

## CLINICAL OVERVIEW

# A critical review of the 2020 International Liaison Committee on Resuscitation treatment recommendations for resuscitating the newly born infant

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### Abstract

The 2020 recommendations from the International Liaison Committee on Resuscitation are an improved version of the 2015 version. The algorithm and 15 procedures are unchanged from 2015, but there are six procedures with new or changed recommendations. One new recommendation is briefing/debriefing following neonatal resuscitation. Procedures with changed suggestions/recommendations are as follows: suctioning of non-vigorous infants delivered through meconium-stained amniotic fluid, sustained inflation of preterm infants, optimising epinephrine (adrenaline), vascular access and discontinuing resuscitative efforts.

**Conclusion:** In this review, we summarise the present recommendations and offer additional comments and views regarding heart rate detection, cord clamping, oxygenation and thermal control.

### KEYWORDS

guidelines, ILCOR, newborn infants, resuscitation

## 1 | INTRODUCTION

Since 2000, the International Liaison Committee on Resuscitation (ILCOR) published international consensus on cardiopulmonary resuscitation and emergency cardiovascular science with treatment recommendations every fifth year.<sup>1–4</sup> After the last recommendations on Neonatal Life Support (NLS) in 2015,<sup>4</sup> ILCOR adapted a new process of continuous evidence evaluation, publishing updates if required.

The new recommendations of 2020 represent a highlight for everyone closely involved with NLS. This year's recommendations represent an impressive summary of accumulated new evidence in the field over the last 5 years. In addition, knowledge gaps are summarised.<sup>5</sup>

Three types of evidence evaluation, systematic reviews, scoping review and evidence update, support the 2020 recommendations. Questions to be answered by systematic reviews were developed using the PICOST (Population, Intervention, Comparator, Outcome, Study design, and Time frame) format. Suggestions are given as weak or strong recommendations. Evaluation of evidence is based on the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) system rating the certainty of effects of an intervention as high, moderate, low or very low. Scoping reviews are identifying evidence of a topic by experts in combination with the NLS task force. Task force members collaborating experts or members of the ILCOR writing groups performed evidence updates. Evidence pertaining to new questions was posted for public comments.

**Abbreviations:** AHA/NRP, The American Heart Association /Neonatal Resuscitation Program; CPAP, continuous positive airway pressure; CPR, cardiopulmonary resuscitation; DR, delivery room; ECG, electrocardiography; GA, gestational age; GRADE, Grading of Recommendations, Assessment, Development and Evaluation; HIE, hypoxic-ischaemic encephalopathy; HR, heart rate; ILCOR, International Liaison Committee on Resuscitation; IO, intraosseous; IPPV, intermittent positive pressure ventilation; NLS, neonatal Life Support; PEA, pulseless electrical activity; PEEP, positive end-expiratory pressure; PICOST, Population, Intervention, Comparator, Outcome, Study design, and Time frame; PO, pulse oximetry; PPV, positive pressure ventilation; RCTs, randomised controlled trials; SI, sustained inflation.

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In our commentary on the 2015 recommendations, we pointed out the difficulty of reading those guidelines when recommendations which had not changed from 2010 were not included in the text. The reader therefore had to go back and forth between the 2010 and 2015 versions. We are therefore pleased to see that all reviewed recommendations, including those not changed since 2015, are published in the text. Similarly, we are pleased that the algorithm was published in the document, although not changed since 2015.<sup>6</sup>

## 2 | PROCEDURES WITH CHANGED RECOMMENDATIONS

Eight main topics were reviewed for the 2020 recommendations. For each issue, evidence was summarised leading to the recommendation given. Knowledge gaps were added, helping the reader to identify the frontiers of the field. Here is a summary of the conclusions of the one new and the five procedures changed from 2015, see also Table 1.

