

# Post-resuscitation (are

## What you will learn

- What to do after neonatal resuscitation
- Medical conditions that may occur following neonatal resuscitation
- Management considerations following neonatal resuscitation
- The role of therapeutic hypothermia in post-resuscitation care



## Key Points

- A baby who required resuscitation must have close monitoring and frequent assessment of respiratory effort, oxygenation, blood pressure, blood glucose, electrolytes, urine output, neurologic status, and temperature during the immediate neonatal period.
- f.) Be careful to avoid overheating the baby during or after resuscitation.
- E) If indicated, therapeutic hypothermia must be initiated promptly; therefore, every birth unit should have a system for identifying potential candidates and contacting appropriate resources.

## Case: An early term pregnancy with fetal distress

A baby was born at 37 weeks' gestation by emergency cesarean section because of maternal fever with signs of fetal distress during labor. After birth, the baby was limp and apneic, and did not respond to the initial steps of newborn care. Positive-pressure ventilation (PPV) was started and continued for 3 minutes until effective spontaneous respiratory effort was established. During the next several minutes, the baby developed labored breathing and required supplemental oxygen to maintain oxygen saturation within the target range. The team leader updated the parents, explained the baby's condition, and described the post-resuscitation care plan.

The newborn arrives in the nursery where vital signs, including temperature, oxygen saturation, and blood pressure are recorded. The baby continues to require supplemental oxygen with labored breathing, and a chest x-ray is requested. A team member obtains a blood sample for glucose, bacteria! culture, and blood gas testing. An intravenous catheter is inserted and the baby receives fluids and parenteral antibiotics. The health care providers discuss their plan for close monitoring and frequent assessment. The baby's father arrives at the bedside where he touches and comforts his baby. The medica! provider gives the father an interval update and explains the treatment plan. Shortly afterward, the team members conduct a debriefing to review their preparation, teamwork, and communication.

## Postnatal (are

The physiologic transition to extrauterine life continues for several hours after birth. Babies who required resuscitation may have problems making this transition even after their vital signs appear to return to

normal. Medical complications after resuscitation may involve multiple organ systems. Many of these complications can be anticipated and promptly addressed by appropriate monitoring.

This program refers to 2 broad categories of postnatal care. The intensity of monitoring and the interventions required for individual babies will vary within these categories.

- **Routine care**

Nearly 90% of newborns are vigorous term babies with no risk factors and they should remain with their mothers to promote bonding, initiate breastfeeding, and receive routine newborn care (Figure 9.1). Similarly, a baby with certain prenatal or intrapartum risk factors, who responded well to the initial steps of newborn care, may only need close observation and does not need to be separated from the mother. Ongoing observation of breathing, thermoregulation, feeding, and activity are important to determine if additional interventions are required. The frequency of these evaluations will be determined by the specific perinatal risk factors and the baby's condition.



**Figure 9.1.** Routine care. (Used with permission of Mayo Foundation for Medical Education and Research.)

- **Post-resuscitation care**

Babies who required supplemental oxygen, PPV, or continuous positive airway pressure (CPAP) after delivery will need closer assessment. They may develop problems associated with abnormal transition and should be evaluated frequently during the immediate newborn period. In addition to routine newborn care, they often require ongoing respiratory support, such as supplemental oxygen, nasal CPAP, or mechanical ventilation. Many will require admission to a nursery

environment where continuous cardiorespiratory monitoring is available and vital signs can be measured frequently (Figure 9.2). Some will require transfer to a neonatal intensive care unit. If a newborn requires post-resuscitation care in a location outside of the mother's room, the parents should be encouraged to see and touch their baby as soon as it is feasible. The period of time needed for close observation is dependent on the newborn's condition, progress toward normal transition, and the presence of identifiable risk factors.



**Figure 9.2.** Post-resuscitation care in a setting where continuous cardiorespiratory monitoring is available and vital signs can be measured frequently

### What medical conditions may occur in babies who required resuscitation?

Abnormalities in multiple organ systems may occur following neonatal resuscitation. Anticipated clinical signs, laboratory findings, and management considerations are summarized in Table 9-1. Individual circumstances will determine which of these management considerations are appropriate.

