Neonatal Resuscitation

Preparation for the Depressed Neonate

Inadequate resuscitation efforts have increasingly been cited as the cause of neonatal morbidity or mortality. Birth asphyxia accounts for nearly 19% of the approximately 5 million neonatal deaths that occur each year worldwide. This observation is sobering, given the fact that approximately 10% of newborns require initial life support at birth, and about 1% need extensive resuscitative measures to survive. Medical personnel attending deliveries must therefore anticipate resuscitation for an asphyxiated or depressed infant. Recognizing the need that “at least one person skilled in neonatal resuscitation should be in attendance at every delivery,” and “an additional skilled person should be readily available,” the American Heart Association and the American Academy of Pediatrics established the Neonatal Resuscitation Program, which is endorsed by the American College of Obstetrics and Gynecology, the American Academy of Family Physicians, and the American Society of Anesthesiology. A recent study documented improved outcomes for high-risk neonates where providers have completed the Neonatal Resuscitation Program.

The Neonatal Resuscitation Program is required in many institutions in Washington State for those who deliver infants. The advantage of this training is obvious—techniques mastered in the program help caregivers provide for the best outcome to newborns. Keeping these skills sharp is an additional challenge, especially in settings where they are infrequently required. The following strategies are recommended:

◆ Be sure that all delivering physicians, in addition to anesthesiologists, nurses, and respiratory therapists involved in newborn care, successfully complete the Neonatal Resuscitation Program. Provide mock resuscitation codes on a regular basis.

◆ Regularly inspect the equipment and medications necessary for newborn resuscitation.

◆ Establish hospital policy that clearly identifies the personnel with primary responsibility for the actual resuscitation. Establish procedures for recruiting additional help if necessary. These policies should adhere to practice guidelines of other specialties. For example, an anesthesiologist providing maternal anesthesia who is present at a delivery may be asked to provide assistance in a resuscitation. However, the anesthesiologist’s primary responsibility is to provide care for the mother according to practice guidelines of the American Society of Anesthesiology.

◆ Place visual aids in the delivery area to remind care providers of the critical steps to follow in the assessment and management of the newborn. The enclosed poster provides an overview of resuscitation in the delivery room.

Resuscitation of the Newborn is Divided into 4 Major Steps:

1. Stabilize the infant and minimize heat loss. Asphyxiated infants have unstable thermoregulatory systems, and recovery from acidosis is delayed with hypothermia. Dry off the infant under a radiant warmer, position the infant in a supine or lateral position with neutral head position, and suction the mouth and nose—a process which should take approximately 20 seconds. If meconium is present in the amniotic fluid or on the infant’s skin, suction the mouth, nose, and posterior pharynx after delivery of the head, but before delivery of the shoulders. If meconium aspiration is suspected, proceed with tracheal suctioning.

2. Assess neonatal respiration within 30 seconds of birth. If the infant is gasping or apneic, begin positive pressure ventilation with 100% O₂ bag-valve mask at a rate of 40-60 breaths per
minute. Initial lung inflation may require pressures of 30-40 cm H$_2$O or greater. Observe chest-wall movement and auscultate over the axillae to confirm adequate ventilation. If positive pressure ventilation is not successful initially, reposition the face mask to improve the seal, administer further suctioning, and increase inflation pressures. If bag and mask ventilation is not adequate after these maneuvers, proceed with immediate endotracheal intubation for ventilation.

3. Assess neonatal heart rate.
   It is very rare that neonatal resuscitation requires chest compression if the neonate is adequately ventilated. Neonatal cardiac arrest is usually secondary to respiratory failure. Tissue hypoxia and acidosis from inadequate ventilation eventually result in bradycardia and cardiac arrest. Perform chest compressions if the neonate’s heart rate is less than 60, despite adequate ventilation with 100% O$_2$ for 30 seconds. Guidelines recommend 90 compressions per minute at a 3:1 ratio of compressions interposed with ventilation. This provides 30 unobstructed breaths per minute.

4. Administer medications.
   Medications should be given if the heart rate remains below 60 after giving 30 seconds of assisted ventilation, and another 30 seconds of coordinated chest compressions with ventilation. An overview of resuscitation, as well as medications, doses, and routes of administration, are given in the Appendix.

