Update for Canadian NRP providers: A case-based review

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Posted: Aug 11 2017

Abstract
The International Liaison Committee on Resuscitation (ILCOR) Neonatal Task Force reviews available resuscitation science every 5 years and develops guidelines which are integrated into educational programs such as the Neonatal Resuscitation Program (NRP). The most recent ILCOR Neonatal Task Force consensus guidelines were published in October 2015. The Canadian Paediatric Society’s NRP Steering Committee has reviewed ILCOR guidelines alongside the 7th edition (2016) NRP materials. Using a case-based approach, this practice point highlights the main changes relating to the delivery of NRP, within the Canadian context.

Keywords: Debriefing, Education, Guidelines, Neonatal resuscitation, Resuscitation training, Simulation

Every 5 years, international experts review the available resuscitation science and formulate guidelines relevant for clinical practice [1]. Recommendations from the International Liaison Committee on Resuscitation (ILCOR) Neonatal Task Force are then reviewed and integrated into educational programs such as the Neonatal Resuscitation Program (NRP). The 7th edition of the NRP textbook, released in 2016, integrates clinical and educational changes emerging from the 2015 guidelines [2].

To facilitate implementation of the 7th edition of NRP within the Canadian context, the Canadian Paediatric Society’s NRP Steering Committee has reviewed the published international guidelines and the 7th edition NRP guidelines and textbook [2]. Using a case-based approach, the principal changes to the delivery of neonatal resuscitation and training are described. The topics covered were chosen on the basis of their relevance to NRP providers.

You and a colleague attend the delivery of a term infant born through meconium-stained amniotic fluid (MSAF). The infant is born apneic and non-vigorous. How should you proceed with resuscitation?

The 2015 guidelines state that “there is insufficient published human evidence to suggest routine tracheal intubation for suctioning of meconium in non-vigorous infants born through MSAF” [1]. In making this suggestion, the ILCOR Neonatal Task Force placed value on possible harm related to the procedure as well as potential benefits from the prompt initiation of resuscitation and assisted ventilation [1].

To prepare for such deliveries, it remains important to have a team member available who is skilled in neonatal intubation and advanced resuscitation. MSAF is a risk factor for abnormal transition and the non-vigorous infant may require mechanical ventilation. Avoiding routine intubation and tracheal suction of meconium does not preclude the need for advanced airway skills at some point(s) during resuscitation and stabilization.

The team should prepare by ‘briefing’, which includes assigning roles, checking equipment and discussing possible complications and management plans. Suction should still be prepared in the event that meconium presents an obstruction to mechanical ventilation.
Resuscitation of the non-vigorous infant starts with initial steps of positioning, drying, stimulation and gentle oropharyngeal suction of the mouth and nose, as required.

When the heart rate is <100 beats per minute (bpm) or the infant has ineffective respirations, positive-pressure ventilation (PPV) should be provided. The efficacy of ventilation should be assessed after 15 seconds of PPV by evaluating heart rate and chest rise.

When ventilation is ineffective, corrective steps should be instituted [2]. The ‘MR.SOPA’ mnemonic—Mask adjustment, Reposition airway, Suction mouth and nose, Open mouth, Pressure increase and Alternative airway—summarizes the corrective actions [3].

If thick meconium appears to be obstructing the infant’s airway, endotracheal intubation and suction are still indicated [2]. Endotracheal tube placement to provide PPV may also be required if initial corrective steps do not result in effective ventilation.

Your team is preparing to attend the delivery of an infant at 27 weeks’ gestational age. How do the most recent guidelines impact the resuscitation of this infant?

As with any resuscitation, appropriately trained personnel should be in attendance and a ‘brief’ provided regarding equipment preparation, anticipated management and role assignment. When delivery of a preterm infant is expected, an appropriate environmental temperature should be maintained and the radiant warmer prepared.

In caring for infants <32 weeks’ gestational age in the delivery room, the 2015 ILCOR guidelines suggest: “a combination of interventions, which may include environmental temperature 23 to 25 degrees celsius, warm blankets, polyethylene wrapping without drying, cap and thermal mattress to reduce hypothermia” [1]. Relevant history should be obtained from obstetric colleagues and plans made for delayed cord clamping if immediate resuscitation is not required. The oxygen blender should be pre-set to administer an initial concentration of oxygen, based on local guidelines. For preterm infants born at <35 weeks’ gestational age, recent ILCOR guidelines recommend a low initial oxygen concentration of 21%–30% [1].

