or lifeguards in the water or on a boat:

- Call for help before you enter the water.
- Provide a flotation device, lifebuoy, rescue tube or other rescue equipment.
- Keep the person´s head out of the water.
- Assess if the person is unresponsive and not breathing. If feasible and safe (with an effective flotation device), provide 5 rescue breaths in the water as soon as possible.
- Retrieve the person to land or a rescue boat as soon as possible.
- Once out of the water, provide 5 rescue breaths if the person is not breathing, if necessary, start standard CPR.
- Attach an AED, if available and after drying the chest, and follow the instructions (Fig. 38).

On land, if the person has drowned and is unresponsive and not breathing:

- If feasible and safe, provide 5 rescue breaths and start standard CPR.
- Attach an AED, if available and after drying the chest, and follow the instructions.

Prevention of hypothermia

- Insulation: Cover the individual with dry blankets or clothing to minimise heat loss.
- Wind protection: Shield the person from wind using barriers or by moving them to a sheltered area.
- Wet clothing removal: Gently remove wet clothing and replace it with dry garments to prevent further cooling.
- Ground isolation: Place insulating materials, such as blankets or pads, between the individual and the cold ground.
- In settings where hypothermia might be common, implement tailored prevention plans and training for first aid providers.

Heat stroke

- Consider symptoms of heat stroke with high ambient temperature, like elevated core body temperature, confusion, agitation, disorientation, seizures or unresponsiveness.
- Prevent exertional heat stroke (i.e. during long-distance sport events in a hot climate) by adequate preparation and provide tools for diagnosis (e.g.: rectal temperature probes) and cooling (e.g. immersion ice-water baths).
- With suspected heat stroke remove the person from the heat source and commence passive cooling by removing excess clothing and placing the person in a cooler/shaded location.
- Use any technique immediately available to provide active cooling, if core temperature >40 °C.
- Use whole body (neck down) cold water (1 to 26 °C) immersion until the core temperature falls below 39 °C, alternatives are: tarp-assisted cooling oscillation (TACO) ice sheets, commercial ice packs, fan alone, cold shower, hand cooling devices, cooling vests and jackets or evaporative cooling (mist and fan).
- Where possible monitor core temperature (rectal thermometer).
- If a core temperature cannot be obtained, continue cooling for 15 min or until neurological symptoms resolve, whichever is first.
- Remember: cool first, transfer second.
- Continue cooling as needed during transportation to a medical facility for further evaluation (Fig. 39).

Snake bite

The only indigenous highly venomous snake in Europe is the European Viper, which has a haemolytic toxic venom.

- Call your local emergency number (112).
- Keep the person calm and at rest.
- Keep the bitten body part still and immobilise the affected limb as this may slow venom spread.
- Remove tight clothes, rings or watches from the affected limb.
- Avoid harmful actions:
  - Do not apply a pressure dressing, ice, heat, or use tourniquets.
  - Do not cut the wound and never try to suck out the venom.

Declaration of competing interest

Declarations of competing interests for all ERC Guidelines authors are displayed in a COI table which can be found online at https://doi.org/10.1016/j.resuscitation.2025.110770.

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