RESUSCITATION REQUIRES A REPEATED, SIMULTANEOUS ASSESSMENT OF RESPIRATIONS, HEART RATE, AND COLOR.

While this information cannot substitute for the more extensive instruction contained in the Neonatal Resuscitation Program, it may serve as a refresher to those who have taken the program. Care providers may find it useful to prepare for each delivery as though the anticipated newborn will require resuscitation. Check the warmer; the suction equipment; bag-valve mask device, oxygen source and manometer; laryngoscope with proper-sized blade and functional bulb; and appropriate endotracheal tube for gestational age or anticipated weight.

Anticipate A Depressed Infant In Circumstances Such As Deliveries Complicated By But Not Limited To:

1. Fetal distress noted during fetal monitoring
2. Chorioamnionitis
3. Meconium
4. Multiple birth
5. Forceps/instrument delivery
6. Breech presentation
7. Congenital anomalies
8. Prematurity
9. Recent narcotic use by mother
10. Exposure to magnesium sulfate
11. Vaginal bleeding, including placental abruption and placenta previa
**Mock Codes**

Even in the best of hospitals, intensive resuscitation efforts for newborns are all too often unanticipated events. Any delay in establishing effective cardiorespiratory function increases the potential risk for hypoxic-ischemic cerebral injury, pulmonary arterial hypertension, and systemic organ dysfunction.

Since intensive resuscitation of neonates is usually infrequent and often unanticipated, clinical expertise and working as part of a proficient team are critical skills to be learned or maintained.

Implementing mock codes as part of your hospital’s regular routines is an easy and effective way to maintain these skills.

**Practice Makes Perfect**

Performing mock codes in your institution can provide many benefits for staff and meet performance standards for continuous quality-improvement projects for JCAHO audits! Some of the benefits include the following:

- By using resuscitation scenarios, clinical skills can be learned or maintained and practiced in a fun way on a regular basis.
- Individuals from different disciplines learn to interact with each other through role-playing.
- Clinical decision making can be practiced in a relatively uncharged situation using various what-if scenarios, such as “What would you do if you were ruling out pneumothorax?” “What would the baby look like?” and “What clinical signs would you watch for?”
- Various systems and equipment problems can be identified and improved upon before a real code occurs.

**The Nuts and Bolts of Setting Up Mock Codes**

Following are suggestions from different institutions to facilitate the process of setting up mock codes, and to assist you with formulating a plan of action.

Schedule mock codes often enough that different personnel can rotate through. Quarterly mock codes are probably enough to refresh your skills without becoming overdone. Whenever possible, make the mock codes interdisciplinary. If your institution utilizes a designated high-risk team or a group of neonatologists, involve them as experts in the planning, implementation, and evaluation phases as much as possible. Other disciplines that might be involved include respiratory therapy, pharmacy, and anesthesia.

Encourage all Birth Center personnel to participate. Post memos ahead of time and send them to individual physicians to encourage participation. Additionally, send memos to staff scheduled for the day of the event to remind them they may be asked to participate.

Designate one person to lead the code. For ease of scheduling, consider designating the physician on call for that day.

Plan a scenario in advance to provide the team with some background information. For example:

*This 30 y.o. G2 P1 female at 32 weeks’ gestation arrived at 1630 after being involved in an automobile accident. FHTs were found to be in the 90s on arrival and stat C/S was performed. Baby is now delivered at 1650 and is blue and limp. No respiratory effort is noted; an initial HR is 60. What do you do?*

The person providing the scenario could be the medical director, neonatologist, or anyone having advanced neonatal skills. This person continues to provide information, and acts as an observer in order to assist with debriefing after the code is completed.
Use actual supplies as much as possible. This allows people to practice skills, such as drawing up and giving epinephrine via an endotracheal tube, as well as assessing, for instance, whether supplies are available, easy to find, and in correct dosages.

To take the anxiety out of role-playing, roles can be drawn out of a hat along with key points or directions. This allows for some spontaneity and prevents an “experts only” code from happening (see “Mock Code Roles” on p. 40).

Include charting as part of the code. Charting can be done on, or transcribed to, a code form and evaluated for completeness (see “Infant Code Record” on p. 43).

Debriefing after a mock code is critical to the overall success of the program. Questions to encourage participation include:

◆ What went well?
◆ What didn’t go as well?
◆ What needs to be worked on?
◆ Did we have the right personnel/supplies/equipment?
◆ Did everyone understand his or her role (and was it performed correctly)?

