New guidelines for newborn resuscitation

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Abstract
The new guidelines from the International Liaison Committee on Resuscitation and American Heart Association/American Academy of Pediatrics for newborn resuscitation underline that efficient ventilation is the key to a successful resuscitation of the newly born infant. Compared with the former guidelines published in 1999, the major changes are (i) less emphasis on using supplemental oxygen when initiating resuscitation, (ii) no need for routine intrapartum oropharyngeal and nasopharyngeal suctioning for vigorous infants born to mothers with meconium staining of amniotic fluid, (iii) occlusive wrapping of very low birth weight infants <28 weeks to reduce heat loss is recommended, (iv) preference for the intravenous versus endotracheal route for adrenaline and (v) more emphasis on parental autonomy at the threshold of viability. A number of gaps in newborn resuscitation have been identified and discussed.

Conclusion: The new guidelines for newborn resuscitation are more evidence-based than previously ones. However, still there is a need for further research and modifications.

The International Liaison Committee on Resuscitation (ILCOR) and its collaborating organizations such as the American Heart Association (AHA) and American Academy of Pediatrics (AAP) have established their new guidelines for newborn resuscitation on review of the evidence for each step (1,2). In spite of the fact that newborn resuscitation is one of the most frequent procedures carried out in medicine, it is far from evidence-based. However, following the release of the 1992 guidelines (3), a major effort to examine the available evidence was undertaken in the 1999/2000 guidelines (4,5). This was done via a meticulous process where problematic areas were identified, all available literature in each area was collected and classified, and the best possible conclusions were drawn on the basis of this process. For the 2005/2006 guidelines, this process has continued and even more refined guidelines have now been published. An aim is to make newborn resuscitation more evidence-based and also to achieve international consensus of such guidelines. I will now review the specific changes in the new guidelines based on ILCOR and AHA/AAP and provide some commentaries regarding each recommendation. The most important changes from 1999 to 2005 are: (i) less emphasis on using 100% oxygen when initiating resuscitation, (ii) no need for routine intra-partum oropharyngeal and nasopharyngeal suctioning for vigorous infants born to mothers with meconium staining of amniotic fluid, (iii) recommendation of occlusive wrapping of very low birth weight infants <28 weeks to reduce heat loss, (iv) preference for the intravenous versus endotracheal route for adrenaline (epinephrine) and (v) increased emphasis on parental autonomy at the threshold of viability. In the new guidelines establishing effective ventilation remains the primary objective in the management of the apneic or bradycardiac newborn infant in the delivery room.

Indications for resuscitation
The previous guidelines (6) listed five questions, which should be asked at each and every delivery:

1. Is the amniotic fluid clear of meconium?
2. Is the baby breathing or crying?
3. Is there a good muscle tone?
4. Is the color pink?
5. Was the baby born at term?

Today we know that a newborn baby is not supposed to be pink in the first few minutes of life (7). Therefore, in the
Resuscitation of the newly born infant

Saugstad

According to the new guidelines, every baby of 28 weeks gestational age or less should immediately without drying be considered to be put into a plastic bag sealing up at the neck in order to prevent heat loss. Covering the head is also of importance to prevent heat loss. Some would find it reasonable to apply this technique also in somewhat more mature infants. Body and skin temperature must be monitored closely to avoid hyperthermia with this technique. Hyperthermia may be detrimental and has been associated with increased risk of brain injury (10,11).

Clearing the airway of meconium
Routine intra-partum oropharyngeal and nasopharyngeal suctioning is not longer advised for infants born to mothers with meconium staining of amniotic fluid (12). Immediate endotracheal intubation and suctioning through the endotracheal tube is not recommended in vigorous infants (i.e. strong respiratory efforts, good muscle tone and heart rate > 100 bpm) (15). Endotracheal suctioning should be performed immediately after birth in non-vigorous infants with meconium in the amniotic fluid presuming the equipment and expertise is available.

Ventilation
The new guidelines emphasize that proper positive pressure ventilation alone is effective for resuscitating almost all apneic or bradycardiac newborn infants. This is the single most important intervention in resuscitating asphyxiated newborn infants that are not breathing at birth. A rapid increase in heart rate is an indicator of the effectiveness of resuscitation (14); however, the rise of the chest may give an immediate feedback of the effectiveness of ventilation. In one series consisting of 600 newborn infants in need of resuscitation, a mean increase in heart rate from 90 bpm to

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**Bag and mask indications: Hr < 100 and or apnea**