Following delivery, delayed cord clamping is appropriate for a minimum of 30 seconds if the baby is stable. Without drying, the baby should be placed in a polyethylene wrap. The infant's temperature should be monitored using a servo-controlled radiant warmer with a temperature sensor, maintaining the baby's temperature within the normal range (36.5°C–37.5°C). Within the first minute after birth, initial steps should be completed and assessment of heart rate and respiratory effort undertaken with the delivery of PPV (if required).

Positive end-expiratory pressure is recommended when resuscitating the preterm infant, although recent guidelines do not recommend a particular device [1]. If the baby is breathing spontaneously at an adequate respiratory rate, continuous positive airway pressure (CPAP) is suggested for initial respiratory support [1]. CPAP pressures of 5 cm to 8 cm H2O may be considered [3]-[6]. Oxygen should then be provided according to recommended target saturations, as measured by a preductal saturation probe (NRP textbook, page 9) [2]. It is important to monitor ongoing respiratory status, as subsequent intubation may be required due to respiratory failure or for the administration of surfactant.

When the infant’s heart rate is less than 100 bpm, PPV should be provided. ‘MR.SOPA’ corrective steps should be incorporated if adequate ventilation is not achieved and oxygen should be increased to meet target saturations. The indications for initiating chest compressions and the recommended ratio of chest compressions to ventilation of 3:1 remain unchanged. The current NRP notes that while heart rate can be assessed by auscultation or pulse oximetry, electronic cardiac monitoring is the preferred method of assessment when administering chest compressions [2]. Canadian recommendations for simplified epinephrine dosing remain at 0.01 mg/kg when administered intravenously and 0.1 mg/kg when administered endotracheally (0.1 mL/kg and 1 mL/kg, respectively of 1:10,000 concentration). Of note, the maximum recommended endotracheal dose remains 0.3 mg (3 mL of 1:10,000 concentration). The indication for administering epinephrine is a heart rate less than 60 bpm despite effective ventilation and 60 seconds of chest compressions.

As with any complex resuscitation, preparedness and effective communication are integral to optimal team performance. Recurrent and frequent training should be considered; specifically, this training should be
geared toward integrating specific task work or teamwork training, depending on learner needs [1].

**Provider education: does an NRP course every 2 years provide enough training? What are the best ways to teach NRP skills?**

One aim of the recent ILCOR review was to evaluate the delivery of resuscitation training in general [8]. Studies have shown that retention of skills beyond 6 months is low for most formalized programs and that efficiency and effectiveness of skill delivery are reduced even 2 to 4 months after initial training [7][9]. Supplementary skills training can be used to improve knowledge and skill performance, but optimal timing for each type of learner remains unclear [7][8].

What is known is that to maximize learning, practice sessions should incorporate pre-determined objectives for specific tasks and the context in which these tasks are performed (i.e., case-based scenarios) [10]. Single skills, like mask ventilation, may only require a heart rate prompt, whereas tasks that require teamwork are best practiced in integrated ‘high fidelity’ simulations. Ideally, training should offer a level of realism that aligns with the complexity of tasks being taught and includes the following stages: clarifying task objectives (briefing), practice performing the task(s) and reflecting on the experience (debriefing) [11]. Non-technical team skills can be developed through simulation or ‘mock code’ exercises.

An effective learning strategy may comprise frequent, brief practice sessions [12]. For example, NRP providers could spend 5 minutes every month practising mask ventilation on a mannequin, while receiving heart rate and saturation prompts. Trainees would be expected to take corrective measures (e.g., using MR.SOPA) to achieve sufficient rise in heart rate and saturation. Repeated opportunities for focused practice would better enable individuals to achieve and retain mastery in the most important NRP skills, such as mask ventilation or the MR.SOPA routine. Short sessions of briefing and debriefing would further reinforce teamwork and taskwork. While there may some challenges to implementing frequent, brief practice sessions across large organizations, they should be encouraged at every opportunity [12].

Instructions for such practice sessions must be clearly shared with learners in focused and concise briefing notes. After simulation or skill station training, reflection should be promoted through debriefing. Debriefing questions specific to the learning objectives should be prepared in advance to help achieve this goal [11].