Use the debriefing session as a means to impart information and bolster interdepartmental communication. One word of caution: Overzealousness in focusing on “what went wrong” or placing blame could impart bad feelings among team members. The best rule of thumb is to provide “gentle direction for correction” and focus on systems changes or types of communication that work well.

Performing mock codes in your institution can only serve to enhance the performance of the resuscitation team and provide a template for actual skills review. It also serves as a way for people to get to know each other’s skill level and expertise, and to practice working as a team, before that next unanticipated code occurs at your institution.

**Key Points for Preparedness in Neonatal Resuscitation**

◆ Require delivering physicians and others attending deliveries to successfully complete the Neonatal Resuscitation Program (AHA, AAP) with regular—consider yearly—recertification.
◆ Ensure proper equipment and regular inspection by a staff member who has successfully completed the Neonatal Resuscitation Program.
◆ Review equipment prior to delivery:
  a. Warmer
  b. Towels
  c. Suction equipment
  d. Bag-valve-mask device, manometer, and oxygen source
  e. Laryngoscope with proper-sized blade, and functional bulb with stylette
  f. Endotracheal tube of appropriate size
  g. Stethoscope
◆ Review the Overview of Resuscitation schema in the delivery room.
◆ Practice mock resuscitation codes with personnel on a regular basis.

**Conclusion**

In a sense, all infants require resuscitation. While most require only the first few steps of the process (e.g., placement under a radiant heat source, drying, positioning, suctioning, and stimulation), others require further steps in the scheme. Reviewing the process of resuscitation and preparing for each delivery as suggested takes a few minutes—minutes that will ensure the best possible outcome after delivery.
References


Special thanks to Elsa Spicochi, R.N., for her mock-code expertise and assistance in writing this review.
### Mock-Code Roles

The following mock-code roles, along with the key points associated with each role, may be cut up and drawn out of a hat. Two Helper and Observer roles are included for use when practical.

<table>
<thead>
<tr>
<th>Roles</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPR—Compressions</td>
<td>key points: rate, depth, position on chest, when to start or stop</td>
</tr>
<tr>
<td>CPR—Ventilation</td>
<td>key points: rate, position of bag and mask, troubleshooting if inadequate chest rise, coordinate with compressions</td>
</tr>
<tr>
<td>Medications</td>
<td>key points: calculate doses, label syringes, anticipate medication needs</td>
</tr>
<tr>
<td>Recorder</td>
<td>key points: VS, meds given (drug, dose, route, and time), labs, lines placed, intubation (time, size of ETT, cm marking @ lip)</td>
</tr>
<tr>
<td>Helper</td>
<td>key points: phone calls (supervisor, RT, pharmacy, lab), VS with BP, chems, opening/locating equipment, pushing drugs, running labs</td>
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<td>key points: phone calls (supervisor, RT, pharmacy, lab), VS with BP, chems, opening/locating equipment, pushing drugs, running labs</td>
</tr>
<tr>
<td>Observer</td>
<td>key points: provide information, evaluate CPR compression and ventilation rates, medication administration, code sheet filled out by the recorder. Note where the code ran smoothly and areas for improvement.</td>
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</tbody>
</table>
### Stabilization Chart

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Normal Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>98–98.6°Fahrenheit</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>120–160 Beats per Minute</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>40–60 Breaths per Minute</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>1.5–2.5 kg infant: systolic &gt;43</td>
</tr>
<tr>
<td></td>
<td>&gt;2.5 kg infant: systolic &gt;52</td>
</tr>
<tr>
<td>Peripheral Perfusion</td>
<td>Capillary filling time &lt;3 seconds</td>
</tr>
<tr>
<td>Blood Gases</td>
<td>Capillary: 7.35–7.45, pCO₂ 35–46, pO₂ &gt;45</td>
</tr>
<tr>
<td></td>
<td>Arterial: 7.35–7.45, pCO₂ 35–45, pO₂ &gt;70</td>
</tr>
<tr>
<td>Blood Sugar</td>
<td>Chemstrip or Dextrostix: &gt;40</td>
</tr>
<tr>
<td></td>
<td>Blood Sugar: &gt;40</td>
</tr>
<tr>
<td>Pulse Oximetry (SaO₂)</td>
<td>Greater than 95% pre- and postductally</td>
</tr>
</tbody>
</table>

Consult your local guidelines—normal values may vary from institution to institution.