#### Temperature instability

After resuscitation, babies may become too cold (hypothermic) or too warm (hyperthermic). Premature newborns are at high risk of hypothermia and this has been associated with increased mortality. Special techniques for maintaining body temperature in preterm newborns are addressed in Lesson 8. Babies may become hyperthermic if their mother has a fever or chorioamnionitis, if the baby has an

**Table 9-1 • Clinical Signs, Laboratory Findings, and Management Considerations**

Organ System	Clinical Signs and Laboratory Findings	Management Considerations
Constitutional	Hypothermia	Delay bathing.
Respiratory	Tachypnea, grunting, retractions, nasal flaring, low oxygen saturation, pneumothorax	Maintain adequate oxygenation and ventilation. Monitor for signs of pulmonary hypertension. Avoid unnecessary suctioning. Cluster care to allow periods of rest. Consider antibiotics. Consider x-ray and blood gas. Consider surfactant therapy. Consider delayed initiation of feedings with use of intravenous fluids.
Cardiovascular	Hypotension, tachycardia, metabolic acidosis, poor perfusion	Monitor blood pressure and heart rate. Consider volume replacement or inotrope administration if baby is hypotensive.
Endocrine-Metabolic	Metabolic acidosis, hypoglycemia (low glucose), hypocalcemia (low calcium), hyponatremia (low sodium), hyperkalemia (high potassium)	Monitor blood glucose. Monitor serum electrolytes as indicated. Consider intravenous fluids. Replace electrolytes as indicated.
Gastrointestinal	Feeding intolerance, vomiting, abdominal distention, abnormal liver function tests, gastrointestinal bleeding	Consider abdominal x-ray. Consider delayed initiation of feedings. Consider use of intravenous fluids. Consider parenteral nutrition.
Renal	Decreased urine output, edema, electrolyte abnormalities	Monitor urine output. Monitor serum electrolytes as indicated. Monitor weight. Restrict fluids if baby has decreased urine output and vascular volume is adequate.
Neurologic	Apnea, seizures, irritability, poor tone, altered neurologic examination, poor feeding coordination	Monitor for apnea. Support ventilation as needed. Monitor glucose and electrolytes. Avoid hyperthermia. Consider anticonvulsant therapy. Consider therapeutic hypothermia. Consider delayed initiation of feedings. Consider using intravenous fluids.
Hematologic	Anemia, thrombocytopenia, delayed clotting, pallor, bruising, petechiae	Monitor hematocrit, platelets, jaundice, bilirubin, and coagulation studies as indicated.

infection, or if the radiant warmer is not used properly. Hyperthermia has been associated with worsened outcomes and should be avoided.

### **Pneumonia and other respiratory problems**

The need for resuscitation may be an early sign that a newborn has pneumonia, a perinatal infection, or an aspiration event. Neonatal pneumonia (Figure 9.3B) may present with tachypnea and other signs of respiratory distress such as grunting, nasal flaring, and

