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Practice Guideline

European Resuscitation Council Guidelines 2025 Newborn Resuscitation and Support of Transition of Infants at Birth

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Abstract

These European Resuscitation Council (ERC) Guidelines 2025 on Newborn Life Support are based on the International Liaison Committee on Resuscitation (ILCOR) Consensus on Science wtih Treatment Recommendations (CoSTRs) for Neonatal Life Support. These Guidelines present a logical approach to resuscitation and support of transition to extra-uterine life, for both preterm and term newborn infants. These Guidelines include factors before birth, training and education, thermal control, management of the umbilical cord after birth, initial assessment, airway, breathing and circulation assessment and interventions, emergency vascular access, low resource and out of hospital settings, communication with parents, and considerations on withholding and discontinuing life sustaining treatments. Life support guidelines for older infants and children are covered in the ERC Guidelines 2025 Paediatric Life Support.

Introduction and scope

The ERC Guidelines 2025 on Newborn Life Support (NLS) include both resuscitation at birth and support of transition from fetus to newborn infant across all gestational ages (GA). Newborn resuscitation differs fundamentally from resuscitation in every other age group due to the unique physiological transition from intrauterine to extrauterine life. The adaptation at birth requires a complex interplay of respiratory, cardiovascular, and metabolic changes, making timely and appropriate intervention crucial. It primarily focuses on supporting postnatal transition, with establishment of lung aeration, effective breathing or ventilation, and optimising pulmonary blood flow.

The evidence to support newborn resuscitation remains limited, with many recommendations extrapolated from animal studies, observational data, or expert consensus. The ERC NLS Writing Group recognises these challenges but has aimed to develop clear, evidence-informed guideline recommendations that balance scientific rigor with practical applicability. By emphasising consistency, simplicity, and effective education, they serve as a foundation for improving newborn resuscitation practices across diverse healthcare environments.

Abbreviations: CPR, Cardiopulmonary resuscitation, C:V, Compression to ventilation (ratio), CI, Confidence intervals, CoSTR, Consensus on Science and Treatment Recommendations, CPAP, Continuous positive airway pressure, DCC, Delayed cord clamping, ECG, Electrocardiography, FRC, Functional residual capacity, GA, Gestational age, HCP, Health care professional, HR, Heart rate, HIE, Hypoxic ischemic encephalopathy, ICC, Immediate cord clamping, IO, Intraosseous, IV, Intravenous or intravascular, NICU, Neonatal Intensive Care Unit, NLS, Newborn Life Support, FiO_2, Fractional inspired oxygen concentration, OR, Odds ratio, PLS, Paediatric Life Support, SpO_2, Peripheral oxygen saturation, PEEP, Positive end-expiratory pressure, PPV, Positive pressure ventilation, RCT, Randomized controlled trial, ROSC, Return of spontaneous circulation, s, Second (s), SGA, Supraglottic airway device, UVC, Umbilical venous catheter

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The ERC Guidelines 2025 NLS are based on the International Liaison Committee on Resuscitation (ILCOR) Consensus on Science and Treatment Recommendations (CoSTRs) for Newborn Life Support.[2–6] For the purposes of these Guidelines, the ILCOR recommendations were supplemented by focused literature reviews undertaken by the ERC NLS Writing Group for topics not reviewed by ILCOR CoSTRs. When required, the Guideline was informed by expert consensus of the ERC NLS Writing Group. The ERC Guidelines 2025 NLS were drafted and agreed by the ERC NLS Writing Group members and the ERC Guidelines 2025 Steering Committee. These Guidelines were posted for public comment between 15 May and 30 May 2025. A total of 69 individuals submitted comments, this feedback was reviewed by the NLS writing group. The Guidelines were thereafter updated where relevant, resulting in 40 changes in the final version. The ERC Guidelines 2025 NLS were presented to and approved by the ERC Board and the ERC General Assembly in June 2025. The methodology used for guideline development is presented in the Executive summary.[7]

For consistency, the ERC Guidelines 2025 NLS describe a baby at birth as a 'newborn infant' and a baby or a neonate as an 'infant' throughout this guideline. The term 'mother' is used to describe the person giving birth, the term 'parents' is used to describe the caregivers.

Newborn life support or paediatric life support?

In agreement with the ERC Guidelines 2025 Paediatric Life Support (PLS) Writing Group, the ERC recommends the following:

- Use the ERC Guidelines 2025 NLS immediately after birth irrespective of birth location (i.e. hospital or home birth)
- The ERC Guidelines 2025 NLS can also be used during Neonatal Intensive Care Unit (NICU) stay, especially in preterm infants or term infants with primary respiratory problems.
- Use the ERC Guidelines 2025 PLS[1] after first hospital discharge.
- Using the ERC Guidelines 2025 PLS[1] during first hospital stay after birth is also reasonable in the following circumstances:
  - after cardiac surgery,
  - in known cardiac arrhythmia, and
  - In other non-respiratory cardiac arrests
- Develop local policies defining which guideline to use for which infants, applicable to the healthcare setting. Factors to take into consideration include:>
  - individual NICU case-mix,
  - algorithm familiarity and training, and
  - human and organisational factors
- Teams may initiate resuscitation using the guideline they are most familiar with (NLS or PLS) and summon appropriate help and switch guideline if needed, in a timely and coordinated manner.

Preterm infants at the threshold of viability

The ERC Guidelines 2025 NLS apply predominantly to management of infants with gestational age (GA) $\geq$ 25 weeks. Until more evidence from trials including the most preterm infants is available, the ERC

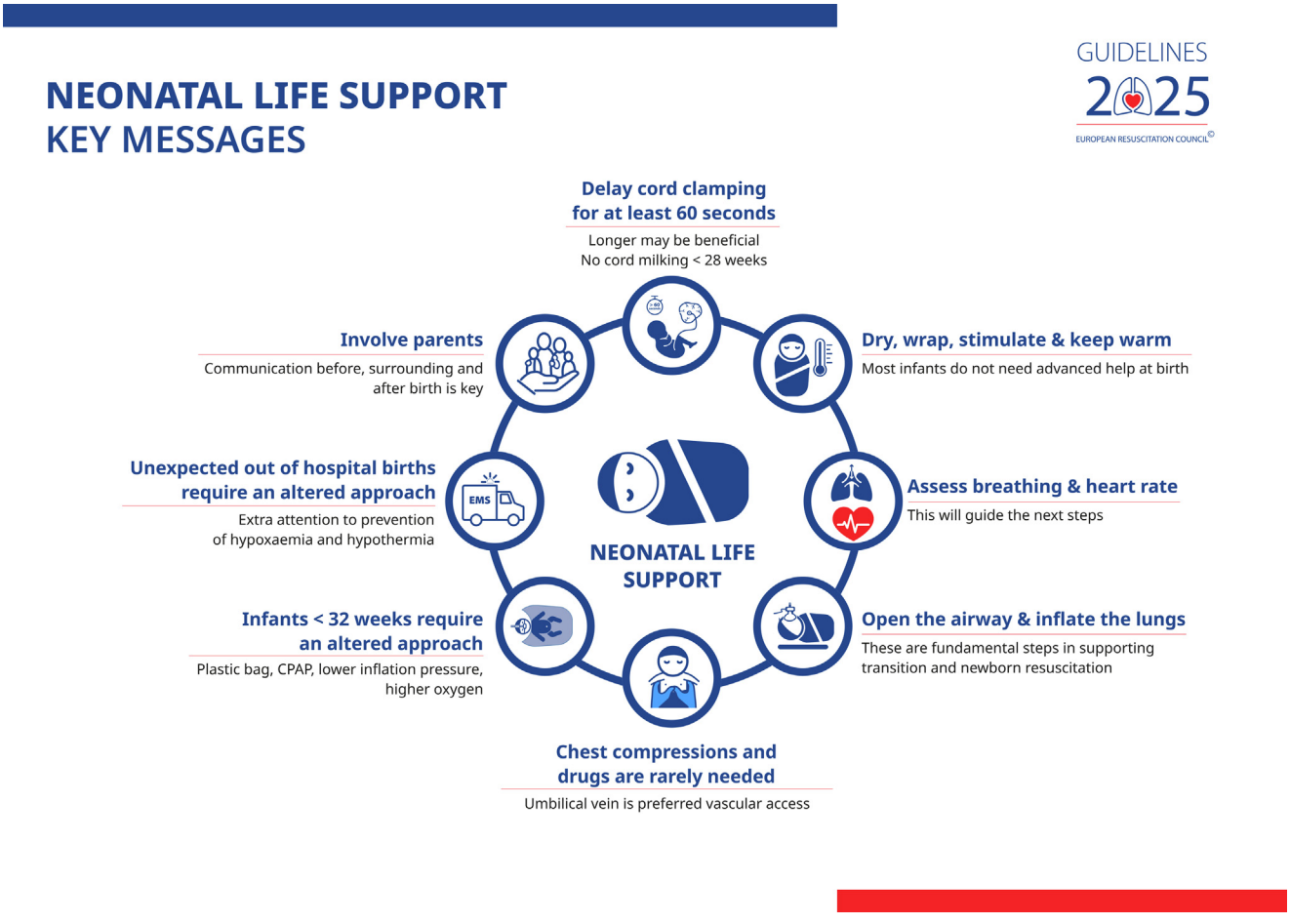

Fig. 1 – Neonatal life support – key messages.

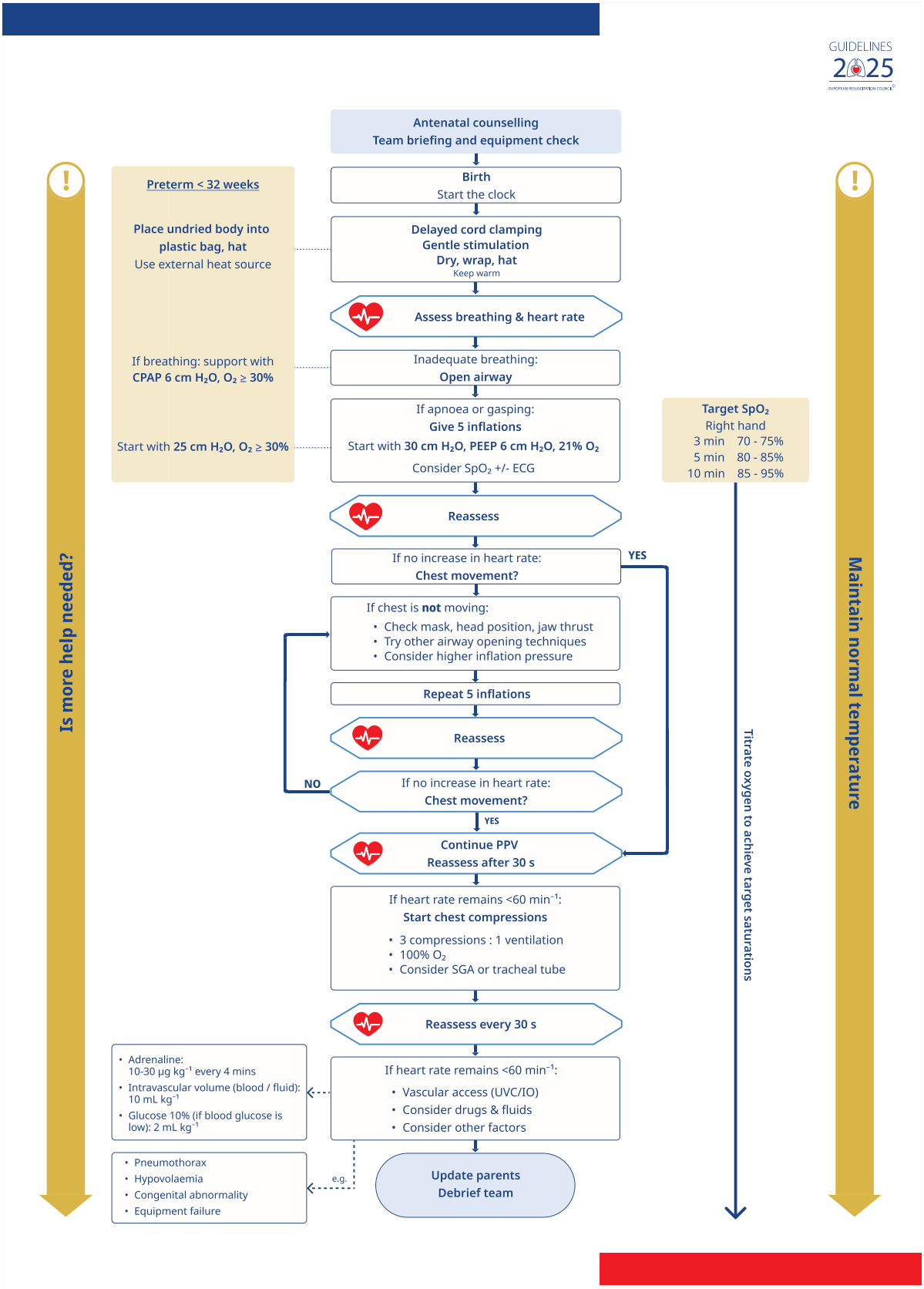

Fig. 2 – Neonatal Life Support algorithm. CPAP: continuous positive airway pressure; ECG: electrocardiography; IO: intra-osseous needle; PEEP: positive end-expired pressure; PPV: positive pressure ventilation; SGA: supraglottic airway; SpO2: peripheral oxygen saturation; UVC: umbilical venous catheter.

Table 1 – Key changes in NLS 2025 Guidelines.