Neonatal resuscitation education should include completion of a formal NRP course every 2 years (at a minimum) but optimally—and whenever possible—should also include frequent training sessions to reinforce and improve skills, based on learner needs. The timing of sessions for each learner level deserves further study, but to maintain a high degree of realism, training exercises should include all members of the interprofessional team and take place in the clinical environment. Active learning, with clear objectives, integrating skills into simulation exercises and debriefing, will enhance individual and team performance.

The summary of key changes in Table 1 is based on 2015 ILCOR and 7th edition NRP guidelines.
For infants <32 weeks’ gestational age, a combination of interventions is recommended to optimize thermoregulation, including Dunn  Ringer’s lactate is no longer recommended for fluid resuscitation. Naloxone use in infants with respiratory depression following maternal Morley  SUPPORT The two-thumb technique is recommended for chest compressions. The compressor should move to head of bed once airway is secured. Placement of an alternate airway with 30 s of effective ventilation provided through this airway should take place before initiation of Perlman  Guidelines for depth of insertion of ETT recommend gestation-based guidelines or use of the nasal-tragus length method  After 15 s of PPV, assessment of HR should take place. If HR is not increasing, chest rise should be evaluated. If the chest is moving, a further 15 s of PPV should be administered before reassessment of HR. If the chest is not moving, corrective steps (MR.SOPA) should be initiated. HR should be reassessed after 30 s of ventilation that moves the chest  Guidelines for depth of insertion of ETT recommend gestation-based guidelines or use of the nasal-tragus length method  Placement of an alternate airway with 30 s of effective ventilation provided through this airway should take place before initiation of compressions  The two-thumb technique is recommended for chest compressions. The compressor should move to head of bed once airway is secured. Reassessment of heart rate should occur after 60 s of chest compressions. ECG is the preferred method for assessment of HR during chest compressions, but auscultation or pulse oximetry can also be used  Ringer’s lactate is no longer recommended for fluid resuscitation. Naloxone use in infants with respiratory depression following maternal narcotic administration is not recommended because there is ‘insufficient evidence to evaluate the safety and efficacy’ of this practice  For infants <32 weeks’ gestational age, a combination of interventions is recommended to optimize thermoregulation, including maintaining room temperature at 23°C, preheating the radiant warmer, use of a hat, placing a thermal mattress under the radiant warmer and using a polyethylene wrap  If the preterm infant is spontaneously breathing but has laboured respirations, consider CPAP. If PPV is required, use of PEEP is recommended

Acknowledgements
This practice point has been reviewed by the Fetus and Newborn, Community Paediatrics, Bioethics and First Nations, Inuit and Métis Health Committees of the Canadian Paediatric Society. It was also reviewed by representatives from the Society of Obstetricians and Gynaecologists of Canada.

References

Table 1.
Summary of key changes in the 7th (2016) edition of the Neonatal Resuscitation Program [1][2]

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<thead>
<tr>
<th>Change</th>
<th>Description</th>
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<tr>
<td>• Focus on teamwork, communication and leadership skills</td>
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<td>• Emphasis on pre-delivery briefing</td>
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<td>• For vigorous term and preterm infants, delayed cord clamping for 30 to 60 s is recommended</td>
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<td>• When meconium is present and the newborn is hypotonic with ineffective respirations, ‘routine intubation for tracheal suction is not suggested’. Initial resuscitation and administration of PPV should be undertaken, as required. Meconium remains a risk factor for abnormal transition and a team with advanced resuscitation skills should be present</td>
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<td>• Starting gases: For the term infant, resuscitation should start with 21% oxygen. For preterm infants &lt;35 weeks’ gestational age, recommended initial gas is 21%–30% oxygen</td>
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<td>• After 15 s of PPV, assessment of HR should take place. If HR is not increasing, chest rise should be evaluated. If the chest is moving, a further 15 s of PPV should be administered before reassessment of HR. If the chest is not moving, corrective steps (MR.SOPA) should be initiated. HR should be reassessed after 30 s of ventilation that moves the chest</td>
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ECG Electrocardiogram; ETT Endotracheal tube; GA Gestational age; HR Heart rate; MR.SOPA: Mask adjustment, Reposition airway, Suction mouth and nose, Open mouth, Pressure increase and Alternative airway; PPV Positive pressure ventilation; PEEP Positive end-expiratory pressure; CPAP Continuous positive airway pressure


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