1. Effect of briefing/debriefing following neonatal resuscitation is a new topic. It was concluded that briefing or debriefing may improve short-term clinical and performance outcomes for infants and staff. Effects on long-term clinical and performance outcomes are uncertain.
2. For non-vigorous newborn infants delivered through meconium-stained amniotic fluid, routine immediate direct laryngoscopy is not recommended with or without tracheal suctioning, whereas immediate resuscitation without direct laryngoscopy is recommended.

3. For preterm newborn infants who receive positive pressure ventilation (PPV) for bradycardia or ineffective respirations at birth, routine use of initial sustained inflation(s) greater than 5 s is not recommended. A sustained inflation may be considered in research settings. For term or late preterm infants who receive PPV for bradycardia or ineffective respirations at birth, it is not possible to recommend any specific duration for initial inflations due to the very low confidence in effect estimates.
4. If the heart rate has not increased to 60/min or greater after optimising ventilation and chest compressions, the administration of intravascular epinephrine (adrenaline) (0.01–0.03 mg/kg) is recommended. If intravascular access is not yet available, administering endotracheal epinephrine (adrenaline) at a larger dose (0.05–0.1 mg/kg) than the dose used for intravenous administration is suggested.
5. Umbilical venous catheterisation is suggested as the primary method of vascular access during newborn infant resuscitation in the delivery room. If umbilical access is not feasible, the intraosseous (IO) route is a reasonable alternative for vascular access during newborn resuscitation. Outside the delivery room setting, either umbilical venous access or the IO route may be used to administer fluids and medications during newborn resuscitation. The actual route used may depend on local availability or equipment, training and experience.
6. Failure to return to spontaneous circulation in newborn infants despite 10 to 20 min of intensive resuscitation is associated with a high risk of mortality and a high risk of moderate to severe neurodevelopmental impairment among survivors. A reasonable time frame to consider discussion of discontinuing resuscitative efforts is around 20 min after birth.

TABLE 1 Procedures for which recommendations were changed from 2015 to 2020.

Clinical situation	Procedure	Recommendation /evidence
Briefing/debriefing	May improve short-term outcomes for infants and staff	None
Non-vigorous delivered through meconium-stained amniotic fluid	Suggest against routine immediate direct laryngoscopy with or without tracheal suctioning	Weak/low
SI for newborns who receive PPV for bradycardia/ ineffective respirations	Preterm: suggest against routine initial SI>5 s Term/late preterm: no recommendations	Weak/low
Epinephrine/adrenaline	If HR not ≥60 bpm after optimising ventilation and chest compressions: suggest intravascular epinephrine (0.01–0.03 mg/kg)	Weak/very low
	If no intravascular access: intratracheal epinephrine (0.05–0.1 mg/kg)	Weak/very low
	If HR remains <60/min repeat dose every 3–5 <sup>th</sup> min	Weak/very low
Vascular access	1. Umbilical venous catheterisation as primary mode 2. IO route a feasible alternative	Weak/ very low
Return of Spontaneous circulation	Failure to achieve return of spontaneous circulation suggest discussion of discontinuing resuscitative efforts considered around 20 min after birth	Weak/very low

HR, Heart rate; IO, Intraosseous; PPV, Positive pressure ventilation; SI, Sustained inflation.

### 3 | PROCEDURES WITH UNCHANGED RECOMMENDATIONS

Procedures without a change in recommendation are as follows: prediction of need of respiratory support in the delivery room, warming adjuncts, heart rate monitoring during neonatal resuscitation, PEEP (positive end-expiratory pressure) versus no PEEP, CPAP (continuous positive airway pressure) versus IPPV (intermittent positive pressure ventilation), T-piece resuscitator

versus self-inflating bag for ventilation, oxygen for preterm resuscitation, oxygen for term resuscitation, CPR (cardiopulmonary resuscitation) ratios for neonatal resuscitation, 2-thumb versus 2-finger compressions for neonatal resuscitation, volume infusion during neonatal resuscitation, sodium bicarbonate during neonatal resuscitation, rewarming of hypothermic newborns, induced hypothermia in settings with limited resources, and post-resuscitation glucose management. See Table 2 for a summary.