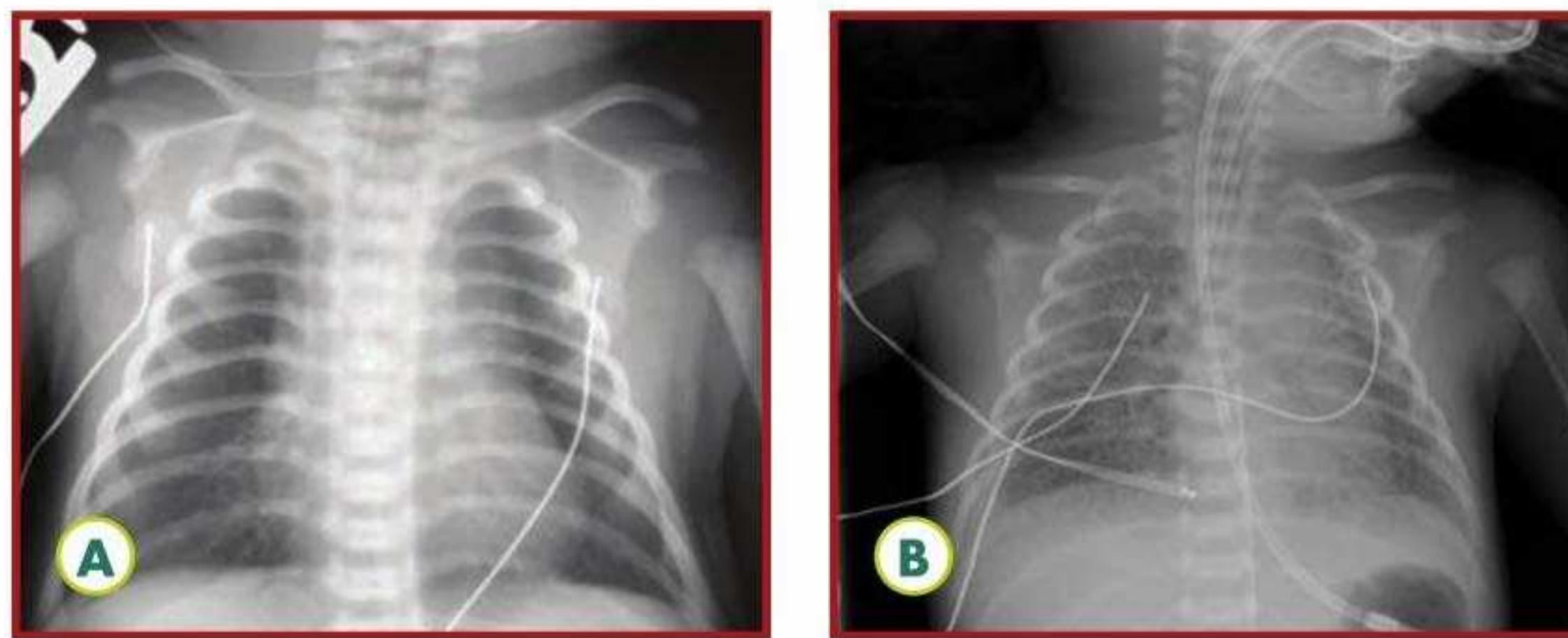


Figure 9.3. Neonatal chest x-rays: (A) normal, (B) pneumonia



Figure 9.4. Right pneumothorax

retracting. It can be difficult to differentiate between respiratory distress syndrome, retained fetal lung fluid, and neonatal pneumonia by chest x-ray. If a baby who required resuscitation continues to show signs of respiratory distress or requires supplemental oxygen, consider evaluating the baby for pneumonia and perinatal infection. Obtain appropriate laboratory tests and begin parenteral antibiotics.

If acute respiratory deterioration occurs during or after resuscitation, consider the possibility that the baby has a pneumothorax (Figure 9.4). Lesson 10 includes details about managing a pneumothorax. If the baby is intubated and develops acute respiratory deterioration, ensure that the endotracheal tube has not become dislodged or obstructed by secretions.

### Pulmonary hypertension

As described in Lesson 1, blood vessels in the fetal lungs are tightly constricted. After birth, the pulmonary vessels relax and blood flows into the lungs where hemoglobin can be saturated with oxygen for delivery to the tissues and organs.

The pulmonary blood vessels may remain constricted after birth. This condition is called persistent pulmonary hypertension of the newborn (PPHN) and is most often seen in babies greater than or equal to 34 weeks' gestational age. PPHN usually is managed with supplemental oxygen and, in some cases, mechanical ventilation. Severe PPHN may require special therapies such as high-frequency mechanical ventilation, inhaled nitric oxide, and extracorporeal membrane oxygenation (ECMO).

After resuscitation, the baby's pulmonary vascular tone can be labile and may increase in response to sudden decreases in oxygen saturation or unintentional hypothermia; therefore, avoid unnecessary suction, excessive stimulation, and immediate bathing. While avoiding sudden decreases in saturation may be beneficial, intentionally maintaining

very high blood levels of oxygen is not likely to be helpful and may cause additional complications. A pulse oximeter should be used to guide oxygen therapy. In the setting of suspected PPHN, an arterial blood gas provides additional useful information that cannot be determined from pulse oximetry alone.

