

Newborn Life Support 2021: changes in neonatal guidelines

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Abstract

A review of neonatal resuscitation guidelines is conducted every 5 years. Due to the SARS-CoV-2 pandemic, the publication of these recommendations by the European Resuscitation Council has been postponed for 1 year. The purpose of this paper is to present the changes since 2015 and the new algorithm for a clinical use. Ten changes have been approved regarding umbilical cord management, meconium-stained liquor, laryngeal mask, initial inflation pressure, air/oxygen, vascular access, adrenalin, and ethics. The guidelines retain the so-called ABC approach for Airway, Breathing and Circulation. In this ABC approach, the focus is on controlling airway opening and lung ventilation while preserving the thermal balance.

Introduction

Every 5 years the European Resuscitation Council (ERC) guidelines for neonatal resuscitation are reviewed. For this purpose, the International Liaison Committee on Resuscitation (ILCoR) 2020 Consensus on Science and Treatment Recommendations for Neonatal Life Support (NLS) recommendations were supplemented by focused literature reviews undertaken by the ERC NLS guidelines group for topics not reviewed by ILCoR (1-2). Due to the SARS-CoV-2 pandemic, the publication of these recommendations has been postponed by 1 year and have been presented at the ERC congress and at our Belgian Resuscitation Council congress in March 2021.

These recommendations concern the newly born who needs assistance in the transition from intrauterine to extrauterine life. Notably, oxygenation and ventilation of the foetus move from dependence of the placental interface to independent lung ventilation ensuing specific hemodynamic modification (3). Around 5-10% of newborns experience difficulties in this transition phase and require assistance at birth. This assistance consists of stimulation, securing open airway and use of positive pressure ventilation to establish spontaneous breathing, 0.1% will need chest compressions and only 0.05% requires adrenalin treatment in combination with chest compressions and ventilation (1). These events affect only a small number of newborns, therefore, knowledge and correct application of neonatal resuscitation guidelines require a continuous training (4).

The ERC has also provided guidelines on neonatal resuscitation in the context of SARS-CoV-2 disease. Knowledge and understanding of the risks to neonates potentially exposed to this virus and the risk of transmission and infection of the virus to health care workers providing care is constantly evolving. For this reason, it is necessary to consult the ERC, national and institutional guidelines for the latest guidance and local policies regarding precautions for both treatment and caregiving (1).

In this paper we present the changes made in 2021 and the algorithm for the management of the newborn in need of support in the transition to extra-uterine life.

Changes in the 2021 guidelines

Ten topics were reviewed for the 2021 recommendations (1). A summary of these reviewed topics is shown in Table 1. The ERC guidelines were

Table 1 : Summary of the changes since 2015

Clinical Situation	Status from 2015 to 2021	Recommendation/ evidence
Management of the umbilical cord	Confirmation: Delay clamping for at least 60 sec, ideally after lung aeration New: If not possible, consider careful cord milking (> 28 weeks)	Moderate to high quality of evidence Low to moderate quality of evidence
Infants born through meconium-stained liquor	Routine airway suctioning with or without laryngoscopy not recommended even in depressed infants Priority given to lung ventilation	Weak recommendation, low certainty evidence
Use of laryngeal mask	Confirmation: Consider laryngeal mask for ineffective mask ventilation only if > 34 weeks, >2000g	Low- to moderate-certainty evidence
Inflation pressure	Initial inflation pressure of 30 cm H2O (term infants) and 25 cm H2O (preterm ≤ 32 weeks)	Limited data
Air/oxygen for preterm resuscitation	Start with 0.21- 0.3 FiO ₂ for preterm 28 to 32 weeks of gestation and with 0.3 below 28 weeks of gestation	Weak recommendation, low certainty evidence)
Chest compressions	Confirmation: If required, FiO ₂ is increased to 1 Secure the airway	No evidence
Vascular access	Umbilical vein Intraosseous access is a possible alternative	Weak recommendation, very low certainty of evidence
Adrenaline	10-30 micrograms/kg recommended if heart rate not increased despite optimal ventilation and chest compression	Weak recommendation, very low certainty evidence
Glucose during resuscitation	250 mg/kg intravenous in a prolonged resuscitation (reversible cause of cardiac arrest)	Expert opinion
Prognosis	Consider stopping resuscitation 20 minutes after birth if there is no response	Low certainty of evidence

developed with the recommendations of ILCoR using the same level of evidence and strength of recommendations. Some recommendations were based on expert consensus and focused literature reviews.