Topic	ERC 2021 NLS Guidelines	ERC 2025 NLS Guidelines
When to use Newborn Life Support (NLS) or Paediatric Life Support (PLS) algorithms	Not included	The NLS and PLS Writing Groups have included aligned statements relating to when it might be appropriate to use either resuscitation algorithm. Both writing groups consider it reasonable for teams to initiate resuscitation of an infant outside the delivery area using the guideline most familiar to them (either NLS or PLS) whilst summoning appropriate help and switching algorithm in a timely fashion if necessary.
Applicability of Guidelines to the most preterm infants at the limits of viability	Not included	The Guidelines acknowledges the paucity of resuscitation data available from extremely preterm infants especially <25 weeks and cautions that this guideline is based upon evidence from predominantly older gestational ages, which limits applicability to extremely low gestational ages
Telemedicine	Not included	Telemedicine can provide remote advice and health systems should consider how this can be used.
Environment and equipment	All equipment must be regularly checked and ready for use. Where possible, the environment and equipment should be prepared in advance of the birth of the infant.	Equipment should be easily accessible and organised in a standardised way. Consider human factor elements when organising equipment and training to maximise efficiency and to minimise time delays.
Delayed cord clamping (DCC)	Where immediate resuscitation or stabilisation is not required, aim for delayed cord clamping of at least 60 s. A longer period may be more beneficial.	Although recommendations about delayed cord clamping have not changed significantly, there is even more emphasis on the importance of delayed cord clamping for all newborn infants, especially preterm infants. In newborn infants needing resuscitation, clamp the cord <30 s to minimise delay to necessary interventions.
Cord milking	Where delayed cord clamping is not possible consider cord milking in infants >28 weeks gestation	The guideline reinforces **not** milking the cord in preterm infants <28 weeks and focusses on trying to perform delayed cord clamping if possible. Cut cord milking is acknowledged as a reasonable alternative if >28 weeks and delayed cord clamping not possible.
Initial assessment – colour	As part of initial assessment, observe tone (& colour).	There is a reduced emphasis on skin colour during initial assessment. This reflects the subjective nature of detecting cyanosis or pallor especially in different skin tones.
Initial assessment – heart rate (HR)	Determine the heart rate with a stethoscope and a saturation monitor +/- electrocardiogram (ECG) for later continuous assessment.	The guideline recognises the increasing role for ECG as a continuous method of HR evaluation which is more precise than other methods. However, auscultation with a stethoscope remains a reasonable first option.
Airway management	If there is no heart rate response and the chest is not moving with inflations consider a 2-person facemask support if single handed initially Securing the airway via tracheal intubation or insertion of a laryngeal facemask.	Use the two-person method of airway support (jaw thrust) if sufficient providers are available as this approach is more effective than single person technique. A supraglottic airway should be considered if facemask ventilation is ineffective.
Airway – no chest wall movement – increasing pressures	If there is no heart rate response and the chest is not moving with inflations, consider a gradual increase in inflation pressure	If there is no HR response, the chest is not moving with inflations and airway opening techniques are ineffective, increase inflation pressure. Reduce inflation pressure when chest movement seen and clinical improvement.

Table 1 (continued)

Topic	ERC 2021 NLS Guidelines	ERC 2025 NLS Guidelines
Airway – video laryngoscopy	The use of video laryngoscopy may aid endotracheal tube placement.	Use video laryngoscopy if available. This reflects evidence of increased first attempt success in tracheal intubation when video laryngoscopy is used. A conventional direct laryngoscope should be available as an alternative.
Breathing – CPAP/PEEP	In spontaneously breathing preterm infants consider CPAP using either facemask or nasal interface. Use PEEP at minimum of 5–6 cm H_2O when providing positive pressure ventilation (PPV) to these infants.	Apply appropriately fitting **nasal interface or a facemask** connected to a device for providing positive pressure ventilation. CPAP and PEEP is now recommended at a level of **6 cm H_2O.**This guideline acknowledges that CPAP may be considered in infants >32 weeks GA with respiratory distress if they require supplemental O_2.
Breathing – Initial oxygen concentration	Infants ≥32 weeks needing respiratory support: start with 21 % O_2. Infants >28 weeks but <32 weeks start with 21–30 % O_2. Infants <28 weeks gestation start with 30 % O_2	Initial oxygen concentration according to gestation has been simplified: Infants ≥32 weeks needing respiratory support: start with 21 % O_2 Infants <32 weeks: start with ≥30 % O_2
Breathing – Oxygen target saturations	Aim to achieve target SpO_2 >25th percentile for healthy term infants. **Time after birth: target SpO_2** • 2 min: 65 % • 5 min: 85 % • 10 min: 90 %	SpO_2 target ranges incorporating newer data from preterm infants in addition to the established data from mostly term infants before DCC was standard practice now result in a target range of acceptable SpO_2 **Time after birth: target SpO_2** . • 3 min: 70–75 % • 5 min: 80–85 % • 10 min: 85–95 %Reduce O_2 if saturations exceed 95 %
Circulation	If chest compressions are required consider securing the airway, ideally with a tracheal tube.	When chest compressions are performed, a supraglottic airway or tracheal tube should be considered, depending on training and experience.
Drugs – Adrenaline	An intravenous dose of adrenaline of 10–30 μg kg^{-1} (0.1–0.3 mL kg^{-1} of 1:10,000 adrenaline [0.1 mg/mL]) every 3–5 min.	The time intervals of intravenous or intraosseous adrenaline have been simplified: 10–30 μg kg^{-1} (0.1–0.32 mL kg^{-1} of 1:10,000 adrenaline [0.1 mg/mL]) every 4 min.
Drugs – Sodium Bicarbonate	Sodium bicarbonate may be considered in a prolonged unresponsive resuscitation with adequate ventilation to reverse intracardiac acidosis.	Removed from 2025 guideline
Drugs – Naloxone	A dose of naloxone may help in the few infants who, despite resuscitation, remain apnoeic with good cardiac output when the mother is known to have received opioids in labour.	Removed from 2025 guideline
Glucose	An intravenous dose of 2 mg kg^{-1} (2 mL kg^{-1} of 10 % glucose) is suggested in a prolonged resuscitation to reduce the likelihood of hypoglycaemia	There is greater emphasis on checking blood glucose during resuscitation and treating only if it is low, rather than empirical treatment of presumed hypoglycaemia during resuscitation. The guideline acknowledges the potential for harm from both hypoglycaemia and hyperglycaemia. The bolus glucose has been aligned with ERC 2025 guideline PLS.
Low resource and remote settings	Not included	The guideline considers out of hospital births as low resource settings, especially when unexpected and/or preterm birth. Includes a section on identifying and managing the common problem of hypothermia and safe transfer to hospital.
Parent input into Guideline 2025	Not included	Guideline has been developed with input by a parent organisation in relevant sub-sections

NLS Writing Group recommends caution when applying the recommendations in these Guidelines to them.[8]

Local approaches should be defined.

Standardised gestational age cut-off across the Guideline

To ensure consistency and practical applicability, the ERC NLS Writing Group standardised the gestational age (GA) cut-off across all subtopics. Although many ILCOR reviews on preterm infants focus on infants <34 weeks, most studies include predominantly infants <32 weeks, therefore 32 weeks was adopted as a pragmatic cut-off. This aligns with the ERC Guideline 2021 NLS[9] and common clinical thresholds for determining the appropriate level of perinatal care.

Key messages and key changes

Key messages are presented in Fig. 1. Summary of key changes is presented in Table 1 and the Neonatal Life Support Algorithm is shown in Fig. 2.

Concise guidelines for clinical practice

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 (Fig. 3).

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:

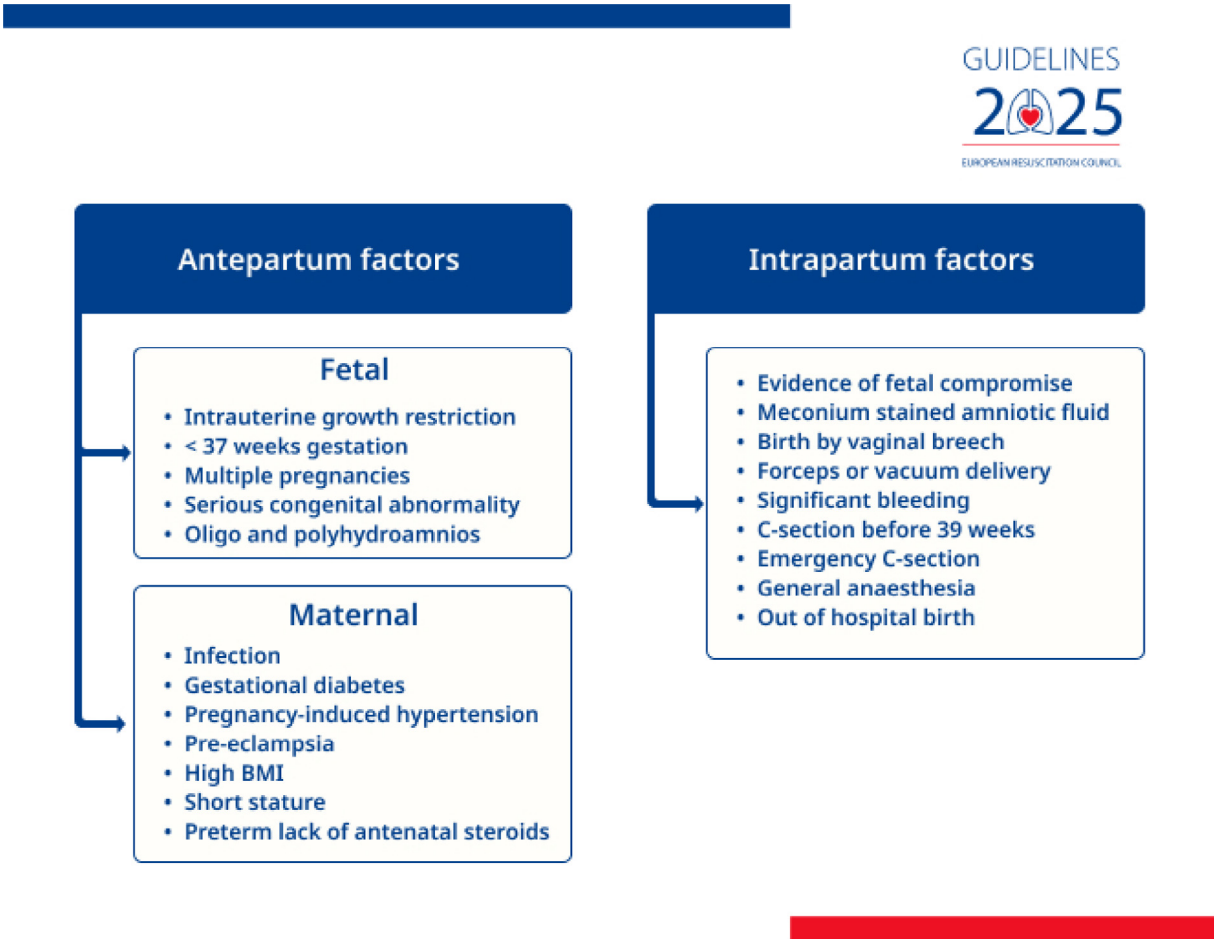

Fig. 3 – Common factors associated with the need for stabilisation, or resuscitation at birth BMI: body mass index.

- 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 educational 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 education 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 her do so 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.

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.

Table 2 – Assessment of breathing and heart rate.

	Assessment	Intervention
Breathing assessment		
Regular	Satisfactory	None required
Slow, gasping or grunting	Inadequate	Assess – may require intervention
Not breathing	Absent	Intervention required
HR assessment		
>100 min^{-1} (fast)	Satisfactory	None required
60–100 min^{-1}	Inadequate	Assess – may require intervention
<60 min^{-1}(very slow or absent)	Emergency	Intervention required

- 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.

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: (Table 2).
  - 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 breathing: 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 newborn infants.
- Do not interrupt resuscitation to place pulse oximetry or ECG.

Response to tactile stimulation

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

Muscle tone & skin colour

- A very floppy infant is likely to need breathing support.
- Hypotonia is common in preterm infants.
- Do not use colour to assess oxygenation.

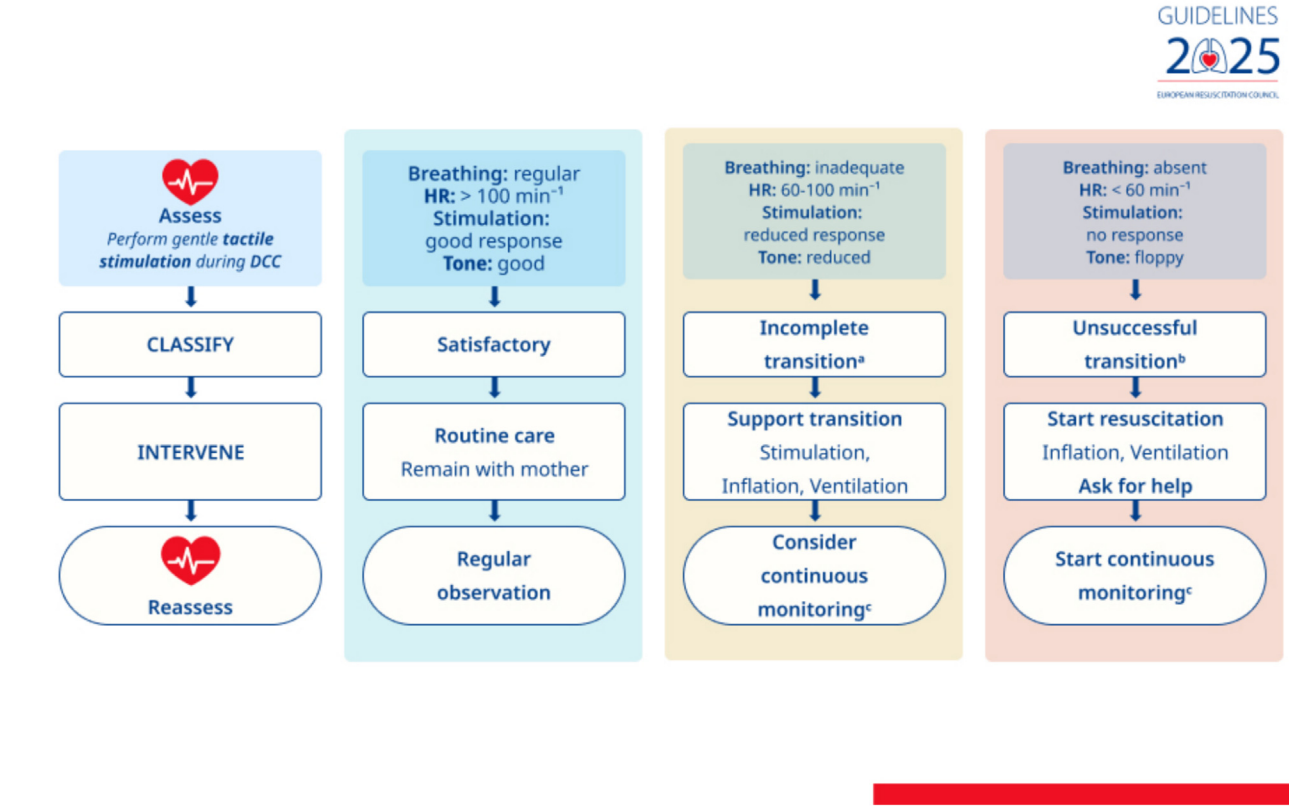

Fig. 4 – Initial assessment and interventions. DCC: delayed cord clamping; HR: heart rate; SpO2: peripheral oxygen saturation; ECG: electrocardiography. [a] Slow HR may indicate hypoxia, so airway and breathing require support. Ventilatory support will likely be adequate for a higher HR and adequate transition. [b] HR suggestive of significant hypoxia, so airway and breathing support required urgently. [c] SpO2 +/- ECG.