<table>
<thead>
<tr>
<th>Ventilate for 30 seconds:</th>
<th>Rate: 40-60/min</th>
<th>Observe heart rate</th>
<th>Pressure: Visible rise and fall of chest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue ventilation</td>
<td>HR &lt; 60</td>
<td>Consider intubation</td>
<td></td>
</tr>
<tr>
<td>Start chest compressions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consider intubation</td>
<td>HR &gt; 100</td>
<td></td>
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</tr>
<tr>
<td>Check for spontaneous respirations</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>HR 60-100</td>
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</table>

*Figure 1* A simple flow sheet for the fundamental steps in newborn resuscitation from initiation of bag and mask ventilation via chest compressions to administration of medications. HR: heart rate given as bpm.
110 bpm occurred between 60 and 90 sec of life (15). An initial pressure of 20 Cm H₂O may be effective but a pressure of ≥30–40 Cm H₂O may be necessary in some babies (16).

The new ILCOR/AHA/AAP guidelines accept bag-mask ventilation to a newborn with a self-inflating bag, a flow-inflating bag or a T-piece mechanical device designed to regulate pressure as needed to provide positive pressure ventilation to a newborn.

**Oxygenation**

There has been a quite dramatic swing in attitudes regarding the use of oxygen for newborn resuscitation since the 1992 guidelines were published. In these guidelines it was stated ‘If cyanosis, bradycardia, or other signs of neonatal distress are noted in a breathing newborn during stabilization, early administration of 100% oxygen is important’. And furthermore, ‘The hazards of administering too much oxygen during the brief period required for resuscitation should not be a concern’ (3).

Today, there is increasing evidence that early administration of 100% O₂ is not as important and in fact may be hazardous and therefore of concern (7,8). In fact, healthy newborn infants need 5–10 min to reach oxygen saturations in the 90% (7,9). The new guidelines therefore state ‘There is currently insufficient evidence to specify the concentration of oxygen to be used at initiation of resuscitation’. And ‘Once adequate ventilation is established, if the heart rate remains low, there is no evidence to support or refute a change in the oxygen concentration that was initiated’. The new guidelines therefore leave it to the judgment of each centre or doctor to decide the initial oxygen concentration.

**Intubation and CO₂ detection**

Very few term or near term newly born infants are in need of tracheal intubation. Most babies in need of tracheal intubation are preterm infants. A laryngeal mask airway that is a mask fitting over the laryngeal inlet may be used if bag-mask ventilation is unsuccessful and endotracheal intubation is unsuccessful or not feasible.

In the new guidelines exhaled CO₂ detectors to confirm tracheal tube placement are recommended. They are reliable even in the smallest pre-term infants, provided there is not a cardiac arrest (17). However, false negative results may be found. Therefore, before withdrawing the endotracheal tube immediately the position of the tube should be checked first with direct laryngoscopy.

**Medications and volume expansion**

Medication is rarely needed because 99.9% of newborns will improve without. With adequate ventilation fewer than 2 per 1000 births will benefit from receiving adrenaline (18). If medication is needed in the acute phase of newborn resuscitation adrenaline (epinephrine) is the most important drug. According to the guidelines a narcotic antagonist, sodium bicarbonate or vasopressors may be useful, however, very rarely. The endotracheal route for adrenaline administration no longer is recommended. The IV dose is 0.01–0.03 mg/kg per dose. An adrenaline concentration of 1:10 000 (0.1 mg/mL) is recommended. However, if the endotracheal route is used a higher dose (up to 0.1 mg/kg) should be considered.

Volume expansion is rarely needed in full term or near term infants (19). However, if needed isotonic crystalloid solution is presently the solution of choice at 10 mL/kg which may be repeated. AHA/AAP recommend infusion over 5–10 min.

**Ethics**

Guidelines for withholding and discontinuing resuscitation are given. They do not differ much from the previous guidelines of 2000. However, the parent’s autonomy in these matters is emphasized more than previously. It is suggested that cardio-pulmonary resuscitation may be considered to be interrupted after 10 min if there is unsuccessful establishment of spontaneous heart rate and respiration: ‘After 10 minutes of continuous and adequate resuscitative efforts, discontinuation of resuscitation may be justified if there are no signs of life’. This is a rather brief observation time. Ten minutes go fast and although rare even when it takes more than 10 min to re-establish the babies own cardiopulmonary function intact cerebral outcome can be obtained. However, evidence regarding infants with 10 min of asystole suggests extremely poor outcome (20).

**Identified gaps in newborn resuscitation**

There still are a number of unanswered questions regarding newborn resuscitation. ILCOR has identified the following:

1. The ideal ratio of chest compressions to ventilation in cardiopulmonary resuscitation (CPR).
2. The benefits and risks of supplementary oxygen during CPR.
3. The benefits and risks of induced hypothermia following neonatal cardiac arrest.