Algorithm of new guidelines for clinical practice

The NLS 2021 guidelines retain the so-called ABC approach for Airway, Breathing and Circulation. The algorithm is shown in Figure 1.

Team and equipment:

Team briefing is regarded as a tool for improved communication. It serves to define the clinical context, to assign roles and responsibilities to each team member and to prepare the equipment. Prenatal counselling can help to define treatment options with the parents, including the extent of resuscitation, in order to propose an accepted care plan at the moment of birth. For each birth, attending staff trained in NLS should be present. A protocol must exist in each facility where deliveries take place to rapidly activate an expert resuscitation team for each birth (5).

The equipment and environment should be checked regularly and ideally before each birth and ready for use. Essential equipment should include a neonatal resuscitation table with radiant heating, an equipment for thermal care, a patient monitoring device (electrocardiogram, pulse oximetry (SpO₂), temperature probe), ventilation equipment (mask and T-piece resuscitator or bag) and oxygenation (air-oxygen blender). Material for airway suction, for advanced airway management (endotracheal tube, laryngeal mask), vascular access and thoracocentesis should be easily available. The same applies to essential drugs (adrenalin, glucose) and fluids (isotonic crystalloid or group O Rh-negative blood).

Birth and initial assessment of the newborn:

The assessment of the newborn may occur during the umbilical cord management. This involves assessing:

- The muscle tone
- Adequacy of breathing
- The heart rate (HR) by stethoscope or ECG electrodes for later continuous assessment

This assessment identifies neonates adapting well to the transition and who can benefit from skin-to-skin contact with the mother or partner from others newborns in need of support or resuscitation (6). During this assessment, tactile stimulation and thermal care are initiated and continued throughout assessment and treatment. Depending on the assessment, the newborn is classified into one of 3 categories :

1. Satisfactory transition: good tone, vigorous breathing or crying, HR > 100/min
2. Incomplete transition: reduced tone, breathing inadequately or apneic, HR < 100/min
3. Failed transition: floppy, breathing inadequately or apneic, HR < 60/min or undetectable.

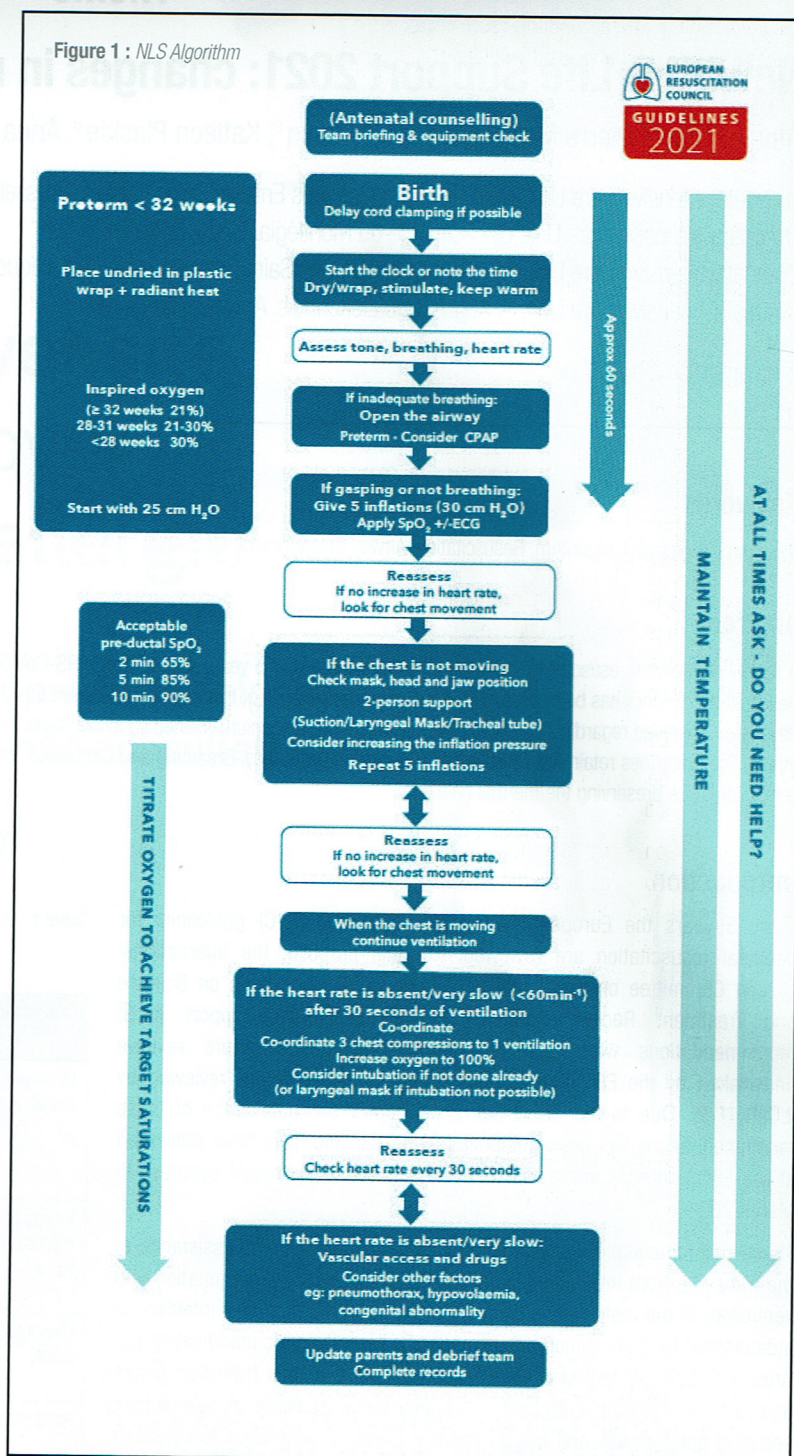
Newborns with a satisfactory transition may benefit skin-to-skin care. The last 2 categories require support or resuscitation as detailed below. For these infants, the actions to be taken thereafter will depend on the assessment, every 30 seconds of the following:

- HR
- Breathing
- SpO₂

Thermal care:

Newborns with a satisfactory transition may benefit from skin-to-skin care. For newborns requiring transition assistance, in

Figure 1 : NLS Algorithm



addition to resuscitative support, maintenance of normothermia is critical. Hypo- and hyperthermia are associated with a poor prognosis and the temperature of the newborn should be monitored to avoid this (1). A combination of actions will be taken to maintain a body temperature of 36.5-37.5°C. This combination of care includes (7,8):

- Room temperature of 23-25 degrees Celsius and at least 25 degrees Celsius for preterm newborns < 28 weeks of gestation
- Avoid draughts by closing the doors and windows and programming the air conditioning appropriately
- Use of preheated radiant warmer, warm dry towel, covering hat
- Use of polyethylene bag (without drying the baby) and warmed humidified gas for babies < 32 weeks of gestation
- Use of a temperature probe to monitor the temperature
- For unplanned, outborn, infants, use of a polyethylene bag after drying the newborn. Well newborns over 30 weeks gestation can be carried skin-to-skin to preserve thermal balance during transport.

The admission temperature of newborn serves as a prognostic factor and can be used as a benchmark quality indicator.

Umbilical cord management to improve the transition to extra-uterine life: The ERC 2021 guidelines recommend delaying cord clamping for at least 60 seconds, ideally until after lung aeration, in a satisfactory transition. Delayed cord clamping allows the transfer of a blood volume of approximately 30 ml/kg from the placental circulation towards the foetus. It improves cardiorespiratory transition to extrauterine life by avoiding bradycardia due to the sudden drop in ventricular preload during immediate clamping. An ILCOR meta-analysis published in 2020 found no increase in hyperbilirubinemia requiring phototherapy or more severe complications related to prematurity such as intraventricular haemorrhage, retinopathy of prematurity, necrotizing enterocolitis or chronic lung disease (10).

Intact cord resuscitation cannot yet be universally recommended. When delayed clamping cannot be performed, cord milking may be considered for newborn over 28 weeks of gestation (11).

Airway and breathing:

Life support begins if the initial assessment indicates an incomplete or failed transition despite tactile stimulation. The first important step is to open and maintain the airway to allow lung ventilation (spontaneous or assisted) and to ensure the success of other resuscitative actions.

Opening the airway:

The airway is opened by placing the infant on its back with the head supported in a neutral position.

For very hypotonic neonates, jaw lift will be required to maintain an open airway. Airway obstruction is often due to incorrect positioning (12). An oropharyngeal airway may be helpful for term newborns when it is difficult to perform jaw lift and mask ventilation or for newborns with facial anomalies such as micrognathia. (13)

Airway suctioning is required only if there are secretions (such as blood, vernix, mucus, meconium) obstructing the airway and interfering with ventilation. In this situation, suction will be done under direct vision using a wide bore suction catheter (14).