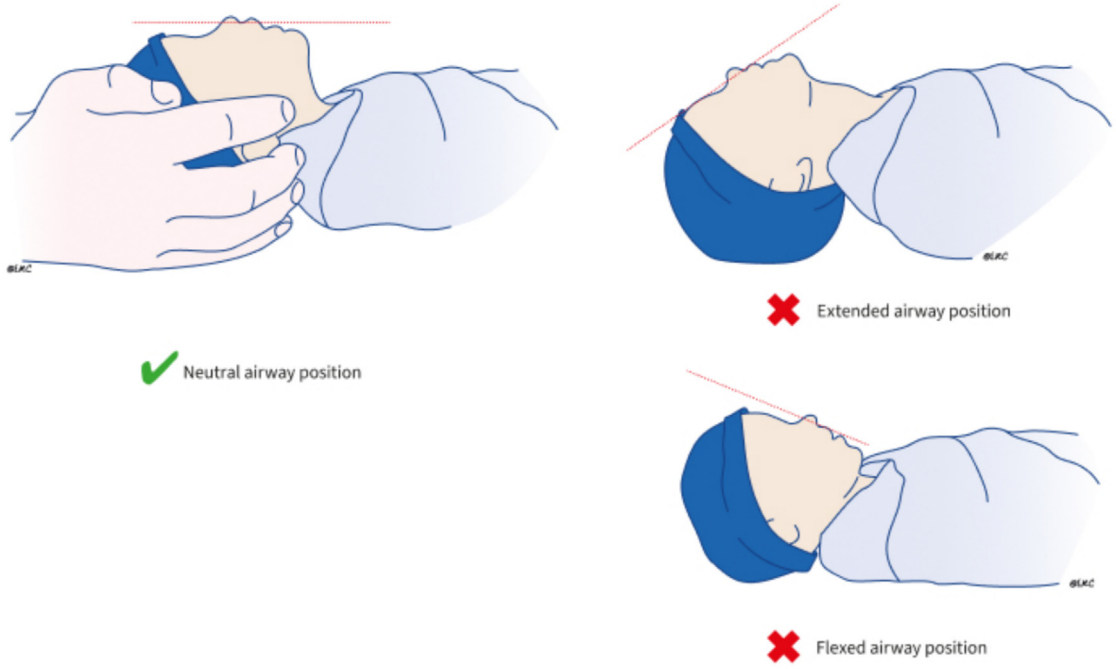

Fig. 5 – Head positions. Head needs to be in a neutral position. Face is horizontal.

- 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 (Fig. 2). These are summarised in Fig. 4.

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}.

Airway

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

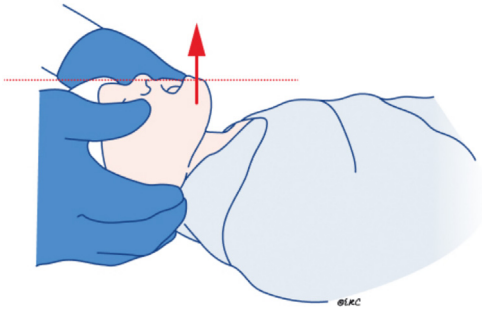

Fig. 6 – Jaw thrust. Jaw thrust = pushing the lower jaw forwards with pressure from behind, enlarges the pharyngeal space.

Position

- Place the newborn infant on their back with the head supported in a neutral position (Fig. 5).
- Gently push the lower jaw forwards with pressure from behind (jaw thrust) to open the airway (Fig. 6).

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.
  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 facemask ventilation and call for help.

Supraglottic airway devices. Consider using an appropriate size supraglottic airway device (SGA) (see manufacturer's instructions for use):

- 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 to 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 interfaces 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 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 (Table 3).

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 30 s 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 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 (CPAP) and positive end-expiratory pressure (PEEP)
- Use either nasal interface or a facemask as device-patient interface to deliver CPAP or 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.

Table 3 – Inflations, inflation pressure, positive end-expiratory pressure and initial oxygen.

GA	Inflations	PIP	PEEP	O_2
≥32 weeks	5 x up to 2–3 s	30 cm H_2O	6 cm H_2O	21 %
<32 weeks	5 x up to 2–3 s	25 cm H_2O	6 cm H_2O	≥30 %

Ventilation devices

- Use appropriately sized nasal interface or facemask.
- 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–75th percentile (Fig. 7).
- 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 30 s 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 SGA placement or tracheal intubation continue with the 3:1C:V ratio.
- Titrate O_2 against the oxygen saturation once a reliable value is achieved (Table 4)

Table 4 – Target oxygen saturation ranges. Derived from Dawson et al. 2010 and Wolfsberger et al. 2024, and consensus within the NLS WG.[10–12]

Time after birth	SpO_2 [%]
3 min	70–75
5 min	80–85
10 min	85–95

- 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 (UVC) 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 bone marrow; 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 medication may be considered where, despite adequate control of the airway, effective ventilation, and chest compression for at least 30 s, 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 mLkg^{-1} of 1:10,000 adrenaline [0.1 mg/mL])
  - 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])
  - 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 mL/kg of 10 % glucose).

Intravascular volume replacement

- Give 10 mL/kg 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 birth in a remote or lower resource setting, and 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 HCPs 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 agreed 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 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 & ventilation

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

Documentation & 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 for 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.

Evidence informing the guidelines

Newborn life support or paediatric life support?

These ERC Guidelines 2025 NLS apply mainly to newborn infants at birth and in the immediate postnatal phase, i.e. during perinatal transition. There is no clear definition of when transition ends. Thus, evidence-based recommendations on when to convert from NLS to Paediatric life support (PLS) guideline are challenging to produce.

Epidemiology

Neonatal intensive care units (NICU) often set distinct age thresholds for admitting and keeping infants. Some transfer infants to paediatric units at 44 weeks' postmenstrual age,[13] whereas other NICUs transfer infants as late as 24 months.[14] Moreover, some NICUs operate separately from birthing hospitals, affecting the patient case-mix. Thus, the incidence of NICU resuscitation with chest compressions and/or adrenaline varies between 0.25 % and 1–2 % of infants,[15–18] and a significant proportion of CPR events in paediatric intensive care units (PICUs) is in infants <1 year of age.[19] Most NICU arrests are respiratory in origin,[17,18] with more respiratory-related instances including tracheal tube and airway complications in NICU resuscitation events compared with PICU/cardiac intensive care unit resuscitation events.[20] Pulseless electrical activity or asystole occurs in 13 % of NICU resuscitation events, while ventricular tachycardia or fibrillation incidents are rare in NICUs.[21]

Differences between NLS and PLS guidelines

Neonatal resuscitation guidelines prioritise ventilation to stabilise bradycardic or asystolic newborns.[9] Paediatric resuscitation guidelines emphasise chest compressions while managing ventilation carefully to prevent overventilation by the HCP.[22] The two Guidelines also diverge in areas such as thermal care for different maturity of newborns, synchronisation of breaths with compressions after tracheal intubation, and use of medications and adjunctive methods.[23] Unlike paediatric guidelines, neonatal guidelines omit management strategies for (septic) shock and arrhythmias other than bradycardia/asystole, leaving out rhythm evaluation and defibrillation.

Evidence informing the transition from NLS to PLS

Several approaches on the use of NLS or PLS have been suggested or are used, such as location-based, age-based, patient-based or provider-based approaches.[23] A location-based approach would be to take education and training implications into consideration by choosing guidelines based on location (e.g., NICU or PICU). Observational studies that found differences in outcomes after PICU versus NICU CPR events did not account for prematurity and low birth weight in infants in the NICU.[24] The presence of fluid-filled lungs only during immediate perinatal transition may provide a rationale for changing from the neonatal to paediatric resuscitation guideline using a time-based approach. For example, after the first 24 h of life,[23,25] or at 44 weeks postmenstrual age as a cut-off point. A patient-oriented approach may be to focus on the pathophysiology of the bradycardia or arrest, as in cases of congenital and acquired heart disease.[26] A provider-based approach may have many similarities with a location-based approach, but if HCP are trained in both NLS and PLS they can apply both.

In the absence of evidence, an approach to education and training tailored towards the decision to use one or both guideli-

nes based on individual unit case-mix and epidemiology of cardiac arrests may be reasonable. The ERC recommends creation of local policies applicable to the healthcare setting (good practice statement).

The most preterm infants at the limits of viability

Survival and outcomes of preterm infants continue to improve, especially for those born at extremely low gestational age (GA).[27] Following recently changed guidance concerning the initial stabilisation of the most preterm infants, i.e. those born below 25 weeks,[28,29] these infants are now increasingly being offered survival-oriented care.[30–32] However historically, trials in neonatal medicine have, almost without exception, excluded the most preterm infants.[33]

Consequently, the ERC NLS Writing Group cautions that recommendations given in the ERC Guidelines 2025 NLS are based on evidence from studies of higher GA infants and any extrapolation of such evidence to the most preterm infants will not fully take into account their distinct physiology and response to treatment.[34]

Implementation

The Utstein formula for survival identifies resuscitation science, efficient education and local implementation as key factors influencing outcomes.[35] To aid health care professionals, hospitals and policymakers in improving local implementation, a ten steps consensus based framework has been published recently.[36]

Factors before birth

Perinatal transition

Survival at birth involves major physiological changes during perinatal transition from fetal to newborn life. First, lung liquid-clearance and aeration need to occur after which pulmonary gas exchange can be established.[37] Most newborn infants transition smoothly, but some have problems with transition and without timely and adequate support might need resuscitation.[38–41] Approximately 11 % of all newborns receive interventions with large variation between hospitals (1.4–38.1 %).[42] Newborn infants born via caesarean section receive an intervention (19.6 %) more often than vaginally born infants (5.9 %), with most common interventions being CPAP (7 %), O_2 supplementation (8 %), suctioning (6 %) and non-invasive ventilation (4 %).[42] Less common interventions include tracheal intubation (1 %), cardiac compressions (0.1 %) adrenaline administration (0.1 %), intraosseous access (0.01 %) and SGA insertion (0.01 %).[42] Intervention frequencies varied considerably between hospitals and countries.[42] In preterm infants, the need for respiratory support is higher, with almost all infants born with a GA < 30 weeks receiving CPAP and/or positive pressure ventilation (PPV).[42]

Risk factors

Several maternal and fetal prenatal and intrapartum factors increase the risk for compromised transition and the need for resuscitation. A recent multicentre survey and an ILCOR evidence update confirm previously identified risk factors for needing assistance after birth.[42,43] There is no universally applicable model to predict risk for resuscitation or need of support during transition, and the list of risk factors in the guidelines is not exhaustive. Elective caesarean delivery at term, in the absence of other risk factors, does not increase the risk of needing newborn resuscitation.[44,45]

In accordance with the unchanged ILCOR recommendation, the ERC recommends that when an infant is delivered at term by caesarean section under regional anaesthesia an HCP capable of performing an initial assessment and assisted ventilation should be present at the birth. It is not necessary for a provider skilled in neonatal intubation to be present at that delivery.[43]

Staff attending births in hospitals

It is not always possible to predict the need for stabilisation or resuscitation before an infant is born. Therefore, the ERC recommends that those in attendance at birth need to be able to undertake initial resuscitation steps effectively. The experience of the team and their ability to respond in a timely manner can improve outcomes of term[46] and preterm infants.[47–49] It is essential that resuscitation teams can respond rapidly if not present from the beginning. In a simulation-based study on term neonatal resuscitation a significant increase in workload was demonstrated in 2-person teams compared to 3-person teams.[50] The ERC advises a process should be in place for rapidly mobilising extra HCPs with appropriate resuscitation skills.

Telemedicine

In hospitals with low birth rates, it can be difficult for staff to maintain neonatal resuscitation skills.[51–53] Video telemedicine may help address these challenges by providing immediate access to neonatal specialists, allowing a neonatologist to virtually assist with neonatal resuscitation at remote locations, which ultimately might improve patient outcomes.[54–57] Limited observational data suggests that video telemedicine may improve the quality of neonatal resuscitation and reduce the need for neonatal transfers and can be introduced without significant adverse effects.[54,58–62]

The ERC recommends that where the technology is available and/or access to a neonatologist is not immediately available, telemedicine use is considered.

Equipment and environment

Suggestions have been made on standardising an optimal layout of a resuscitation area,[63] but no published evidence has demonstrated improvement in patient outcome due to specific arrangements. However, some studies suggest a reduced retrieval time for emergency materials when organized according to specific frameworks such as the ABC protocol (airway, breathing, circulation),[64] task-based package approach,[65] or with a focus on emergency supplies or airway management.[49]

Briefing, debriefing & checklists

Briefing with role allocation and the use of checklists improve team functioning and communication and are suggested.[66,67] Evidence on the isolated impact of briefing on patient outcomes is challenging, as it is typically implemented within quality improvement bundles. However, an ILCOR scoping review (2021) on the effect of briefing and debriefing on the outcome of neonatal resuscitation concluded that 'improvements in the process of care (...), short term clinical outcomes and a reduction in communication problems' were associated with briefing and debriefing.[68,69] The use of checklists during briefings and debriefings may help improve team communication and process, but there is little evidence of effect on clinical outcomes.[70,71] The ERC recommends (de)briefing the team present at birth and suggests the use of cognitive aids.

Education

For an in-depth discussion on resuscitation education principles, see ERC Guidelines 2025 Education for Resuscitation. Research on educa-

tional methods in neonatal resuscitation is evolving, but due to study heterogeneity with non-standardised outcome measures, there is still little evidence on the effect of different educational modalities on clinical outcome.[72–74] Nevertheless, available studies on the clinical impact of neonatal resuscitation education are summarised in Table 5.

Frequency of training

Infrequent neonatal resuscitation training and rare clinical exposure lead to skills decay. Two observational studies using video analysis found that annual training may be insufficient,[85] as skills deteriorate within 3–6 months, highlighting the benefits of high-frequency, short-duration sessions.[40,86] After NLS courses significant knowledge and skill decay was found within three months, with technical skills declining faster than knowledge.[87] Another study focusing on neonatal ventilation skills, found that airway patency requires training every 4.5 months, and face-mask seal every 1.5 months.[85] The ERC recommends training at a minimum interval of 12 months, preferably supplemented with more frequent short booster sessions every 3–6 months.

Technical skills, behavioural skills and self-efficacy

Optimal newborn life support requires neonatal providers to possess not only technical expertise but also behavioural skills, including team collaboration competences, crisis resource management, and personal resilience.[88,89] A 2021 ILCOR systematic review about training of team competences in resuscitation found improved skills performance during clinical resuscitation and suggests its inclusion in basic and advanced life support courses.[5,90] Providers need strong confidence to perform NLS optimally, initiate and persist in resuscitation, and stay resilient under pressure.[91–93] Confidence can be achieved, among others, through practice and reflection, and observational learning, where participants are motivated to attain a similar level of performance as they observed in their peers.[91,94,95] The ERC recommends incorporating team collaboration competencies in newborn life support training.