### **Hypotension**

Hypotension during the post-resuscitation phase may occur for multiple reasons. Low oxygen levels around the time of birth can decrease both cardiac function and blood vessel tone. If the baby had significant blood loss, the circulating blood volume may be low and contribute to hypotension. Babies with sepsis may have normal or high cardiac output, but they may become hypotensive because of dilation of peripheral blood vessels.

Babies who require significant resuscitation should have their blood pressure monitored until it is stable within an acceptable range. If there is evidence of hypovolemia, volume expansion with a crystalloid solution, or blood transfusion, may be indicated. Routine volume expansion without evidence of hypovolemia is not recommended. Some babies may require a medication such as dopamine, dobutamine, or epinephrine to improve cardiac output and increase systemic blood flow.

### **Hypoglycemia**

Glucose consumption is increased when metabolism occurs without adequate oxygen (anaerobic metabolism). Hypoglycemia may occur because glucose stores are depleted rapidly during perinatal stress. A transiently high glucose level may occur in some stressed newborns before the blood glucose level begins to fall. Glucose is an essential fuel for brain function in newborns and prolonged hypoglycemia may contribute to brain injury after resuscitation.

Babies who require resuscitation need to have their blood glucose level checked soon after resuscitation and then at regular intervals until it remains stable and within normal limits. Intravenous dextrose may be necessary to maintain normal blood glucose levels until oral feedings are established.

### **Feeding problems**

The newborn's gastrointestinal tract is very sensitive to decreased oxygen and blood flow. Feeding intolerance, poor motility, inflammation, bleeding, and perforation of the intestinal wall can occur after resuscitation. In addition, sucking patterns and oral feeding coordination may be affected for several days because of neurologic

dysfunction. Alternative methods for providing nutrition may be required during this interval.

Ideally, feedings should be initiated with breast milk. If the baby is born very preterm or is unable to start breastfeeding, work with the mother's health care providers to develop a plan that supports expressing and storing breast milk as soon as possible after birth.

### **Renal failure**

Hypotension, hypoxia, and acidosis can decrease blood flow to the kidneys and cause either temporary or permanent renal failure. Acute tubular necrosis (ATN) is usually a temporary form of renal failure that may occur after resuscitation. It can cause fluid retention and significant electrolyte abnormalities. Babies initially may have low urine output and require fluid restriction for several days. During the recovery phase, they may develop very high urine output and require additional fluid.

Babies who require significant resuscitation should have their urine output, body weight, and serum electrolyte levels checked frequently. Adjust fluid and electrolyte intake based on the baby's urine output, body weight changes, and laboratory results.

### **Metabolic acidosis**

Metabolic acidosis is a common finding after resuscitation because acids are produced when tissues receive insufficient oxygen and blood flow. Severe acidosis may interfere with heart function and worsen pulmonary hypertension. In most cases, the acidosis will gradually resolve as the baby's respiratory and circulatory systems recover. The most important intervention is to identify and correct the underlying cause of the metabolic acidosis.

### **Seizures or apnea**

Newborns with hypotension, hypoxemia, and acidosis may develop signs of brain injury. This injury is called hypoxic-ischemic encephalopathy (HIE). Initially, the baby may have decreased muscle tone, lethargy, poor respiratory effort, or apnea. Seizures may appear after several hours. Babies who have required extensive resuscitation should be carefully examined for signs of HIE. A standardized neurologic assessment is a useful tool. Consultation with a specialist should be considered.

Lethargy, apnea, and seizures may be signs of other conditions such as exposure to maternal narcotics or anesthetics, infection, electrolyte disturbances, or metabolic abnormalities.



## When should therapeutic hypothermia (cooling) be considered?

Studies have demonstrated that therapeutic hypothermia (cooling) after resuscitation reduces the risk of death and improves neurologic outcomes in late preterm and term babies with moderate to severe HIE.

If your hospital does not have a neonatal hypothermia program, contact the closest referral center that provides this therapy as soon as you suspect that a baby may be a candidate. Work with your referral center to develop an organized plan to identify candidates for therapy and quickly arrange for transport. Delay in the recognition or referral of a baby that qualifies for cooling could mean that treatment cannot be initiated because the baby is outside of the therapeutic window.