TABLE 2 Procedures for which recommendations were not changed from 2015 to 2020.

Clinical Situation	Procedure
Anticipation and preparation	If antenatal risk factors provider skilled in assisted ventilation should be present
Warming adjunct to reduce hypothermia <36°C	<32 w GA: under radiant warmer combined with environmental temperature of 23–25°C, warm blankets, Plastic wrapping without drying, cap, thermal mattress
Suctioning	Routine oropharyngeal and nasopharyngeal suctioning with clear or meconium-stained amniotic fluid is no longer recommended
Heart rate monitoring	ECG is suggested used to provide a rapid and accurate estimate of heart rate
PEEP	Suggest used for initial ventilation of premature newborn infants No recommendations for term infants
CPAP	Suggested for spontaneous breathing preterm newborn infants requiring respiratory support in the DR
T-piece versus self-inflating bag for initial PPV	No recommendation of one device over another
Oxygen for preterm resuscitation	<35 w GA who receive respiratory support suggest start with 21%–30%
Oxygen for term resuscitation	35 w GA or greater suggest start with 21% Recommend against starting with 100% O <sub>2</sub>
Chest compression ratios	3:1 compression to ventilation rate
Chest compression method	2-thumb, hands encircling the chest
Volume infusion	Early replacement with crystalloid or red cells if blood loss and not responding to resuscitation
Sodium bicarbonate	Discouraged during brief CPR, may be useful during prolonged arrest
Rewarming of hypothermic newborns	No recommendations regarding either rapid ( $\leq 0.5^\circ\text{C/hr}$ or slow ( $\geq 0.5^\circ\text{C/hr}$ )
Induced hypothermia in settings with limited resources	Suggest treatment of term or near term with evolving moderate to severe HIE
Post-resuscitation glucose	Intravenous glucose considered as soon as possible to avoid hypoglycaemia

CPAP, continuous positive airway pressure; CPR, cardiopulmonary resuscitation; DR, delivery room; ECG, electrocardiogram; GA, gestational age; HIE, hypoxic-ischaemic encephalopathy; hr: hour; PEEP, positive end-expiratory pressure; PPV, positive pressure ventilation; w, weeks.

## 4 | DISCUSSION

The ILCOR task force and the NLS collaborators have done an impressive body of work improving the NLFS recommendations. By grading the existing evidence, giving recommendations and summarising the knowledge gaps the reader are better able to understand the basis for each recommendation. The 2020 version is easier to handle than the previous one. The algorithm, although not changed is printed in the text, and all recommendations are spelled out, even if no changes were made.

### 4.1 | Time of birth

Because the golden minute, the first 60 s after birth, is so critical for newborn life support, we are disappointed that the definition of time of birth is still not given specifically in the recommendations. In our opinion, the clock should be started the moment the whole body is out.<sup>7</sup> However, there still are different practices around the world.

### 4.2 | Heart rate detection

In the 2015 recommendations, ILCOR suggested for the first time that heart rate in the delivery room should be monitored primarily by ECG. We disagreed with this because there were few solid data on this issue. In addition, in most delivery rooms in the world ECG was not available. We therefore suggested auscultation as the primary method to assess heart rate.<sup>8</sup>

The research question posed by ILCOR 2020 was as follows: 'In neonates requiring resuscitation at delivery, does the use of Electrocardiography (ECG) compared to pulse oximetry (PO) or auscultation result in a faster and more accurate heart rate assessment?' ILCOR refers to seven additional studies published after the 2015 guidelines including 2 systematic reviews, 2 randomised controlled trials and 3 observational studies. We do not agree with the ILCOR authors claiming these studies support the 2015 recommendation. It is true that most studies show that ECG gives an earlier signal than pulse oximetry. Still several of these studies quoted by ILCOR do not recommend the use of ECG alone. A recent review from Tanzania demonstrating signals from ECG dry electrodes are obtained as late as median (25–75th percentile) of 102 (73–144) seconds after birth.<sup>9</sup>