System training

In situ neonatal simulation training is highly effective not only for training in human factors and teamwork, it also enables adaptation of team composition, the environment and equipment to create ideal circumstances for newborn resuscitation performance.[96–99] Simulation training may also be used to rigorously test new neonatal environments or procedures. The ERC recommends that simulation training forms part of resuscitation training.

Thermal control

The World Health Organization recommends keeping newborn temperatures between 36.5 °C and 37.5 °C.[100] Exposed, wet newborn infants cannot maintain their body temperature in a room that feels comfortably warm for adults. The mechanisms (convection, conduction, radiation, evaporation) and effects of hypothermia and how to avoid these have been reviewed elsewhere.[101,102]

Hypothermia may impair respiratory function, lower the arterial oxygen tension, cause elevated pulmonary vascular resistance, and increase the risk of metabolic acidosis, hypoglycaemia, and bradycardia.[101] Two recent systematic reviews showed associations between admission hypothermia and various morbidities (intraventricular haemorrhage, bronchopulmonary dysplasia, sepsis, retinopathy of prematurity) and mortality in very low birthweight infants (<1500 g) and very preterm infants, respectively.[103,104]

As the admission temperature of non-asphyxiated infants is associated with morbidity and mortality at all gestations and in all settings,[5,105,106] the ERC recommends recording temperature as both a predictor of outcome and a quality indicator.[9] A recent systematic review and network meta-analysis showed that (the combination of) plastic bags/wraps, plastic caps, thermal mattress, and heated humidified gases in the delivery room reduced major brain injury and mortality in preterm infants.[107] The ERC recommends that as a minimum, plastic bags/wraps and hats are used in preterm infants at birth, and where available heated humidified gases are also used at the earliest opportunity in preterm infants.

To align recommendations across the ERC Guideline 2025 NLS, we use 32 weeks as a pragmatic cut-off in our recommendations.

Temperature monitoring

Temperature monitoring is key to avoiding hypothermia. However, there is very little evidence to guide the optimal placement of temperature monitoring probes on the infant. In a study of 122 preterm infants (28–36 weeks) randomised to different sites for temperature monitoring, dorsal, thoracic, and axillary sited probes all had comparable temperature measurements.[108] There are no published studies comparing the use of rectal temperature probes. The ILCOR NLS Task Force does not specify the site where the temperature should be determined.[43,109,110]

In infants <1500 g immediately after birth, servo-controlled thermoregulation did not improve admission normothermia compared with using a radiant warmer in manual mode.[111] ILCOR stated that there is insufficient published human evidence to suggest for or against the use of a radiant warmer in servo-controlled mode compared with manual mode in infants <34 weeks directly after birth.[112] In newborns who are unintentionally hypothermic after birth, ILCOR concluded that there is insufficient evidence to recommend either a rapid (≥0.5 °C/hour) or slow (<0.5 °C/hour) rewarming rate.[113]

The ERC recommends that all newborn infants undergoing resuscitation and all preterm infants undergoing support of transition have their temperature monitored frequently or continuously during resuscitation until stabilisation.

Hyperthermia

Hyperthermia (≥38.0 °C) should be avoided, because it is associated with adverse effects.[9] Infants born to febrile mothers have a higher incidence of perinatal respiratory compromise, neonatal seizures, early mortality, and cerebral palsy.[114–116] Animal studies indicate that hyperthermia during or following ischaemia is associated with a progression of cerebral injury.[116]

Term and near-term infants ≥34 weeks

ILCOR treatment recommendation[110,117] suggests a room temperature of 23–25 °C in infants ≥34 weeks.[110,117] If support of transition or resuscitation is not required, immediate skin-to-skin care is good practice to maintain normothermia. A Cochrane review involving 46 trials and 3850 dyads of mothers with their (predominantly healthy term and some late preterm) newborns concluded that skin-to-skin contact may be effective in maintaining thermal stability and improve maternal bonding and breast-feeding rates.[118] Aligning with ILCOR, the ERC recommends skin to skin care, and in the situation where skin to skin care is not possible, and resuscitation is not required, to consider the use of plastic bags/wraps among other measures.

Table 5 – Summary of studies on effect of NLS training.

Reference	Study design	Setting	Intervention	Sample size	Results
Agudelo-Pérez (2022)[80]	Review 11 studies with NWKM level IV, all HBB studies; 8 pre-post intervention, 2 prospective cohort studies, 1 clinical trial;	LMIC	One-day trainings (HBB) in various intervals	n = 412,741 newborns	↓ overall neonatal mortality ↓ intrapartum stillbirth ↓ 1d-mortality
Bayoumi (2022)[75]	Pre-post intervention; 1 level III unit (18000/a births)	HIC	5 in-situ simulation trainings and 27 workshops in post-era (2016–2021)	n = 799 in courses, n = 1,199 newborns, n = 326 intubations	↑ success rate LISA ↓ duration of intubation
Bhatia (2021)[76]	Pre-Post intervention; tertiary unit with 3 sites (9000/a births), multidisciplinary	HIC	10–12 in-situ simulation workshops per year (2012–2018)	n = 445 HCW, n >40,000 newborns, n = 11,284 resuscitations	↓ perinatal mortality ↓ chest compressions, ↓ medication
Mayer (2022)[77]	Retrospective observation; 5 hospitals (2 district, 2 regional, 1 tertiary)	MIC	Annual one-day training (HBB, 2016–2020)	n = 4795 HCW, n = 123.898 newborns	↓ neonatal mortality
Mileder (2024)[72]	Pre-Post intervention; 1 level IV unit (3500/a births), multidisciplinary	HIC	41 in-situ simulation trainings in 4 months	n = 48 HCW, n = 28 resuscitations	↑ 5-minute Apgar score
Lima (2023)[83]	Pre-post intervention; 5 hospitals (secondary healthcare regions)	MIC	n = 700 training sessions in 106 NRP courses	n = 431 HCW	↓ neonatal mortality in DR
Lindhard (2021)[82]	Review 2 Studies with NWKM level IV Lebanon: pre-post intervention Mexico: pair-matched study	LMIC	Lebanon: QI with 10 ex-situ simulation workshops (22 hospitals, 3 years); Mexico: 2 simulation trainings (12 hospitals)	Lebanon: n = 256 HCW, n = 84,398 births; Mexico: n = 450 HCW;	↓ neonatal mortality, ↑ team performance
Patel (2017)[79]	Review 20 studies with NWKM level IV	LMIC	Variability in neonatal resuscitation training curricula, from basic to advanced life support	n = 1,653,805 newborns; variability in participants of the interventions	↓ neonatal mortality ↓ stillbirth mortality ↓ perinatal mortality
Schwindt (2022)[73]	Pre-Post intervention; 1 level II unit (2000/a births), multidisciplinary	HIC	11 in-situ simulation trainings in post-era (2015–2019)	n = 35 core and 200 additional HCW, n = 13,950 newborns, n = 826 resuscitations	↓ chest compressions
Vadla (2022)[78]	3-year prospective clinical observation study	LIC	High-frequency, self-guided skills training (simulator with automatic feedback)	n = 10,481	↓ time to first ventilation ↓ pauses in ventilation = neonatal mortality
Vadla (2024)[74]	Prospective observational study; 1 hospital site (3000/a births)	LIC	Annual one-day training (HBB 2nd, 2017–2021) + Low dose high frequency trainings	n = 12,983 newborns, n = 1,320 resuscitations	↓ neonatal mortality

Collected evidence from studies in neonatal settings[72–83] on the impact of simulation-based training, focusing on Kirkpatrick Level IV outcomes (clinical resuscitation outcomes) as defined by the New World Kirkpatrick Model.[84]

Abbreviations: HBB: Helping babies breathe; HCW: healthcare workers; HIC: high income country; LISA: less invasive surfactant administration; LIC: low income country; MIC: middle income country; NRP; Neonatal Resuscitation Program NWKM: new world Kirkpatrick model; PPV: positive pressure ventilation; QI: Quality improvement.

Preterm infants <34 weeks

For infants <34 weeks a room temperature of 23–25 °C is suggested.[109,112] For infants <28 weeks, room temperature should ideally be >25 °C.[101,102,119] The use of plastic bags or wraps (without drying) is advocated in infants <34 weeks. Further thermal control while using radiant warmers in the delivery area can be achieved with a combination of warmed blankets, cap, thermal mattress, heated humidified respiratory gases, and skin-to-skin care. With these interventions, both hypothermia and hyperthermia are possible and require attention.[112] Quality improvement programs, including the use of checklists, continuous feedback, and debriefing have shown to significantly reduce the incidence of hypothermia at admission in very preterm infants.[119,120]

Delivery or operating room cuddles

Following stabilisation after birth it may be possible to offer physical contact between the parents and their baby in the form of supervised skin-to-skin contact or a cuddle. Studies have considered the feasibility of a delivery room cuddle in relation to physiological variables (HR, temperature).[121,122] The effect of delivery room cuddles on thermoregulation was conflicting; with

some studies reported no difference[121–124] and others reported more hypothermia in infants who received skin to skin care after birth.[123–127] There is emerging evidence of positive effect on maternal bonding[121,128,129] and that delivery room cuddles may promote breast feeding in near term and term infants.[129] However, there is also evidence of potential risks including accidental extubation, disconnections, or apnoea.[116,119]

Current evidence is insufficient to provide a specific recommendation and there is no ILCOR evidence review on this topic. Discussing the possibility of a delivery room cuddle on an individual basis is reasonable, if the clinical team feels confident to support this. However, the practicality of offering this will not be clear until after their baby has been born. If a delivery room cuddle is impractical, encourage brief physical contact, e.g. touching their baby's hand as an alternative. Where resuscitation measures are required, this takes priority.

Umbilical cord clamping

There is no universally accepted definition of 'delayed' or 'deferred' cord clamping (DCC), only that it does not occur immediately after birth. Early or immediate cord clamping (ICC) has been defined as less then 30 s after birth, later or delayed cord clamping as >30 s after birth or when cord pulsation has ceased.[130,131] Physiological based cord clamping (PBCC) is not based on time, but on physiological parameters (i.e. when breathing has been initiated).[132,133] When possible, interventions for stabilising the infant may take place close to the mother with intact cord.[134]

The ERC recommends facilitating at least 60 s of DCC for newborn infants without need for support; and to clamp the cord <30 s to minimise delay in interventions in those in need for resuscitation. If intact cord stabilisation can be safely performed, longer DCC is preferred, especially in newborn infants <34 weeks.

Rationale: Experimental and observational studies

Although ICC was introduced as part of a package to reduce postpartum haemorrhage,[135] its impact was minimal and primarily associated with reduced birth weight.[136,137] Clamping the cord before lung inflation and the increase in pulmonary circulation has occurred results in reduced ventricular preload and increased left ventricular afterload,[138] impairing the circulation and causing hypoxia.[132,138] A second rationale for DCC is placental transfusion – blood redistribution from placenta to newborn which can account for up to 25 % of placental volume.[139,140] Gravity and uterine contractions do not drive this transfusion,[141,142] but spontaneous breathing of the infant might. Therefore, clamping should ideally be delayed until breathing has been established.[143]

Infants ≥34 weeks

A 2019 Cochrane review found that DCC compared to ICC increased birth weight, neonatal haemoglobin, and reduced iron deficiency at 3–6 months, without increasing polycythaemia.[144] A 2021 ILCOR meta-analysis of 33 trials in newborns ≥34 weeks confirmed these findings, showing no effect on mortality or need for resuscitation.[131] DCC improved early (≤24 h) and later (7 days) haematological and circulatory parameters, but had no impact on longer term anaemia, neurodevelopment, or phototherapy.[131]

Evidence on DCC in (near) term newborns needing resuscitation is limited. One study found no HR difference between cord intact resuscitation and ICC,[145] while two RCTs reported better vital parameters, higher Apgar scores, and reduced need for ventilation and/or chest compression.[146,147] Only one trial reported mortality with no difference.[147] Admission temperatures were similar across all three trials.[145–147]

Infants <34 weeks

Multiple trials have compared DCC with ICC in preterm infants. Most used DCC for 30–60 s, excluding infants needing immediate resuscitation. Studies using intact cord resuscitation applied longer clamping times. A 2021 ILCOR meta-analysis (infants <34 weeks) DCC (≥30 s) may slightly improve survival,[130] with better cardiovascular stability, less inotropic support, improved haematological indices, and fewer transfusions – without effects on prematurity complications (or adverse maternal outcomes). Subgroup analysis showed a possible positive link between survival and DCC duration.[130,148,149] A separate systematic review and individual participant data meta-analysis confirmed reduced mortality with DCC vs ICC, but no difference in morbidity or transfusion rates.[148]

A network meta-analysis comparing short (15–45 s), medium (45–120 s), and long (>120 s) cord clamping times with ICC and cord milking found the strongest survival benefit with longer delays (mortality OR 0.31, 95 % CI 0.11–0.80).[149] They concluded that for newborns requiring resuscitation/stabilisation, longer DCC is only feasible with intact umbilical cord.[149]

Three multi-centre RCTs on intact cord resuscitation have been completed. Two used fixed clamping times and one used physiological criteria. The VentFirst trial (<29 weeks) found no difference in intraventricular haemorrhage or mortality between 120 s DCC with intact cord ventilation vs DCC 30–60 s and ventilation afterwards.[150] No difference was reported in the composite outcome of death, severe intraventricular haemorrhage, and bronchopulmonary dysplasia between 3-minute intact cord resuscitation and cord milking.[151] In the ABC3 trial physiologically based cord clamping vs 30–60 s DCC showed no overall difference in intact survival, but improved outcomes in male infants and with increased intact cord resuscitation experience.[152]

Umbilical cord milking

Umbilical cord milking has been considered an alternative to DCC when DCC is not feasible.[153] In 'intact cord milking', the cord is milked 3–5 times before clamping, promoting faster blood transfer. In 'cut cord milking', a ~25 cm cord segment is milked after clamping, usually during resuscitation.[153] Experimental studies show intact cord milking causes significant fluctuations in cerebral blood flow.[154,155] A large clinical trial in preterm infants was stopped early due to increased risk of severe intraventricular haemorrhage in the <28 weeks GA subgroup who were randomised to umbilical cord milking.[156] Meta-analyses in preterm infants showed no differences in mortality or morbidity.[148,149] Umbilical cord milking reduced transfusion need compared to ICC, but to DCC. A recent cluster RCT in 1730 non-vigorous infants ≥35 weeks found no difference in mortality or NICU admission between intact cord milking and ICC.[157] The reported reduction in moderate-to-severe hypoxic ischemic encephalopathy (HIE) (RR 0.49, 95 % CI: 0.25–0.97) was based on unadjusted data and may reflect later clamping. The ERC recommends that for all infants the focus should be on DCC instead of umbilical cord milking. The ERC recommends avoiding cord milking in infants <28 weeks, acknowledging that intact cord milking is an alternative to DCC in infants ≥28 weeks, only if DCC cannot be performed.