Initial inflations and assisted ventilation:

Initial inflations are indicated in apnoea and gasps or if ineffective breathing is observed. They are performed without delay, using an appropriated sized face mask. The aim is to establish an adequate functional residual capacity which is an important step in the transition process. It contributes to changes in pulmonary blood flow through improved oxygenation.

Suggested inflation pressures have been increased from previous guidelines, to 25 and 30 cm H₂O for preterm neonates less than 32 weeks of gestation and neonates over 32 weeks of gestation respectively (1). The first 5 inflations are sustained and last 2 to 3 seconds. Assisted ventilation can be achieved with a self-inflating bag, a flow inflating bag or a T-piece resuscitator. The last one allows to obtain more reproducible insufflation pressures and PEEP (positive end-expiratory pressure), a more consistent inspiratory time and can support spontaneous breathing. The ventilation rate recommended by the ERC, after the five first inflations, is 30 inflations/minute (1, 15).

At the same time, neonatal monitoring devices (ECG electrodes, pulse oximeter) are placed if not already done. The assessment of ventilation is based on the evaluation of HR and chest movements and is performed every 30 seconds. An increase in HR or a stable HR (if > 100/min) indicates an appropriate ventilation and oxygenation. Persistent bradycardia is a sign of hypoxia which is usually due to ineffective ventilation. Lack of chest movement may reflect airway obstruction, insufficient insufflation pressures or inappropriate sealing of the mask. If a HR response is present, ventilation should be continued until the newborn begins to breathe efficiently with a HR above 100/min.

The initial FiO₂ (fraction of inspired oxygen) according to the gestational age of the newborn is still a matter of debate. Recommendations are starting in room air at 32 weeks of gestation or more, FiO₂ 0,21-0,3 at 28-31 weeks of gestation and 0,3 at < 28 weeks of gestation. The target saturations have

been simplified 65% - 85% - 90% at 2 - 5 - 10 minutes of life respectively. The FiO₂ is adapted to the targeted preductal saturation, summarized in table 2, every 30 seconds to prevent both hypoxia and hyperoxia (16).

Table 2 : Initial inflation pressure, inspired fraction of oxygen (FiO₂) and pulse oximetry (SpO₂) target according to the gestational age

Term	Inflation Pressure	FiO ₂	Minimal SpO ₂ targets
Full term	30 cm H ₂ O	0.21	65 % (2 min) 85 % (5 min) 90 % (10 min)
≥ 32 weeks			
28-31 weeks	25 cm H ₂ O	0.21-0.3	
< 28 weeks			

Failure to respond:

If mask ventilation fails, actions should be undertaken to control the opening and integrity of the airway. These actions are as follows:

- Recheck head position, consider (or check) jaw thrust
- Recheck equipment, mask size, position, and seal
- Consider alternative open airway actions:
 - 2 persons mask ventilation
 - Inspection of the pharynx and suction of obstructive secretion if present
 - Use of an oropharyngeal/nasopharyngeal airway if unable to assure a secure airway.
 - Securing the airway through endotracheal intubation or laryngeal mask placement. It must be performed by competent caregivers with appropriate equipment.
- Gradual increase in inflation pressure until chest movement is observed
- Call for help by experts without delay

Repeat the five first inflations and check continuously the HR, chest movements and SpO₂. The actions required to control a complicated airway opening are presented in Table 3.

Table 3 : opening and maintenance of the airway

Action to be taken when mask ventilation fails
1. Recheck head position, consider or check jaw lift
2. Recheck equipment, mask size, position and seal
3. Other airway actions: <ul style="list-style-type: none"> - 2 persons mask support - inspection of the pharynx and suction to remove obstructing foreign matter if present - use of an oropharyngeal/nasopharyngeal airway (if unable to secure the airway) - securing the airway via tracheal intubation or laryngeal mask
4. Gradual increase in inflation pressure (until the chest is moved)
5. Call for help by expert without delay
6. Repeat inflations and check continuously heart rate, chest movement (and SpO ₂)

The indications for intubation in the delivery room have not changed: ineffective face mask ventilation with no increase in HR and no chest movement despite all preventive actions (see above), prolonged face mask ventilation, chest compressions, special circumstance (suction the lower airway, congenital diaphragmatic hernia...). Tracheal tube insertion is done by trained staff with the appropriate equipment. If intubation is not possible or unsafe due to a congenital anomaly, lack of equipment or skills, the initial respiratory management with a laryngeal mask is possible and is considered a safe alternative. It should be remembered that the laryngeal mask has not been

evaluated in situations such as meconium-stained liquor, chest compressions or emergency drug administration (17). It requires a brief training on a manikin, the Belgian working group is working on an implementation of this guideline in the local NLS courses in Belgium.