Johnson and Schmölder also refer to the problem of pulseless electrical activity (PEA) reported to occur in 40%–50% in a newborn asphyxig piglet model. Based on these considerations, they recommend assessments of heart rate using a combination of palpation, auscultation, pulse oximeter and ECG.<sup>10</sup> The American Heart Association /Neonatal Resuscitation Program (AHA/NRP) recommendation seems more appropriate than that of ILCOR: 'Auscultation of the precordium remains the preferred physical examination method for the initial assessment of the heart rate. Pulse oximetry and ECG remain important adjuncts to provide continuous

heart rate assessment in babies needing resuscitation'.<sup>11</sup> This is in agreement with our view and means that there is still a place for the stethoscope in the delivery room.

### 4.3 | Cord clamping

The understanding of proper cord clamping has increased over the last 5 years or so. We are surprised these recommendations are not updated, at least regarding resuscitation on an intact cord, so-called physiological cord clamping, and cord milking. The latter is associated with increased risk of intraventricular haemorrhage in the most immature preterm infants. The rate of severe IVH (22%) in babies 23–27 weeks' gestation subjected to cord milking is compatible with rates reported in the Vermont-Oxford Network database: 36% for infants <24 weeks GA and 17% for infants 24–26 weeks GA.<sup>12,13</sup> Moreover, milking the cord in preterm lambs when the animal previously has breathed significantly reduces the risk of haemodynamic complications in the brain.<sup>14</sup>

### 4.4 | Oxygenation

Regarding oxygenation of preterm infants, ILCOR suggests starting with 21%–30% oxygen for all preterm infants <35 weeks. In our opinion, data indicate that infants <29 weeks should be started with at least 30% O<sub>2</sub>.<sup>15</sup>

During the last 5 years, data were published suggesting a better outcome in preterm infants <29 weeks' gestational age if a SpO<sub>2</sub> of 80% is reached within 5 min of age.<sup>16</sup> Perhaps this could have been mentioned in the 2020 recommendations? Moreover, the combination of bradycardia (>2 min) and SpO<sub>2</sub> <80% at 5 min is a strong predictor of death and/or severe IVH.<sup>17</sup> Further, delaying cord clamping has changed the reference range for SpO<sub>2</sub> at least in term newborn infants.<sup>18</sup> It is likely that, in the near future, values for targeted SpO<sub>2</sub> may need to be modified accordingly.

The recommendations for FiO<sub>2</sub> during chest compressions are not changed. Although animal studies have indicated air is as good as 100% O<sub>2</sub> during this procedure, clinical data are lacking.<sup>19</sup> It is however interesting that the new ILCOR recommendations for paediatric life support phrase this differently: 'There is insufficient information to recommend a specific inspired oxygen concentration for ventilation during attempted resuscitation after cardiac arrest in infants and children'.<sup>20</sup> Perhaps the neonatal and paediatric recommendations regarding this issue should be harmonised?

### 4.5 | Vascular access

The administration of endotracheal epinephrine (adrenaline) should not delay attempts to establish vascular access. Administration of further doses of epinephrine (adrenaline) every 3 to 5 min, preferably intravascularly, if the heart rate

remains less than 60/min, is suggested. If the response to endotracheal epinephrine (adrenaline) is inadequate, the authors suggest that an intravascular dose be given as soon as vascular access is obtained, regardless of the interval after any initial endotracheal dose. Intraosseous (IO) access is discussed, and ILCOR finds IO access as an alternative to the strongly supported umbilical venous route as the primary method of vascular access in the delivery room. ILCOR also warns of serious complications reported after IO. Although a weak recommendation with very low certainty of evidence, ILCOR suggests either the umbilical venous access or the IO route may be used to administer fluids and medications during newborn resuscitation outside the delivery room.