Initial assessment

Breathing

Not crying may be due to apnoea and can function as a marker of inadequate breathing needing support.[158] In an observational study of almost 20,000 infants (>22 weeks GA) just after birth in a rural hospital setting, 11 % were not crying, around half of whom were assessed as

apnoeic. About 10 % of those assessed as breathing at birth became apnoeic. Breathing without crying compared to breathing and crying was associated with a 12-fold increase in morbidity.[158] The presence or adequacy of breathing effort in preterm infants can be difficult to assess as breathing can be very subtle and is often missed.[159,160] When breathing was perceived as inadequate infants were more likely to receive interventions.[161,162] The ERC recommends assessing rate, depth, symmetry and work of breathing.

Heart rate

HR is the most sensitive indicator of a successful response to resuscitation interventions.[145,163,164] There is no published evidence clearly defining the thresholds for intervention during newborn resuscitation. Historically, heart rates of >100 min^{-1} were pragmatically selected as reassuring and <60 min^{-1} as prompting interventions.[165] A 2023 ILCOR review found no new evidence on alternative HR thresholds.[166] In uncompromised breathing term infants undergoing DCC, the HR is usually above 100 min^{-1}.[164] In an observational study in resuscitated term/near-term infants, initial HRs at birth were distributed showing bimodal peaks around 60 and 165 min^{-1}.[167] In preterm infants <30 weeks the HR did not stabilise until it reaches approximately 120 min^{-1} and, in some, stability was only achieved once the HR was >150 min^{-1}.[168] A recent study in extremely or very preterm neonates with favourable outcome established that the 10th percentile of HR at 2, 5, 10, and 15 min after birth were 70, 109, 126, and 134 min^{-1} respectively, indicating varying expected HR values during the immediate postnatal transition period.[11]

Heart rate assessment. The main methods of HR assessment are auscultation, pulse oximeter, and ECG. The advantages and disadvantages of these are summarised in Table 6. Most studies excluded newborns who were bradycardic at birth, required resuscitation or were very preterm infants, which limits applicability of study results.[5,169,170] Auscultation by stethoscope is simple and enables rapid assessment of HR in any setting, including low resource settings (ERC practice statement). The 2024 ILCOR review suggests that if resources allow, ECG to continuously assess HR is reasonable, with pulse oximeter and auscultation as alternatives.[169,170] It is currently unclear if speed/precision of HR assessment at birth is associated with clinically important differences in interventions, performance or outcomes.[169,170] There is insufficient evidence to recommend the use of digital stethoscopes, Doppler ultrasound, dry electrode technology or other techniques to assess HR at birth.[169,170] The ERC recommendations align with ILCOR. Initial HR assessment can be done by auscultation; continuous HR assessment through ECG or pulse oximetry are recommended with ongoing resuscitation.

Tactile stimulation

ILCOR systematic reviews on both cord management and tactile stimulation suggest tactile stimulation immediately after birth in infants with inadequate breathing efforts, regardless of method of umbilical cord management.[161,183,184] Tactile stimulation should not delay the initiation of breathing support if required. The optimal type and length of tactile stimulation as well as differences in different gestational ages is unknown.[184] An RCT in a preterm population reported that repetitive stimulation improved oxygen saturations and reduced need for supplemental inspired oxygen.[185] Data from an observational study shows that tactile stimulation at birth is associated with more spontaneous breathing, especially if the cord was still intact.[158] The ERC recommends performing tactile stimulation on all newborn infants at birth, especially if breathing is inadequate, but it must not delay initiation of breathing support if required.

Colour

Healthy infants are cyanosed at birth, reflecting lower *in utero* saturations, but this improves within approximately 30 s of the onset of effective breathing.[160] Peripheral cyanosis is common and does not, by itself, indicate hypoxia. Persistent pallor despite ventilation may indicate significant acidosis, or, more rarely, hypovolaemia with intense cutaneous vascular vasoconstriction. Colour is an unreliable marker of oxygenation, and it should not be used to judge oxygenation.[186] The ERC recommends using pulse oximetry to measure oxygen saturations in preference to using colour as a proxy for oxygenation.

Airway

Airway obstruction is most commonly caused by suboptimal airway positioning, lack of pharyngeal tone, and adducted vocal cords, especially in preterm newborns.[187,188] There is no evidence that normal lung fluid and secretions cause obstruction.[189] In line with ILCOR, the ERC recommendation is not to routinely suction clear fluid from the oropharynx.

Position

With flexion and extension of the neck, the newborn airway can easily become occluded.[190] Evidence on the mechanisms of airway occlusion in the newborn is limited. A retrospective analysis of images of the airway of 53 sedated infants between 0–4 months undergoing cranial MRI indicates how, in extension, obstruction might occur through anterior displacement of the posterior airway at the level of the tongue.[191] Video review of airway position and airway obstruction also found hyperextension of the neck is associated with airway obstruction.[192] Therefore, the ERC recommends a neutral head position to ensure optimal airway patency in newborn infants.

Jaw thrust and two-person method

Studies in children demonstrate that anterior displacement of the mandible enlarges the pharyngeal space through lifting the epiglottis away from the posterior pharyngeal wall, reversing the narrowing of the laryngeal inlet.[193] Two-person manual ventilation techniques are superior to single handed airway support: it reduces facemask leak and is more effective,[190,194–196] which is recommended by the ERC.

Preterm newborns

Vocal cord adduction is a cause of airway obstruction at birth in preterm infants <30 weeks.[188] In an observational study of 56 preterm infants <32 weeks significant facemask leak (>75 %) and/or obstruction to inspiratory flow (75 %) were identified using respiratory function monitoring in 73 % of interventions during the first 2 min of PPV.[197] In an animal model of premature birth, phase contrast X-rays demonstrated that the larynx and epiglottis were predominantly closed (adducted) in those with un-aerated lungs and unstable breathing patterns, making intermittent PPV ineffective unless there was an inspiratory breath, and only opening once the lungs were inflated.[187] This may be an explanation for the challenges in inflating preterm infant lungs, but a solution for overcoming these phenomena is not yet known.

Table 6 – Heart rate assessment.

Method of HR assessment	Continuous HR monitoring?	Advantages	Disadvantages	Recommendations
Auscultation with stethoscope	No	Rapid assessment Cheap Simple Readily available in all settings	Intermittent HR monitoring Less reliable compared to other HR methods	Auscultation might be used for quick first assessment Auscultation reasonable alternative for HR assessment Auscultation (+/- pulse oximetry) should be used if ECG is unavailable, malfunctioning or PEA is suspected
Pulse Oximetry *Ideally placed on the right hand or wrist.*	Yes	Continuous HR monitoring Provides a measure of oxygenation and perfusion	May underestimate HR as ECG in first 2–5 mins Interference in values caused by: o Signal dropout o Movement o Hypoperfusion o Lighting Potential cost implication	Unclear whether connecting sensor to infant first or to the pulse oximetry first confers advantage
Electrocardiogram (ECG)	Yes	Continuous HR monitoring Faster and more accurate than pulse oximetry	May indicate a HR in absence of cardiac output May adhere poorly to infants with vernix Potential cost implication	Use of ECG is reasonable to assess HR after birth ERC recommends ECG should not replace pulse oximetry for further treatment, but used in addition

Sources for Table 6: [16,169–181,182]

Abbreviations: HR: heart rate; ECG: electrocardiogram; PEA: pulseless electrical activity.

Suctioning

Routine oropharyngeal and nasopharyngeal suctioning in newborn infants has not been shown to improve respiratory function, may delay other necessary manoeuvres and the onset of spontaneous breathing and is associated with adverse events.[198–202]

The ERC, following ILCOR, does not recommend routine intrapartum oropharyngeal and nasopharyngeal suctioning for newborn infants with clear or meconium-stained amniotic fluid.[189] If suctioning is attempted, in order to clear a presumed blocked airway, it should be undertaken under direct vision, ideally using a laryngoscope and a wide-bore catheter or Yankauer sucker. Bulb suctioning can be useful if no vacuum source is available. A meconium aspirator, attached to a tracheal tube, can clear thick material from the trachea, applied suctioning should not exceed 150 mmHg (20 kPa).[203,204]

Meconium

Lightly meconium-stained liquor is common and usually does not cause difficulty with transition. Non-vigorous newborns delivered through meconium-stained amniotic fluid are at significant risk for requiring advanced resuscitation and a neonatal team competent in advanced resuscitation may be required. Routine suctioning of non-vigorous infants can delay initiating ventilation and there is no evidence to support intrapartum suctioning nor routine tracheal intubation and suctioning of vigorous infants born through meconium-stained liquor.[205–207] Evidence from retrospective registry-based studies,[208,209] meta-analyses,[210–212] a post policy change impact analysis,[213] and ILCOR 2025[6] all support omitting suctioning in favour of immediate ventilation.

The ERC recommends against routine suctioning of either pharynx or trachea in newborn infants born through meconium –stained liquor and recommend providing standard NLS. If there is evidence of airway obstruction, the ERC recommends suctioning under direct vision in the first instance. Rarely, airway obstruction may occur below the level of the larynx, and this may require tracheal suctioning.

Airway devices

Supraglottic airway devices (SGA). SGAs are effective in newborns, particularly if facemask ventilation or tracheal intubation is unsuccessful or not feasible.[5] A systematic review showed that PPV with SGAs was more effective than bag-facemask ventilation in terms of shorter resuscitation and shorter duration of ventilation with less need for tracheal intubation.[214] Bag-facemask ventilation was effective in more than 80 % of enrolled infants. Efficacy of an SGA was comparable to tracheal intubation.

Aligned with ILCOR, ERC recommends using an SGA as a valid alternate airway device, particularly if tracheal intubation is unsuccessful or intubation skills are unavailable.[5,6]

Studies generally included infants with birth weight >1500 g or GA≥ 34 weeks, so evidence supporting SGAs in more premature infants is limited.[214,215] A 2024 Cochrane update found no or little difference in neonatal morbidities and mortality when giving surfactant via an SGA compared with a tracheal tube.[216] The SGA has not been evaluated in the setting of meconium-stained fluid, during chest compressions, or for the administration of emergency intra-tracheal medications. ILCOR considers it reasonable to use an SGA during chest compressions if tracheal intubation is not possible/unsuccessful (good practice statement)[6] and the ERC aligns with this.

Oropharyngeal airway. Although the oropharyngeal airway is effective in children,[217] there is no published evidence demonstrating effectiveness in maintaining airway patency at birth. In an RCT of 137 preterm newborns where gas flow through a facemask was measured, obstructed inflations were more common in the oropharyngeal compared to control group.[218] However, by helping lift the tongue and preventing it occluding the laryngeal opening, an oropharyngeal airway may facilitate airway support where difficulty is experienced and where other airway opening techniques, like jaw thrust, fail to improve ventilation.

Nasopharyngeal airway. A nasopharyngeal airway may help establish an airway where there is congenital upper airway abnormality[219] and has been used successfully in preterm infants at birth.[159,217–219]

Tracheal tube. Safe tracheal intubation is facilitated by well-trained clinicians with appropriate equipment, and the use of an intubation checklist.[220] Tracheal tube insertion depth and internal diameter can be estimated from birth weight or gestational age.[221–225] Neither provide a perfect estimate but weight might be slightly more accurate than GA.[224] Rules of thumb are less accurate in the youngest and smallest newborns.[224,225] Therefore, once insertion, confirmation of tracheal tube position by clinical assessment, appropriate imaging and the use of exhaled CO_2 detection is required.[226] Contingency plans should be made for an unexpectedly difficult airway. Declining intubation skills mean unsuccessful intubation is more common and safe airway management around intubation attempts is vital (Table 7).[227,228]

Video laryngoscopy. A 2024 ILCOR systematic review of video laryngoscopy versus direct laryngoscopy[229,230] found higher overall intubation success rates and higher first attempt success rates using a video laryngoscopy compared to a direct laryngoscope. These findings are confirmed by a 2025 systematic review.[231]

Where resources and training allow, the ERC recommends using a VL to intubate newborn infants, especially in settings where less experienced staff are intubating. Direct laryngoscopy remains a reasonable option, and such a laryngoscope should be available as a backup device.

Exhaled CO_2

Detection of exhaled CO_2 alongside clinical assessment is used to confirm tube placement in the trachea in newborn infants, even from >400 g.[9,232–235] Failure to detect exhaled CO_2 strongly suggests tube misplacement – no trace, wrong place.[233,236] However, studies relating to exhaled CO_2 have mostly excluded infants in need of extensive resuscitation. False negative CO_2 detection can occur in cases of poor or absent pulmonary blood flow, tracheal obstruction, low or absent cardiac output in resuscitation at birth and in birthweight <1500 g.[234,236] Where there is no CO_2 detection after tracheal intubation, tracheal tube position should be rechecked by VL or direct laryngoscopy by the most skilled person present as soon as possible to avoid unnecessary tracheal tube removal.

Like ILCOR,[235] the ERC recommends using exhaled CO2 detection combined with clinical assessment, to confirm tracheal tube placement.

Both qualitative (colorimetric) and quantitative (waveform) CO_2 detection methods have been successfully used in intubated newborn infants.[237] Colorimetric detection offers a simple, easy to use, cheap device where a colour change indicates exhaled CO2. Waveform detection provides a continuous graphical and numerical representation of exhaled CO2 throughout the respiratory cycle, allowing for continuous monitoring, but requires specialised equipment and power sources may not be readily available in all delivery area settings. Colorimetric detection failed to detect correct tube placement in one-third of delivery area intubation in very preterm infants in one study.[238] Although waveform capnography is more sensitive in adults, limited newborn data advise caution, especially if being used during resuscitation.[239–241]

Table 7 – Approximate tracheal tube size and lengths for oral and nasal intubation.[221–223]

Birthweight (grams)	Gestation (weeks)	Internal diameter (mm)	Oral intubation length (cm)	Nasal intubation length (cm)
500	23–24	2.5	6.0	7.0
750	25–26	2.5	6.5	7.5
1000	27–29	2.5	7.0	8.0
1250	30–32	2.5	7.5	8.5
1500	30–32	2.5/3.0	7.5	8.5
1750	33–34	2.5/3.0	8.0	9.0
2000	35–36	3.0	8.5	9.5
2500	36–37	3.0	9.0	10.0
3000	37–39	3.0/3.5	9.5	10.5
3500	39–41	3.5	10.0	11.0
4000	41–43	3.5	10.5	11.5

The ERC cannot recommend one method over the other.