Continuous Positive Airway Pressure:

In spontaneously breathing preterm infants consider CPAP to support respiration after delivery (18). Use mask or nasal prongs of an appropriate size. A T-piece resuscitator can deliver either CPAP and positive pressure ventilation with PEEP. Self-inflating bags cannot be used to provide CPAP during spontaneous respiration.

Circulation:

Chest compressions:

Chest compressions are indicated if HR is very slow (< 60/min) or absent despite 30 seconds of successful ventilation (only if chest movements is observed). Call for experienced help without delay. When starting this action, FiO₂ is increased to 1. It should be noted that this recommendation is not based on human studies and animal studies do not support it (19). The circulatory support provided by chest compressions can only be effective if lung ventilation is adequate to deliver oxygen to the myocardium. The technique of compressing with both thumbs on the lower third of the sternum, encircling the thorax, remains unchanged. The same applies to the compression to ventilation ratio, which remains 3:1. This means that the chest compression is done alternately with ventilation, corresponding to 15 cycles per 30 seconds (19). Re-assess every 30 seconds.

Adrenaline:

Exceptionally, the administration of drugs is required during the resuscitation of the newborn. Asystolia and severe bradycardia are due to severe hypoxia. Therefore, ventilation and adequate oxygenation are the critical steps to restore spontaneous circulation. Adrenaline is indicated if the HR remains very slow or absent despite 30 seconds of alternating chest compressions and ventilation. It is administered intravenously through an umbilical venous catheter at a dose of 10 to 30 mcg/kg every 3 to 5 minutes if necessary (1). When umbilical catheterization is not possible, an intraosseous access should be provided. If no venous or intraosseous access is available a dose of adrenaline of 50 to 100 mcg/kg should be administered endotracheally. However, this should not delay the insertion of the venous access.

Volume replacement:

Volume replacement is indicated in the situation of suspected blood loss or shock unresponsive to other resuscitative measures. Ten mL/kg of isotonic crystalloid or group O Rh-negative blood should be administered intravenously or intra-osseously.

Failed resuscitation: think of other factors

If there is no response to properly initiated resuscitative measures, other causes that may interfere with successful resuscitation such as pneumothorax, hypovolemia, intoxication (examples maternal medications: opiates, sedatives, beta-blockers), or congenital anomalies should be considered (1).

Preterm infants:

The algorithm applies equally to preterm newborns. In most situations, the preterm neonate needs transition support rather than resuscitation. This assistance is based on 3 main cornerstones:

1. Thermal protection with the use of heated and humidified gases and a polyethylene bag (bag designed for this purpose or feeding bag) in infants below 32 weeks of gestation and/or below 1500 g
2. Gentle ventilatory support with early application of CPAP for spontaneously breathing preterm infants with FiO₂ according to gestational age
3. Early glucose supplementation to prevent hypoglycaemia due to low glycogen stores.

Post-resuscitation care:

Newborns in need of transition support or resuscitation at birth will require specific further management. This includes, but is not limited to:

- Constant monitoring of vital parameters
- Monitoring of blood glucose levels and treatment of possible hyper- or hypoglycaemia
- Respiratory and circulatory support
- Therapeutic hypothermia for asphyxiated neonates with signs of hypoxic ischemic encephalopathy
- Updating parents

Prognosis: withdrawing or withholding resuscitation:

It seems reasonable to discontinue resuscitation 20 minutes after birth if there is a failure to restore spontaneous circulation despite well conducted intensive resuscitation due to the high risk of severe neurological impairment and of death. The recommendation of the ERC is to perform intensive treatment when there is more than 50% survival and acceptable morbidity, tailored to the regional or national outcomes. In Belgium, this generally includes most infants with congenital anomalies or newborns over 24 weeks of age in the absence of aggravating factors (hypoxia-ischaemia, intrauterine infection) (1). For overt situations with a high risk of mortality and severe morbidity such as extreme prematurity (< 22 weeks of gestational age), anencephaly or bilateral renal agenesis, it seems reasonable to withhold resuscitation (20).

When withdrawing or withholding resuscitation, the aim of care should be focused on the comfort of and respect towards the newborn and family. Decisions involving withholding or withdrawing resuscitation should be made after team discussion and informing parents by an experienced paediatrician or neonatologist.