#### 4.6 | Thermal control

To maintain a normal temperature, ILCOR still recommends that preterm infants <32 weeks' gestation undergo the transition under a radiant warmer with a combination of warm environment (23–25°C in the delivery room), warm blankets, plastic wrapping without drying, cap, and thermal mattresses to reduce hypothermia (temperature <36°C on admission to NICU). We still have concerns that the combination of radiant warmer and thermal mattresses may induce hyperthermia.

Regarding recommendations for rewarming of unintentionally hypothermic newborns at hospital admission, the treatment recommendation is unchanged with no strong evidence for either rapid rewarming (0.5°C/h or greater) or slow rewarming (0.5°C/h or less).

For induced therapeutic hypothermia in settings with limited resources, the treatment recommendation is also unchanged; that is, that term or near-term newborn infants may be treated with therapeutic hypothermia (low-quality evidence); it is hoped that the results from a multicentre randomised controlled trial of therapeutic hypothermia (NCT02387385) with planned enrolment of 418 infants in India, Bangladesh and Sri Lanka will provide valuable additional information.<sup>21</sup> However, this study uses a servo-controlled cooling device and not passive hypothermia and/or ice packs as in the recommended intervention, so the new information will only pertain to servo-controlled device cooling. Indeed, the treatment recommendation advises the critical importance of clearly defined protocols such as those used in the randomised controlled trials (RCTs) in high-income countries, including strict temperature control at 33–34°C for 72 h. This is difficult to achieve with passive cooling and/or ice packs. We are therefore still concerned with the suggestion of cooling with ice-packs in low-resource setting. Nevertheless, we strongly agree with the recommendation for cooling to only be considered in neonatal care facilities with the capabilities for 'multidisciplinary care and availability of adequate resources to offer intravenous therapy, respiratory support, pulse oximetry, antibiotics, anticonvulsants, and pathology testing'.<sup>1,5,22</sup>

#### 4.7 | Discontinuation of resuscitation

It is interesting to notice how recommendations regarding discontinuing resuscitation have changed substantially the last 20 years. In 2000, it was stated that discontinuation of resuscitative efforts may be appropriate if resuscitation of an infant with cardiorespiratory arrest does not result in spontaneous circulation in 15 min. In 2005, it was stated that resuscitation of newly born infants after 10 min of asystole is very unlikely to result in survival or survival without severe disability. Five years later, this was changed to: 'If there are no signs of life after 10 min of continuous and adequate resuscitative efforts, it may be justifiable to stop resuscitation'. In 2015, the 10-min limit was maintained. However, in 2010 'justifiable' to stop was changed to 'appropriate', and in 2015 to 'reasonable'. This contrasts with the new recommendations arguing that a reasonable timeframe to consider before ending resuscitation 'is around' 20 min after birth.<sup>1–5</sup>

This shift in attitude strongly indicates that one should be careful drawing to firm conclusions regarding outcome based on heart rate and other clinical assessments during the first 15–20 min of life if there is need for resuscitation. The present recommendations regarding this issue are more adequate than previous ones. We think it is good for the patient, the parents and the providers that this more flexible approach is introduced.

#### 4.8 | Conclusion

The 2020 NLS treatment recommendations represent an important progress. The authors have carried out a substantial work for the benefit of neonatologists worldwide. We are still of the opinion ILCOR should have included auscultation together with ECG and other methods to detect heart rate in the delivery room. We also miss more specification regarding cord clamping and development of SpO<sub>2</sub> the first minutes of life. We also are concerned about some of the recommendations for thermal control. Among the new suggestions, all the recommendations were weak with low or very low certainty/evidence. This indicates there is plenty of scope for further research in this field.

#### CONFLICT OF INTERESTS

OD Saugstad was a reviewer for the 2020 Pediatric Life Support Recommendations.

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**How to cite this article:** Saugstad OD, Robertson NJ, Vento M. A critical review of the 2020 International Liaison Committee on Resuscitation treatment recommendations for resuscitating the newly born infant. *Acta Paediatr*. 2021;00:1-6. <https://doi.org/10.1111/apa.15754>