Exhaled CO_2 can be used in non-intubated patients.[242–245] Exhaled CO_2 detector use with interfaces such as SGAs are standard in adult patients, but as newborn physiology differs markedly from that of older children and adults, practices of proven benefit for older patients may not apply to neonatal patients, especially during perinatal transition.

The ERC currrently cannot recommend the routine use of exhaled CO2 detection in non-intubated newborn infants in the delivery area.

Respiratory flow monitoring

Flow monitoring via a respiratory function monitor was reported in an RCT to confirm tracheal tube position faster and more reliably that end-tidal CO_2 detection, suggesting it may be used as an additional measure to assess correct tube or SGA placement.[246,247] One study reported higher quality of PPV at birth with less excessive tidal volumes and less leak when respiratory function monitoring was used.[248] However, an ILCOR systematic review[249] and a 2025 evidence update[6] found insufficient evidence to recommend for or against the routine use of respiratory function monitoring to guide PPV at birth, and ERC recommendations align with ILCOR.

Breathing

Initial inflations and assisted ventilation

Lung inflation must begin without delay in apnoeic or inadequately breathing newborn infants. An observational study in low-resource settings found a 16 % increase in morbidity/mortality for every 30 s delay in starting ventilation.[250] Optimal inflation pressure, inspiratory and expiratory times, and duration of PPV remain uncertain.

Facemask

Facemask ventilation is limited by leaks, often caused by poor facemask fit or suboptimal technique, both of which contribute to facemask leak which can be improved after training.[195,251] A clinical study demonstrated obstruction and/or leak >75 %) during initial ventilations in preterm infants.[197] An observational study in preterm infants <32 weeks suggested that the application of a facemask to support breathing might induce apnoea by triggering the trigeminocardiac reflex in spontaneously breathing infants. However, the significance of this is currently unclear.[252]

Nasal interfaces

While facemasks are most commonly used, nasal interfaces (single or binasal short or long prongs or nasal masks) have been found to be as effective as facemasks.[253,254] Emerging studies suggest nasal interfaces also reduce delivery room intubation and PPV use in infants <28 weeks).[255,256,257] The ERC recommends performing PPV using either a facemask or nasal interfaces.

Inflation duration

Initial inflations or spontaneous breathing establish functional residual capacity (FRC).[258,259] There is ongoing debate about the optimal inflation duration.[260–268] This should not be confused with sustained inflations (i.e. inflations $\geq$5 s), which are not recommended by ILCOR or the ERC.[9,43] Previous ERC guidance recommended (up to) 2–3 s inflations,[9] while other NLS guidelines around the world support shorter durations of inflations ($\sim$1 s).[12,269] Available evidence shows no clear advantage nor disadvantage of longer (2–3 s) over shorter ($\sim$1 s) inflations.[12,268,270,271]

As a HR response may not be seen until at least 20 s of PPV in bradycardic infants,[272,273] the number of inflations should vary depending on the length of inflation. Although there is no evidence to suggest superiority nor inferiority of 2–3 s over 1 s inflations, since the ERC has recommended inflation times of or up to 2–3 s since inception, this approach is used in NLS courses throughout Europe. Therefore, the ERC continues to recommend 5 inflations of up to 2–3 s based on pragmatic consensus.

Inflation pressure

Inflation pressures of 30 cm H_2O are usually sufficient to inflate the fluid-filled lungs of apnoeic term infants, based on historical cohort studies.[259,274,275] However, a prospective cohort study of 821 term and near-term infants resuscitated using bag-facemask ventilation found median peak pressures of 36 cmH_2O required for successful stabilisation.[276] For preterm infants, an initial inflation pressure of 25 cmH_2O is considered reasonable,[263,277–279] though higher pressures may be needed due to greater airway resistance. If no chest movement is observed, the ERC recommends increasing inflation pressures, regardless of GA, to achieve lung inflation.

Ventilation rate

Evidence on the optimal ventilation rate for newborn resuscitation is limited. In an observational study of 434 late preterm and term infants, ventilation at 30 breaths min^{-1} achieved adequate tidal volumes without hypocarbia, with the best CO_2 clearance at 10–14 mL/kg.[280] An observational study suggest that PPV rates >60 min^{-1} compared to rates <60 min^{-1} fail to achieve adequate tidal volumes.[281] Other studies suggest optimum rates for PPV are 30–40 min^{-1}.[259,274] The ERC recommends PPV rate of 30–40 min^{-1} once lungs have been inflated.

Effectiveness of inflations

The primary sign of adequate lung inflation is a rapid HR increase, usually within 20–30 s of onset of effective ventilations.[163,282,283] Chest wall movement usually indicates lung inflation, although this may be less obvious in preterm infants.[284] Excessive chest movements may indicate excessive tidal volumes, which should be avoided. If HR improves but breathing remains inadequate, PPV must continue.

Failure of the HR to increase is most often due to suboptimal airway control or inadequate ventilation.[195,251,285] Adjustments to head/airway position,[190] choosing alternative airway opening techniques, or increased inflation pressures may be needed.[276] In preterm infants, facemask pressure, glottal closure, or triggering the trigeminocardic reflex may impair PPV.[187,197,286,287] Although exhaled CO_2 monitoring can sometimes detect such obstructions and facemask leaks, current evidence is insufficient to recommend its routine use to assess quality of PPV.[245]

Sustained inflations >5 s

Animal studies suggested longer inflations may have physiological benefits,[288,289] but clinical benefits in human infants have not been demonstrated. In preterm infants, there is evidence of possible harm from sustained inflation >5 s.[290] A Cochrane systematic review found that sustained inflations (15–20 s) were not better than intermittent ventilation ($\leq$ 1 s) for reducing mortality, intubation, need for respiratory support or bronchopulmonary dysplasia.[291] An ILCOR review advises against routine use of sustained inflations >5 s in preterm infants receiving PPV at birth, due to a possible increase in mortality

in infants <28 weeks. ([266,268] ILCOR did not recommend a specific inflation duration for late preterm and term infants due to low-confidence in the estimates of the effect. The ERC guidance aligns with ILCOR and recommends against sustained inflations >5 s in preterm infants.

CPAP and PEEP

Successful respiratory transition at birth relies on alveolar aeration, lung inflation, and formation of FRC.[292] Most premature infants can breathe at birth but often struggle to obtain and maintain FRC.[293,294] (251) The need for respiratory support at birth is inversely correlated to GA.[295,296] Animal studies show that a few early inflations at high tidal volumes can cause lung injury and inactivate surfactant.[297,298] Preclinical studies demonstrated that applying CPAP or PEEP immediately after birth assists lung inflation.[299] Unlike CPAP, PEEP is only present during exhalation and is applied during manual or mechanical ventilation.[300] While other non-invasive respiratory supports are under investigation, CPAP remains the gold-standard for newborn infants <32 weeks.[301]

CPAP for infants <32 weeks. Large RCTs show that starting CPAP at birth, compared with intubation and ventilation, significantly reduces death and bronchopulmonary dysplasia.[302–306] An ILCOR systematic review recommends starting CPAP promptly in spontaneously breathing preterm infants with respiratory distress instead of TI and PPV.[6,43,307]. The ERC Guideline 2025 NLS align with this recommendation. Whilst some RCTs used CPAP levels up to 8 cmH_2O,[302,303] an observational study shows that levels of 5–6 cmH_2O are most commonly used in practice.[308] Comparative studies on optimal CPAP levels remain limited.[309,310] A 2021 Cochrane Review concluded that it was not possible to recommend a specific starting level.[310] Animal data suggest that CPAP at 15 cmH_2O (with O_2 60 %) improves lung inflation compared to 4–8 cmH_2O.[311] An ongoing trial is studying dynamic CPAP (8–12 cm H_2O) vs static CPAP (6 cm H_2O) at birth. (clinicaltrials.gov NCT04372953).

Until higher-quality evidence is available, and based on indirect measures showing better lung inflation at 6 cm H_2O,[301] aligning with the European Consensus Guidelines on the Management of Respiratory Distress Syndrome,[312] the ERC recommends starting CPAP at 6 cm H_2O in spontaneously breathing preterm infants <32 weeks.

CPAP for infants ≥32 weeks. The 2022 ILCOR CoSTR, states that there is insufficient evidence for or against routine CPAP in late preterm and term infants.[313] However, late preterm infants and term infants with conditions such as transient tachypnoea of the newborn, or those requiring supplemental O_2, may benefit from CPAP (good practice statement).[314] The ERC considers it reasonable to start CPAP at 6 cm H2O in newborn infants ≥32 weeks with respiratory distress needing supplemental O_2.

PEEP during PPV. Self-inflating bags can be equipped with PEEP valves to deliver defined PEEP during PPV, but cannot provide CPAP, even with attached bias gas flow.[315] ILCOR recommends using PEEP during initial PPV of preterm newborn infants at birth.[43] Accordingly, the ERC recommends starting with a PEEP of 6 cmH_2O in preterm newborn infants receiving PPV.

Assisted ventilation devices

Recent reviews summarize the principles of interfaces, devices and settings for delivering CPAP, PEEP and PPV during fetal-to-neonatal transition.[315,316] T-piece resuscitators deliver more consistent CPAP/PEEP compared to self-inflating bags.[315] ILCOR (2021) concluded T-piece resuscitators may slightly improve outcomes like survival, intraventricular haemorrhage and bronchopulmonary dysplasia over self-inflating bags.[317,318] Thus, the ERC recommends using T-piece resuscitators for PPV at birth, but self-inflating bags should be available as a backup if gas supply fails.

Oxygen

Term infants and late preterm infants ≥ 32 weeks

Lower inspired O_2 concentrations may result in suboptimal oxygenation where there is significant lung disease,[319] while higher O_2 may delay spontaneous breathing in term infants.[320] ILCOR recommended starting with 21 % O_2 in infants ≥35 weeks receiving respiratory support at birth, and advises against 100 % O_2.[43] An updated systematic review (2164 patients) demonstrated 27 % lower short-term mortality with 21 % O_2 vs 100 % O_2, without differences in neurodevelopment or hypoxic ischaemic encephalopathy (HIE).[321] For neonates born at 32–34^{+6} weeks, ILCOR found insufficient evidence for specific O_2 recommendations.[6] The ERC recommends starting with 21 % O_2 in infants ≥32 weeks and titrating O_2 to achieve target saturations.

Preterm infants <32 weeks

In preterm infants, higher supplemental O_2 improves breathing effort and oxygenation and results in shorter facemask ventilation and higher minute volumes.[286,322]

The NetMotion individual patient data network meta-analysis (1055 infants from 12 studies) suggested high O_2 >90 % may reduce all-cause mortality compared to lower O_2 (<30 % and 50–65 %).[323] An updated ILCOR study level meta-analysis found insufficient evidence to definitively recommend high (>50 %) vs low (≤50 %) O_2 (1804 infants from 16 studies + NetMotion, infants <35 weeks).[6,323,324] For infants <32 weeks, the ERC recommends starting resuscitation with ≥30 % O_2 and adjusting O_2 to achieve and maintain target saturations.

Target oxygen saturations

In 2010 target oxygen saturation curves were published, however, these data predated DCC and the majority of included infants were ≥37 weeks (Fig. 7).[10] In 2024, different saturation and HR references were published for infants <32 weeks stabilised according to more current guidelines. All included infants had favourable outcomes, defined as survival without cerebral injury (Fig. 8).[11]

Most (92 %) of the cohort received O_2 and CPAP (91 %).[11] Table 8 provides an overview of target saturation ranges that are also used in the Newborn Resuscitation Programme (NRP).[10–12]

A systematic review showed that failing to reach SpO_2 ≥80 % at 5 min doubled the risk of death and severe intraventricular haemorrhage in very preterm infants.[325]

Nearly all infants <32 weeks require supplemental O_2 after birth,[10,11,325] but achieving target saturations in the minutes after birth can be challenging; only 12 % reached 80 % SpO_2 at 5 min of life.[325] SpO_2 readings <60 % are considered inaccurate.[182] Dark skin tones may be associated with oxygen saturation discrepancies, with a higher incidence of occult hypoxaemia,[326] although limited data suggests that the discrepancy may be less pronounced in neonates.[327,328]

There is no direct evidence for the optimal oxygen saturations to strive for after birth. The ERC provides a consensus-based recom-

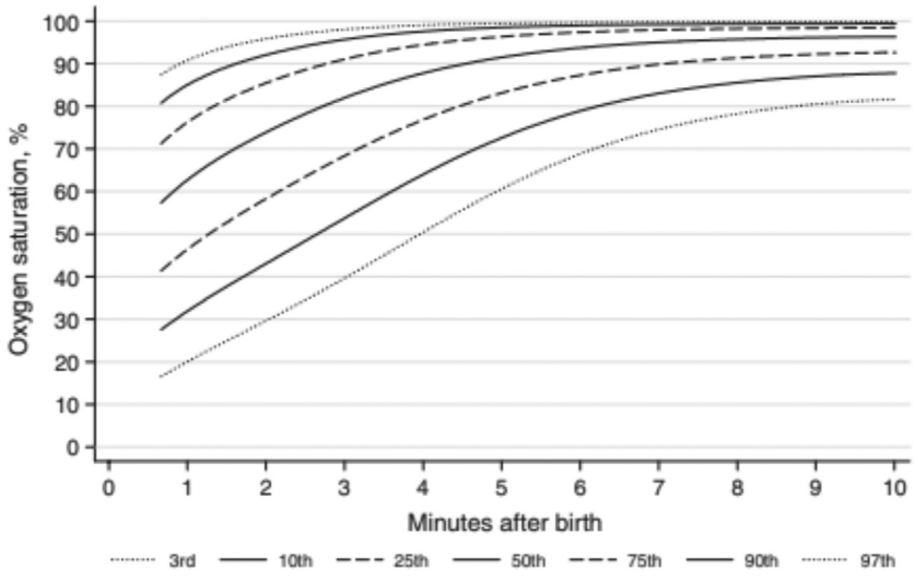

Fig. 7 – Oxygen saturations in healthy infants at birth without medical intervention (3rd, 10th, 25th, 50th, 75th, 90th, 97th centiles. Reproduced with permission.[299]

Table 8 – Overview of oxygen saturation target ranges.[10–12]

	Dawson[10]		Wolfsberger[11]		Dawson[10]		NRP[12]
	<32 weeks, n = 29		<32 weeks, n = 207		>=37 weeks, n = 308		
	P25	P75	P25	P75	P25	P75	
3 min	67	83	51	77	71	90	70–75
5 min	82	91	73	92	83	96	80–85
10 min	89	95	89	95	94	98	85–95

NRP: Newborn Resuscitation Program.

mendation on uniform oxygen saturation targets across all GAs, balancing out the perceived detrimental effects of hypoxia that may be worse than those for hyperoxia (Table 4).