### References

## Initial Signs of Arrest:
- Apnea
- Hypotension
- Bradycardia
- Absence of Pulses
- Cyanosis / Sats
- Other

## IV Access:
- Peripheral
- Central Line

## Patient Card Imprint

### History of Events Prior to Arrest:

### VITAL SIGNS

<table>
<thead>
<tr>
<th>TIME</th>
<th>HEART RATE</th>
<th>BLOOD PRESSION</th>
<th>RESPIRATIONS</th>
<th>ABG / LABS SENT</th>
<th>GLUCOSE / CHEMISTRY</th>
<th>EPINEPHRINE (0.1-0.3 mcg/kg)</th>
<th>SODIUM BICARBONATE</th>
<th>SUCRENE (0.15 mcg/kg)</th>
<th>MARCAIN (0.1 mg/ml)</th>
<th>DOXYCINE (mg kg)</th>
</tr>
</thead>
</table>

### Other

- Intubation: Oral
- Nasal
- Tube size

### Meds Dose Route

- Intubation and placement verified by
- NG tube inserted / placement verified by

### Infusions

- Include mg, mg, mEq / IV, ET, IO
- Include mg

### Patient's Response

- Code terminated by
- Code terminated at
- Transferred to
- Time
- Time expired

### Sample

**Infant Code Record**

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Neonatal Resuscitation Program - Reference Chart

The most important and effective action in neonatal resuscitation is ventilation of the baby's lungs with oxygen.

**Endotracheal Intubation**

<table>
<thead>
<tr>
<th>Gestational Age (weeks)</th>
<th>Weight (kg)</th>
<th>ET Tube Size (ID, mm)</th>
<th>Depth of Insertion* (cm from upper lip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;28</td>
<td>&lt;1.0</td>
<td>2.5</td>
<td>6 - 7</td>
</tr>
<tr>
<td>28 - 34</td>
<td>1.0 - 2.0</td>
<td>3.0</td>
<td>7 - 8</td>
</tr>
<tr>
<td>34 - 38</td>
<td>2.0 - 3.0</td>
<td>3.5</td>
<td>8 - 9</td>
</tr>
<tr>
<td>&gt;38</td>
<td>&gt;3.0</td>
<td>3.5 - 4.0</td>
<td>9 - 10</td>
</tr>
</tbody>
</table>

*Depth of Insertion (cm) = 6 + weight (in kg)

**Medications for Neonatal Resuscitation**

- **Epinephrine**
  - Concentration: 1:10,000
  - Preparation: 1:10,000 solution in 1 mL syringe
  - Dosage/Route: 0.01 - 0.03 mg/kg (0.1 - 0.3 mL/kg) ET or IV
  - Rate/Precautions: Give rapidly, flush catheter/ET tube with 0.5 - 1 mL, normal saline

- **Volume expanders**
  - Normal saline (recommended)
  - Preparation: Ringer's Lactate (negative blood)
  - Dosage/Route: 10 mL/kg IV (Umbilical vein)
  - Rate/Precautions: Give over 5-10 minutes

- **Sodium Bicarbonate**
  - Concentration: 0.5 mEq/mL (4.2% solution)
  - Preparation: Estimated volume drawn into syringe(s)
  - Dosage/Route: 2 mEq/kg (4 mL/kg) IV only (Umbilical vein)
  - Rate/Precautions: Give slowly, over at least 2 minutes (1 mEq/kg/min)
  - Consider: Give only if newborn is being effectively ventilated

Postresuscitation medications (Including post delivery room):
- **Naloxone hydrochloride**
  - 0.1 mg/kg; give rapidly; IV or ET (preferred); IM, SQ (acceptable)

- **Glucose/D10W**
  - 2 mL/kg (200 mg/kg) IV over 1 - 2 minutes;

- **Phenobarbital (for seizures)**
  - 20 mg/kg slow IV push (1 mg/kg/min);

- **Dopamine (for hypotension)**
  - 2 - 20 mcg/kg/min by continuous IV infusion

Drip Calculation:

**IM** - Intramuscular; **ET** - Endotracheal; **IV** - Intravenous; **SQ** - Subcutaneous