Discussion

Several issues presented in these new guidelines deserve to be discussed:

Evidence informing the guidelines:

Most of the recommendations proposed in the guidelines have moderate to low levels of evidence. Other recommendations are based on expert opinion in support of local clinical practice (1,2,21). More well-designed studies are needed to increase the level of evidence of neonatal resuscitation guidelines. There are differences between the neonatal resuscitation guidelines proposed by the American Heart Association (AHA) and the ERC (21). We will discuss some of these differences.

Umbilical cord management:

Like the AHA, the ERC recommends delayed cord clamping when resuscitation is not required. Only the ERC suggests, in situation of incomplete transition, to delay cord clamping while providing appropriate thermal care and initial steps of resuscitation. This recommendation is based on a pilot study. Further studies are underway to support this management strategy. Umbilical cord milking is an alternative, for newborns over 28 weeks of gestation, when delayed umbilical cord clamping is not possible. This strategy is avoided before 28 weeks of gestation because a high rate of severe intraventricular haemorrhage in extreme preterm infants after cord milking is described in a single multicentre randomized controlled trial (11).

Assisted ventilation:

In the ERC recommendations, HR is not included in the criteria for initiating positive pressure ventilation, unlike in the American Heart Association (AHA) guidelines. However, a neonate with absent HR or below 100 bpm will not have spontaneous or effective breathing, so HR assessment does not appear to be essential for the initiation of insufflations.

ERC recommends a ventilation rate of 30 ventilations/minute after 5 initial inflations of 2-3 seconds. The rate is in the range proposed by ILCOR (30-60/minute) and below the range of the AHA (40-60/minute) (21). This is supported by an observational study using expired CO₂ as a predictor of good ventilation, who argues that a lower respiratory rate (30/minute) allows a higher tidal volume to be administered and therefore allowed better

ventilation (15). The 5 initial inflations of 2-3 seconds are only proposed by the ERC and is based on expert opinion.

As the ILCoR, initial inflation pressures are increased to 25 and 30 cm H₂O for preterm neonates less than 32 weeks of gestation and neonates over 32 weeks of gestation respectively. This is supported in part by an observational study describing that in neonates over 36 weeks of gestation lower lung compliance required higher insufflation pressures (on average 36 cm H₂O) to achieve adequate functional residual capacity (1,21,22)

Oxygen:

Concerning the FiO₂ initially used, the stratification proposed by the ERC is based on expert opinion. The target saturations have been simplified 65% - 85% - 90% at 2 - 5 - 10 minutes of life respectively. Based on a meta-analysis of 8 randomized controlled trial, it was recommended that in preterm infants before 32 weeks of gestation, an oxygen saturation below 80% and/or HR below 100/min at 5 minutes of age should be avoided due to the high risk of death and severe intraventricular haemorrhage (23).

Opening and maintenance of the airway:

The algorithm suggests possibilities to manage an extremely difficult airway opening. This detailed approach to airway management is only present in the ERC algorithm. The recommendation for 2-person ventilation technique when chest is not moving is based on two studies in newborn paediatric anaesthesia (12,24).

Extreme prematurity:

Although we don't have official data, the intensive management of extreme prematurity at 22 and 23 weeks of gestation does not seem to be a common practice in Belgium. A systematic review shows that there is a wide variability in recommendations (more particularly between 23 and 24 weeks of gestational age) (25). In most neonatal intensive care units, there is general agreement for comfort care at 22 weeks of gestation and intensive resuscitation at 25 weeks of gestation.

Conclusion

The ERC neonatal resuscitation guidelines focus on thermal control, securing airway opening and guide us how to make adequate ventilation. The laryngeal mask is part of the resuscitation algorithm as an alternative to intubation. The target saturation values have been simplified. Other actions, such as increasing FiO₂ to 1 during chest compressions, are consistent with paediatric and adult resuscitation algorithms, while respecting the physiology of transition to extra-uterine life. As a result, the management of the neonate in emergency situations is clarified for less experienced caregivers in neonatal resuscitation. Most of the recommendations proposed in the guidelines have moderate to low level of evidence. Other recommendations are based on expert opinions in support of local clinical practice. More well-designed studies are needed to increase the level of evidence of neonatal resuscitation guideline. Resuscitation at birth affects only a small number of newborns. Therefore, knowledge and correct application of neonatal resuscitation guidelines require a continuous training.

Disclosure of potential conflicts of interest

The authors declare that they have no conflict of interest.

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