Titration of oxygen

Timely adjustment in delivery of O_2 is critical to avoid hypoxia, hyperoxia and bradycardia. The ERC recommends reviewing O_2 every 30 s[329] and adjusting O_2 to achieve target SpO_2. There can be a delay between titration of intended O_2 and delivery of O_2 to the baby. One study suggests a T-piece resuscitator takes 19 s (IQR 0–57) to achieve the desired O_2 at the distal end,[330] and another that nasal interfaces may reduce this delay (Fig. 8).[331]

Cerebral tissue oxygenation monitoring

Using the same population of preterm infants, the application of different statistical methodology has resulted in differing conclusions.[332–334] The ERC, following the 2024 ILCOR recommendation, recommends that near infrared spectroscopy monitoring of cerebral oxygenation in the delivery room should only be considered where resources permit, preferably within structured research trials to help close knowledge gaps.[6,333]

Circulatory support

Circulatory support with chest compression is effective only after successful lung inflation and subsequent oxygen delivery to the heart. Ventilation may be compromised during chest compressions, so ensuring effective ventilation before starting chest compression is critical.[335]

Threshold for initiating and discontinuing chest compressions

The HR threshold to initiate chest compression at birth (<60 min^{-1}) was based on expert opinion and limited animal data.[166,336] No human studies have compared different HR thresholds for initiating chest compression in human newborns,[166] and current practice remains to start chest compression if HR is <60 min^{-1} after successful lung inflation.

In asystolic piglets, starting chest compression after 30 or 60 s of PPV resulted in comparable outcomes, however, delaying chest compression beyond 90 s worsened outcomes.[165] Two narrative reviews reconsidered the HR threshold for starting chest compression at birth,[336,337] suggesting chest compression could potentially be delayed an additional 30 s of PPV, if HR is rising after 30 s of ventilation, but still <60 min^{-1}, though more research is needed.

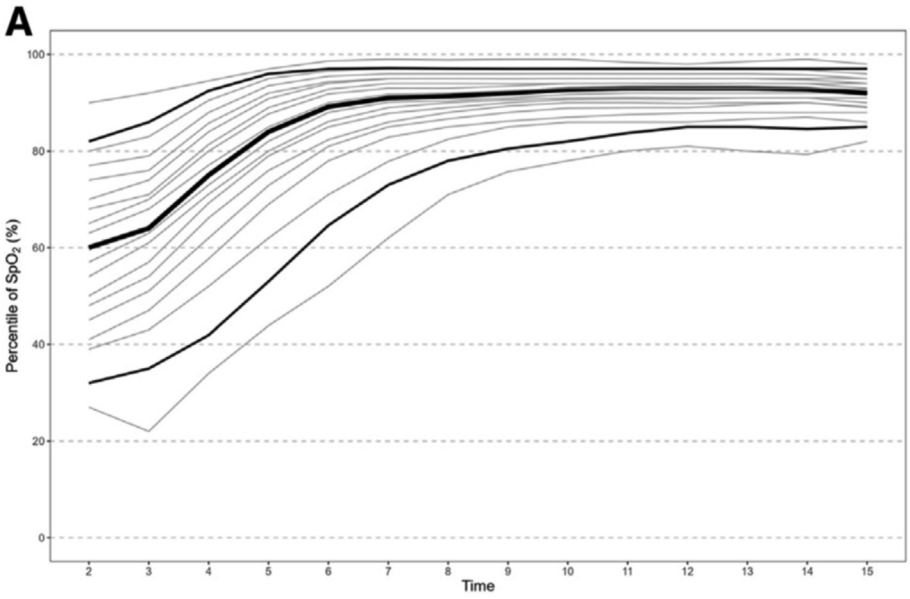

Fig. 8 – Oxygen saturations during the first 15 min after birth of infants <32 weeks with favorable outcome of SpO_2 (%); (10th, 50th, and 90th centile (bold lines); 5th, 15th, 20th, 25th, 30th, 35th, 40th, 45th, 55th, 60th, 65th, 70th, 75th, 80th, 85th, 95th centile (gray lines)). Reproduced with permission.[9]

The ERC recommends considering an additional 30 s of PPV when HR is still <60 min^{-1} but increasing. The ERC also recommends checking the HR every 30 s unless using continuous monitoring (pulse oximetry, ECG). Whilst chest compression may be discontinued when HR is >60 min^{-1}, a continued increase in rate and confirmation of cardiac output, e.g. auscultation, pulse check, pulse oximetry, signs of life, are necessary to truly demonstrate improvement. Stability often occurs only when HR exceeds 120 min^{-1}.[167,168]

Compression technique

ERC recommendations align with ILCOR, whose 2023 systematic review reaffirmed that for infants at birth, the two-thumb-hands-encircling-the-chest method should be used to deliver CC, because it results in improved compression depth, less fatigue, and better digit placement than the two-finger technique.[6,166] Two overlapping or adjacent thumbs should be placed on the lower third of the sternum from either the lateral or over-the-head position.[338,339] The over-the-head position may facilitate umbilical catheterisation. Alternative techniques were also considered but were not superior (Fig. 9).[166]

Compression depth

In a post-transitional piglet model, compressions of 25–40 % depth achieved ROSC, while 12.5 % compression depth did not.[340] Evidence in human newborn infants is lacking,[166] although deeper com-

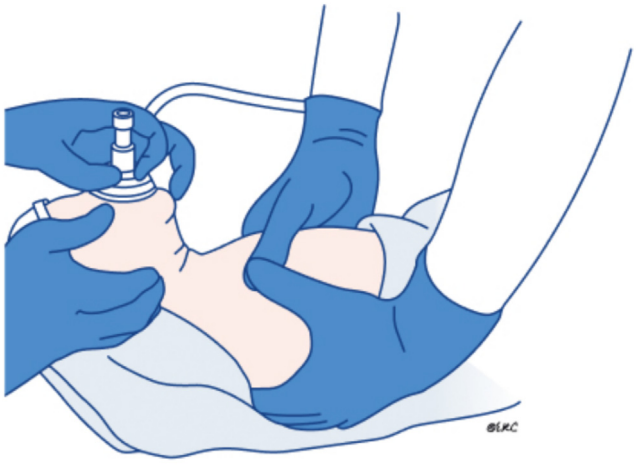

Fig. 9 – Two thumbs encircling technique for chest compressions.

pressions improved blood pressures in post-surgical infants.[341] Full recoil between compressions is important.[342–346] The ERC recommends compressing the sternum one-third of the anterior-posterior chest diameter (good practice statement), allowing full recoil between compressions.

Compression-to-ventilation ratio

ILCOR (2023) found insufficient evidence to change the recommended 3:1C:V ratio, aiming for 90 compressions and 30 ventilations per minute.[43,166] However, the quality of compressions and ventilations is probably more important than the rate.[347] Animal studies suggested chest compression with sustained inflations improved outcomes over 3:1C:V, but human trials remain inconclusive.[347–350] The ERC continues to recommend a 3:1C:V ratio for resuscitation at birth, even after securing the airway.

Supplemental oxygen during chest compressions

Available evidence remains insufficient to alter the recommendation of increasing O_2 to 100 % when starting chest compression (good practice statement).[9,166] No human studies have compared 21 % with 100 % O_2 (or any other O_2 concentration) during chest compression,[351] and animal studies reported no major differences in time to ROSC, mortality, inflammation, or oxidative stress between concentrations.[166,351] Both hypoxia and hyperoxia can be detrimental.[166,351] In a transitional term ovine model of asphyxia-induced cardiac arrest, 21 % O_2 was associated with lower cerebral oxygen levels and higher brain lactic acid after ROSC compared to be reported with the 100 % O_2.[352] Rapid weaning of inspired O_2 after ROSC may prevent hyperoxia and thereby possibly mitigate oxidate stress and organ damage. Thus, ERC recommends that, once HR recovers, O_2 should be actively reduced, guided by pulse oximetry (good practice statement).

Prompts and feedback devices

Earlier studies suggested exhaled CO_2 monitoring and pulse oximetry may be useful in detecting ROSC.[353–356] ILCOR reviewed 16 studies examining chest compression in relation to (audio)visual feedback devices, auditory feed forward devices, audiovisual prompts provided by a decision support tool, capnography, and blood pressure monitoring, but findings were difficult to compare due to heterogeneity.[166] Currently, ERC cannot recommend the clinical use of prompts or feedback devices to assess CC during neonatal resuscitation

Automated chest compression devices

Mechanical chest compression devices are used in adults but not yet in newborns.[357] In a neonatal asphyxiated piglet model, machine-delivered chest compression improved stroke volume and left ventricular contractility compared to manual chest compression.[358] More research is needed before clinical use in human newborn infants can be recommended.

Vascular access

Umbilical venous catheter (UVC) and intraosseous (IO) access

No new evidence was identified comparing umbilical venous catheter (UVC) route or use of intravenous (IV) cannulas against the intraosseous (IO) route in the newborn for drug administration in any setting in an ILCOR systematic review.[43] A systematic review on the use of IO in neonates in any situation identified one case series and 12 case reports of IO device insertion into 41 neonates delivering several drugs including adrenaline and fluid/blood.[359] First attempt success rates for IO varied from 50–86 %. Both UVC and IO access have complications associated and adverse events have been described.[43,360–363]

The actual route and method used may depend on local availability of equipment, training and experience.[43] There is limited evidence on the effectiveness of IO devices immediately after birth, or the optimal site or type of device,[364,365] although simulation studies undertaken in a delivery room setting suggest that the IO route can be faster to insert and use than UVC.[366,367] Proximal tibia is the anatomical site usually used in newborn infants, but proximal and distal femur may be feasible as well.[368,369] IO access might be possible in preterm infants. However, device-specific weight limitations must be considered. ERC recommends, in alignment with ILCOR, to use UVC as the primary method of vascular access at birth, and if UVC is not feasible, or birth occurs in another setting, the IO route is a reasonable alternative.

Peripheral access

No studies were identified reviewing the use of peripheral IV cannulation in infants requiring resuscitation at birth. A retrospective analysis of 61/70 stable newborn preterm infants in a single centre showed that peripheral IV cannulation is feasible and successful in most cases at first attempt.[370]

Medication

Medications are rarely indicated in resuscitation of the newborn infant.[42,371,372] Bradycardia is usually caused by profound hypoxia and the key to resuscitation is inflating the fluid filled lungs and establishing adequate ventilation. However, if the HR remains less than 60 min^{-1} despite effective ventilation and chest compressions, it is reasonable to consider the use of medication. Knowledge of the efficacy of medication in newborn resuscitation is largely limited to retrospective studies, as well as extrapolation from animals and adult humans.[373]

Adrenaline

A systematic review identified two observational studies involving 97 newborns comparing doses and routes of administration of adrenaline.[374] There were no differences between IV and endotracheal adrenaline for the primary outcome of death at hospital discharge, for failure to achieve return of spontaneous circulation, time to return of spontaneous circulation or proportion receiving additional epinephrine. There were no differences in outcomes between 2 endotracheal doses. No human newborn studies were found addressing IV dose or dosing interval (very low certainty evidence). Recent animal data show no differences in response to doses between 0.2, 0.4, or 0.8 IU/kg vasopressin, or 0.02 mg/kg adrenaline and support intravenous administration as the most effective route for adrenaline.[375] Despite the lack of newborn human data, it is reasonable to use adrenaline when effective ventilation and chest compressions have failed to increase HR above 60 beats min^{-1}.

ILCOR suggests that if adrenaline is used, an initial dose of 10–30 μg kg^{-1} (0.1–0.3 mL kg^{-1} of 1:10,000 adrenaline [1 mg in 10 mL]) should be administered intravenously.[6] If intravascular access is not yet available, endotracheal adrenaline at a larger dose of 50–100 μg kg^{-1} (0.5–1.0 mL kg^{-1} of 1:10,000 adrenaline [1 mg in 10 mL]) is suggested but should not delay attempts at establishing

vascular access.[376] If HR remains <60 min^{-1} further doses – preferably intravascularly – every 3–5 min are suggested. If the response to tracheal adrenaline is inadequate ILCOR suggests an IV dose is given as soon as vascular access is established regardless of the interval between doses.[5,6,43,377] In previous editions, an interval of 3–5 min was advised. For pragmatic reasons, ERC recommends using iv/io route preferably at a dose of 10–30 mcg kg^{-1} or an endotracheal dose of 100 μg kg^{-1}; and to repeat further doses of adrenaline every 4 min if required.

Glucose

Dysglycaemia (hyper or hypoglycaemia) is common during neonatal resuscitation and may be associated with poorer resuscitation outcomes. Hypoglycaemia is an important additional risk factor for perinatal brain injury.[378] The definition of hypoglycaemia in the context of resuscitation is unknown. Hyperglycaemia is a stress response and does not need to be corrected during resuscitation but may need to be addressed during post resuscitation care. Different amounts of bolus glucose have been published varying between 1 and 2 ml Kg^{-1}, with the majority advising 2 ml Kg^{-1} intravenously.[379–381] To align with these publications and the ERC 2025 Guideline PLS, the ERC recommendation is to check blood glucose during a prolonged resuscitation and if low, IV or IO glucose should be given as a 200 mg kg^{-1} bolus (2.0 mL kg^{-1} of 10 % glucose). After successful resuscitation formal steps to prevent both hypoglycaemia and hyperglycaemia should be instituted.

Intravascular volume replacement

Early intravascular volume replacement is indicated for newborns with blood loss who are not responding to resuscitation.[43] Therefore, if there has been suspected blood loss or the newborn appears to be hypovolaemic and has not responded adequately to other resuscitative measures then consider giving volume replacement with crystalloid or red cells. Blood loss causing acute hypovolaemia in the newborn is a rare event. There is little to support the use of volume replacement in the absence of blood loss when the newborn is unresponsive to ventilation, chest compressions and adrenaline. However, because blood loss may be occult and distinguishing normovolaemic newborns with shock due to asphyxia from those who are hypovolaemic can be problematic, a trial of fluid administration may be considered.[9,43]

The ERC recommends in the absence of suitable blood (i.e. group O Rh-negative blood), isotonic crystalloid rather than albumin is the solution of choice for restoring intravascular volume and to give a bolus of 10 mL kg^{-1} initially. If successful it may need to be repeated to maintain an improvement. When resuscitating preterm newborns, fluid is rarely needed and has been associated with intraventricular and pulmonary haemorrhages when large volumes are infused rapidly.[382]

Sodium bicarbonate

ILCOR concluded that a 2005 treatment recommendation on the use of sodium bicarbonate during prolonged resuscitation was not supported by a systematic review using contemporary ILCOR methods of evidence appraisal; consequently, the recommendation for the routine use of sodium bicarbonate has been withdrawn from the 2025 CoSTR.[6] Indeed, there may be harm associated with its use, as it is hyperosmolar and generates CO_2 which may impair myocardial and cerebral function.[383] Given insufficient data to recommend routine use of bicarbonate in resuscitation of the newborn the ERC has followed ILCOR's recommendation and removed it from the Guideline.