A number of others could be listed as well. For instance, the indications for volume therapy and which fluid is optimal. The optimal glucose level one should maintain is not described. In the new guidelines it is stated that infants requiring resuscitation should be treated and monitored to maintain glucose in the normal range; however, this range was not defined.

Another important area for the future research is optimal ventilation. Excessive tidal volume in pre-term infants may be deleterious not only for the lungs but also for the brain. Today we know that too high or low tidal volume may be deleterious to the pre-term newborn lungs. Data from the study by Bjorklund et al. on newborn premature lambs showed that even a few breaths with a high tidal volume may injure the lungs (21), and it is known that inflammatory processes are initiated using too low tidal volumes (22). The next generation of ventilation bags therefore should offer the possibility to measure tidal volume. However, Palme Kilander and Tunell (23) demonstrated that bag and mask ventilation is not as efficient for gas exchange as spontaneous ventilation. If a baby can breathe successfully...
on its own, interference should not be provided by health personnel. Milner et al. showed tidal volume is substantially higher when ventilating via an endotracheal tube compared with bag and mask (24). This perhaps is not always an advantage.

Whether or not a PEEP should be used is not concluded in the new guidelines. It is clear from studies in pre-term lambs that PEEP improves oxygenation (25). Although very little data are available regarding any benefits of using PEEP in newborn resuscitation (26) many still believe this is beneficial. Randomized studies therefore should be conducted exploring this and other questions as soon as possible.

From a practical point of view, it is a strength that the guidelines give directions about how much time one should spend before moving from one step to the next. Why 30 sec has been chosen for each step is unclear to me. This seems to be a rather short period to assess the effect of bag and mask ventilation. Palme Kilander and Tunell have demonstrated it may take 1–2 min to achieve gas exchange of 2 mL/kg/min with bag and mask ventilation (23). Furthermore, if heart rate is <60 bpm after 30 sec of efficient ventilation, this bradycardia still is most often of respiratory origin and not cardiac. To start chest compressions that early is not evidence based and these parts of the guidelines should be questioned.

The optimal oxygen concentration obviously should be determined. My opinion is that the use of 100% oxygen in primary resuscitation should be abandoned because we today know this may be detrimental (27). A Cochrane review and another meta-analysis find room air reduces neonatal mortality with 30% (28) and 40% respectively (29). Furthermore, a number of ill effects of short exposure of oxygen have been found both clinically and experimentally (30,31). It, therefore, is surprising that the AAP seems to be more conservative than ILCOR and maintains that pure oxygen should be used initially, although the development in this area is acknowledged and AAP supports the option using less than 100% oxygen (8,9). In Canada and Sweden, national guidelines have decided that newborn resuscitation should start out with room air.

What we now need to determine is if there are any conditions where oxygen supplementation is truly needed and in such cases when should it be started. Should one start low and increase according to the needs as judged by pulse oximetry and/or the clinical response or start higher for instance at 40% and reduce quickly? Furthermore, is oxygen worse or perhaps better if there is a chooroamnionitis?

What the optimal pCO₂ is should now be added to the discussion of newborn resuscitation. Hypocapnia probably is not beneficial for the newborn brain (32). However, perhaps a moderate hypercapnia should be aimed at in order to accelerate normalization of cerebral blood flow? Experimental data indicate this may be more important when resuscitation is carried out with 21% O₂ (33). The optimal level of pCO₂ is an area that is not discussed in the new guidelines; however, this specific aspect should be emphasized in future research.

CONCLUSIONS

ILCOR has estimated that as many as 10% of all newborn infants need some intervention at birth and approximately 1% more extensive intervention (1). If this is correct, up to 13–14 million of the world’s annual newborn infants need intervention and of these approximately 1.5 million will need intensive therapy. Optimal resuscitation procedures should therefore become a high priority. The new guidelines for newborn resuscitation represent a major step forward and may improve outcome of newly born infants. Still these guidelines are inadequate in many ways. For instance, the recommendations to move from one step to the other after 30 sec may be too fast and to start chest compressions after 30 sec of ventilation may be too early. The guidelines regarding the use of 100% O₂ may be too conservative. How to best ventilate a newly born baby who is not breathing due to birth asphyxia is not clearly defined, what tidal volume to use to obtain an adequate rise in heart rate should probably be addressed. A PEEP probably is beneficial and so may also a moderate hypercapnia be.

Therefore, there are already a number of topics to discuss for those who are planning the next resuscitation guidelines coming out in approximately 5 years.

References