Naloxone

Naloxone is very seldomly used during newborn resuscitation (writing group experience). There is no high-certainty evidence for the use of naloxone during resuscitation.[384] Consequently, the ERC cannot recommend the use of Naloxone in that setting.

Low resource or remote settings

Infants born unplanned out of hospital are often in a remote area with lower resources and at higher risk of needing resuscitation. Resuscitation then needs to be provided by out of hospital practitioners, possibly with less experience of neonatal resuscitation. Stabilisation is followed by additional challenges of safe transfer to an appropriate healthcare facility. Hypoxia and hypothermia are common and should be anticipated and proactively managed.[105,385–387] Not all hospital settings have the same resources, and remote locations may benefit from use of telemedicine.

Planned home births

A systematic review of eight studies involving 14,637 low risk planned home births compared with 30,177 low risk planned hospital births concluded that the risks of neonatal morbidity and mortality were similar.[63] However, unplanned births are more at risk of needing resuscitation and despite risk stratification, infants born at home may still require resuscitation.[388] Those attending home births must have appropriate skills to manage this. Thermal care with a focus on prevention of hypothermia is essential irrespective of birth location.[387] This can be supported, by increasing room temperature in the birth location (e.g., turn heating up, close windows), use of warming mattresses or skin-to-skin contact. Plastic bags can be used for preterm babies as a useful thermal care adjunct alongside a heat source.

Post-resuscitation care

Glucose management

Hypoglycaemia may occur after perinatal asphyxia because of rapid glucose consumption during anaerobic metabolism, stress-induced hyperinsulinism, impaired gluconeogenesis, and concomitant risk factors.[389,390] Conversely, hyperglycaemia may result from endogenous stress hormone release, adrenaline administration, and reduced insulin sensitivity. Both hypoglycaemia and hyperglycaemia occur frequently after resuscitation: approximately 1 in 7 and 1 in 4 newborns in the first 6 h, increasing to 1 in 5 and 1 in 2 newborns at ≥24 h after birth, respectively.[389] Infants with hypoxic-ischaemic encephalopathy and severe acidosis are particularly at risk.

Animal studies suggest hypoxic cerebral injury is worsened by both hypoglycaemia and hyperglycaemia.[391,392,393] Research in human infants with hypoxic-ischaemic encephalopathy has revealed that initial hypoglycaemia and glycaemic lability are associated with more brain injury on MRI, lower cognitive scores, and poorer neurological outcome.[394–397] Hyperglycaemia and glycaemic lability were also associated with amplitude-integrated electroencephalographic evidence of worse global brain function and seizures.[398]

Hypoglycaemia and hyperglycaemia are associated with higher mortality rates, and (early) hypoglycaemia (≤12 h after birth) also causes more neurodevelopmental impairment in newborns treated with therapeutic hypothermia for moderate-to-severe hypoxic-ischaemic encephalopathy.[399,400] A systematic review and meta-analysis confirmed the association of hypoglycaemia and hypergly-

caemia with death and worse neurodevelopmental outcome in babies with neonatal encephalopathy.[401] Early hypoglycaemia and hyperglycaemia were independently associated with death and/or severe neurodevelopmental impairment at 18 months in infants with moderate-to-severe hypoxic-ischaemic encephalopathy, irrespective of cooling.[402] Fluctuating glucose levels in neonates with hypoxic-ischaemic encephalopathy also correlate with unfavourable outcomes.[403,404]

ILCOR concluded that evidence on glucose management is scarce.[389] Only two good practice statements could be issued and these are the ERC recommendations: 1) measure blood glucose concentration early and regularly after resuscitation until normoglycaemia is achieved; 2) titrate infusion of intravenous glucose against the infant's blood glucose values to avoid hypoglycaemia and iatrogenic hyperglycaemia. Although the optimal blood glucose target range for newborns with HIE is uncertain,[4,405] it seems appropriate to maintain blood glucose ≥2.6 mmol/l (47 mg/dL) (good practice statement).[390,400]

Thermal care

If therapeutic hypothermia is not indicated, hypothermia after birth should be corrected because of its association with poor outcomes.[117] Infants should be maintained within the normal temperature range (36.5–37.5 °C).[100,117]

Hyperthermia (≥38 °C) after cardiopulmonary resuscitation is also associated with unfavourable outcomes (death, moderate or severe disability) in neonates, children, and adults.[406–410] A secondary analysis of an RCT comparing whole-body cooling with standard care in term infants with hypoxic-ischaemic encephalopathy demonstrated that the risk of death or moderate-to-severe disability was increased 3.6–5.9-fold for every 1 °C increase in temperature.[411] Hyperthermia should thus be avoided.[412] The ERC recommends monitoring temperature and aiming for normothermia.

Therapeutic hypothermia

A Cochrane review including 11 RCTs comprising 1505 term and late preterm infants calculated that therapeutic hypothermia resulted in a statistically significant and clinically important reduction in the combined outcome of mortality or major neurodevelopmental disability to 18 months of age and concluded that newborn infants at term or near-term with evolving moderate-to-severe hypoxic-ischaemic encephalopathy (HIE) should be offered therapeutic hypothermia.[411] A more recent systematic review and meta-analysis including 29 RCTs with 2926 infants ≥35 weeks of gestation with HIE showed that therapeutic hypothermia diminishes the risk of neurological disability and cerebral palsy.[412] The overall effect of therapeutic hypothermia on mortality was uncertain.

Cooling should be performed in NICUs with the capabilities for multidisciplinary care, using clearly defined protocols. During transfer to a NICU, servo-controlled active cooling is the preferred method to maintain hypothermia in the desired range.[413] Treatment should commence within 6 h of birth, target a temperature between 33 °C and 34 °C, and continue for 72 h, with rewarming over at least four hours.[414] A clinical trial of 364 infants randomised to receive longer (120 h) or deeper (32 °C) cooling found no evidence of benefit of longer cooling or lower temperatures.[415] Animal data strongly suggest that the effectiveness of cooling is related to early intervention. Hypothermia initiated at 6–24 h after birth may have benefit, but there is uncertainty in its effectiveness.[416] Such therapy can be considered on an individual basis. Current evidence is insufficient to recommend routine therapeutic hypothermia for infants with mild HIE.[417]

The ERC recommends applying therapeutic hypothermia in term newborns (≥37 weeks) with evolving moderate-to-severe HIE in low- and middle-income countries as long as appropriate supportive neonatal care can be provided. There is insufficient evidence to offer a recommendation on therapeutic hypothermia in low- and middle-income countries for late preterm infants (34 to 37 weeks).

Oxygenation & ventilation

Evidence on oxygen targets in infants with perinatal asphyxia is lacking. It seems prudent to continuously monitor oxygen saturations and regularly draw arterial blood gases.[418] Considering the increased risk of pulmonary hypertension in infants with hypoxic-ischaemic encephalopathy, sometimes aggravated by therapeutic hypothermia, measurement of pre and post-ductal saturations is sensible.[419–423] Both hypoxaemia and hyperoxaemia can be detrimental.[424] The ERC recommends titrating O_2 to avoid hypoxaemia and hyperoxaemia, and to aim for normocapnia.

A review of nine retrospective studies reported that hypocapnia in newborns with HIE is associated with adverse short- and long-term outcomes.[425] A retrospective cohort study including 188 infants managed with therapeutic hypothermia for HIE showed that hypocapnia was associated with more severe brain injury on MRI in a dose-dependent fashion.[426] Targeting normocapnia appears sensible after neonatal resuscitation.[424]

Prognostication

The Apgar score was designed to focus attention on the newborn and to identify infants needing interventions.[427] Individual components of the score (e.g. breathing, HR) reflect the physiological relationships during postnatal transition. Lower scores at one minute are associated with more interventions at 5 and 10 min.[42] Although the overall Apgar score is widely recorded in clinical practice and for research purposes, its applicability has been questioned because of large inter- and intra-observer variations and racial bias.[428160,429,430] A retrospective study involving 42 infants (23–40 weeks) found a significant discrepancy (average 2.4 points) between retrospective video-based Apgar scores and scores applied by those attending the birth.[428] Individual components of the Apgar score are used to guide resuscitation, but the overall Apgar scores are not. Apgar scores are calculated after resuscitation and are often required by institutions and national registries.

Several studies have looked at the prognostic ability of clinical parameters, biochemical results, medication use, neuroimaging, and neurophysiological studies to predict neurodevelopmental outcomes of newborn infants (treated) with (hypothermia for) hypoxic-ischaemic encephalopathy.[431–438] However, a recent systematic review concluded that all clinical prediction models proposed so far have methodological limitations hampering their routine use in clinical practice.[439]

The ERC cannot recommend a specific clinical prediction model.

Clinical team debriefing

Debriefing after a resuscitation may help improve team performance in subsequent resuscitation events.[440] A meta-analysis revealed that team debriefings after simulated events outperformed non-debriefing teams by approximately 25 %.[441] Another meta-analysis of 61 studies evaluated the effectiveness of After-Action Reviews following training and clinical events, indicating an average improvement effect size of 0.79 (Cohen's d) in task performance, cognitive skills, attitudes toward training/learning.[442]

An ILCOR review on the effect of debriefing on clinical outcome (resuscitation skills and knowledge) and patient outcome (good neu-

rological outcome, survival at discharge, survival to hospital) found studies with no effect, but also improved favourable neurological outcome, survival to discharge, ROSC, chest compression depth, rate and fraction and adherence to guidelines. No undesirable effects from debriefing could be demonstrated. The ERC recommends post-event debriefing after neonatal cardiac arrest in settings that have adequate resources.[67]

Communication with the parents

The principles governing the need for good communication with parents are derived from clinical consensus and enshrined in published European guidance.[443,444] Mortality and morbidity for newborns varies according to region, ethnicity and to availability of resources.[445–447] Social science studies indicate that parents wish to be involved in decisions to resuscitate or to discontinue life support in severely compromised infants.[448,449] Local survival and outcome data are important in appropriate counselling of parents. The institutional approach to management (for example at the border of viability) affects the subsequent results in surviving infants.[450]

The ERC is supportive of family presence during cardiopulmonary resuscitation.[451] Healthcare professionals are increasingly offering family members the opportunity to remain present during resuscitation, and this is more likely if the resuscitation takes place within the delivery room. Parents' wishes to be present during resuscitation should be supported where possible.[43,452,453]

There is insufficient evidence to indicate an interventional effect from parental presence on patient or family outcome. Being present during the resuscitation of their baby seems to be a positive experience for some parents but there are concerns among professionals and family members that it may impair performance.[43,453]

In a single centre review of management of birth and resuscitation at the bedside, parents who were interviewed were supportive, but some found witnessing resuscitation difficult.[454] Clinicians involved felt the close proximity improved communication, but interviews suggested support and training in dealing with such situations might be required for staff.[455] In a retrospective survey of clinicians' workload during resuscitation the presence of parents appeared to be beneficial in reducing perceived workload.[456]

Qualitative evidence emphases the need for support during and after any resuscitation, without which the birth may be a negative experience with post traumatic consequences.[457,458] There should be an opportunity for the parents to reflect, ask questions about details of the resuscitation and be informed about the support services available.[452] It may be helpful to offer any parental witness of a resuscitation the opportunity to discuss what they have seen at a later date.[457,458]

Decisions to discontinue or withhold resuscitation should ideally involve senior paediatric staff.

The ERC recommends that where practically possible and parental inclination allows, parents should be supported and empowered to be present during the resuscitation of their newborn infant with appropriate support from staff. Decisions to discontinue or withhold resuscitation should involve senior paediatric staff.

Discontinuing or withholding treatment

Discontinuing resuscitation

Failure to achieve return of spontaneous circulation in newborn infants after 10–20 min of intensive resuscitation is associated with a high risk of mortality and a high risk of severe neurodevelopmental impairment among survivors. There is no evidence that any specific duration of resuscitation universally predicts mortality or severe neurodevelopmental impairment.

The outcomes of infants whose heart rate has been absent for longer than 10 min are not universally poor.[459–461] An ILCOR systematic review identified 13 studies involving 271 infants with at least 10 min of asystole, bradycardia or pulseless electrical activity. Of these infants, 70 % died, 18 % survived with moderate/severe neurodevelopmental impairment, and 11 % survived without moderate/severe impairment.[462] Another review identified 820 infants with absent heart rate >10 min after birth: 40 % survived; 21 % survived with moderate to severe neurodevelopmental impairment and 19 % without moderate or severe neurodevelopmental impairment.[463] A secondary analysis of the Optimising Cooling Trial, found that a 10-minute Apgar score of 0 alone did not predict well death or moderate or severe disability.[464] It can be helpful to consider clinical factors, effectiveness of resuscitation and the views of other members of the clinical team about continuing resuscitation.[465]

The ERC recommends discontinuing resuscitation after prolonged cardiopulmonary resuscitation if all recommended interventions have been applied and potentially reversible causes excluded. A reasonable time to consider this is around 20 min after birth.

In extremely preterm infants, prolonged resuscitation is associated with lower survival rates and higher morbidity; it may be appropriate to discontinue resuscitation sooner.[462,466] The decision should be individualized. The decision to cease resuscitation is a medical decision, but it is important, where possible, to give the family updates during the resuscitation and advance warning that there is a high chance the baby will not survive.

Withholding resuscitation

In situations where there is extremely high predicted mortality and severe morbidity in surviving infants, withholding resuscitation may be reasonable, particularly when there has been the opportunity for prior discussion with parents.[27–29,467,468] Examples from the published literature include extreme prematurity (GA <22 weeks and/or birth weight less than 350 g),[468] and anomalies such as anencephaly and bilateral renal agenesis. Withholding resuscitation and discontinuation of life-sustaining treatment during or following resuscitation are considered by many to be ethically equivalent and clinicians should not be hesitant to withdraw treatment when it would not be in the best interests of the infant.[469] The ERC recommends a consistent and coordinated approach to individual cases by the obstetric and neonatal teams which actively involves the parents. In conditions where there is low survival and a relatively high rate of morbidity, and where the anticipated burden to the child is high, parental wishes regarding resuscitation should be sought and supported.[444]

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.2025.110766.

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