If the decision is made to transport the baby to another center, follow instructions from the referral center to avoid unintentional hyperthermia while awaiting transport.

## Focus on Teamwork

Post-resuscitation care highlights several opportunities for effective teams to use the Neonatal Resuscitation Program® (NRP®) Key Behavioral Skills.

Behavior	Example
Anticipate and plan.	Plan where post-resuscitation care will take place at your institution. Discuss what type of post-resuscitation care will be provided in the mother's room and when care should be transferred to a transitional area or intensive care nursery. Plan who will be responsible for ongoing monitoring and who to contact if the baby's condition changes. Develop a plan to rapidly recognize babies who may qualify for therapeutic hypothermia and who to contact if this therapy may be indicated. Practice how to initiate therapeutic hypothermia or the process for promptly transferring the baby to a referral center with the required expertise.
Know your environment.	Know what equipment is available in your institution to obtain a blood gas, electrolytes, and serum glucose level. Know how to use the temperature sensor on your radiant warmer.
Delegate workload optimally.	Many procedures need to be performed during the first hour after a successful resuscitation. Plan who will perform each task to avoid unnecessary delays.
Communicate effectively.	Bring the care team together for a post-resuscitation debriefing to reinforce good teamwork habits and identify areas for improvement. Identifying small changes may result in significant improvements in your team's performance and patient safety.

## Quality Improvement Opportunities

Ask yourself the following questions and begin a discussion with your team if you find a difference between the NRP recommendations and what is currently done in your own hospital setting. Consider using the suggested process and outcome measures to guide your data collection, identify areas for improvement, and monitor if your improvement efforts are working.

### Quality improvement questions

- If a baby has received oxygen, PPV, or CPAP during the initial stabilization, who will be responsible for post-resuscitation care and continued assessments?
- f.) What resources are available to care for a baby who requires advanced neonatal care?
- E) What challenges does your team face when transporting a newborn from the delivery location to an environment where continuous cardiorespiratory monitoring is available and vital signs can be measured frequently?
- Have neonatal care providers been trained to identify babies that may be candidates for therapeutic hypothermia?
- Do you know who to contact if you believe a baby is a candidate for therapeutic hypothermia?
- Do you have a process to support the mother's breastfeeding plan when the newborn requires ongoing monitoring?

### Process and outcome measures

- How often is a resuscitation record completed that documents all interventions performed during resuscitation and stabilization?
- f.) How often does the resuscitation team complete a post-resuscitation debriefing?
- E) How often are babies hypoglycemic after resuscitation?
- How often are babies transferred from the delivery location to an advanced care nursery/unit?

- 0 How often does the receiving medical center conduct a collaborative review with the referring medical center of babies transported to its facility?

## Frequently Asked Questions

### **Can post-resuscitation care and monitoring be performed in the mother's room?**

The location of post-resuscitation care is less important than ensuring that appropriate monitoring occurs, medical conditions that require intervention are promptly recognized, and the necessary treatment is initiated. In many institutions, this will require transfer to a transitional nursery or intensive care setting.

### **Should sodium bicarbonate routinely be given to babies with metabolic acidosis?**

No. Infusing a chemical buffer, like sodium bicarbonate, may appear to be a helpful intervention; however, there is currently no evidence to support this routine practice. Sodium bicarbonate infusion has several potential side effects. When sodium bicarbonate mixes with acid, carbon dioxide (CO<sub>2</sub>) is formed. If the baby's lungs cannot rapidly exhale the additional CO<sub>2</sub>, the acidosis will worsen. Although the blood measurement of acid (pH) may appear to improve, sodium bicarbonate may interfere with other acid buffering systems and actually worsen the acidosis inside of cells. In addition, rapid administration of sodium bicarbonate may increase the risk of intraventricular hemorrhage in preterm newborns.

## LESSON 9 REVIEW

1. A baby born at 36 weeks' gestation received positive-pressure ventilation and oxygen supplementation in the delivery room. This baby (does)/(does not) need frequent evaluation of respiratory effort and oxygenation during the immediate neonatal period.
2. If a newborn requires admission to a neonatal intensive care unit, the parent(s) (should)/(should not) be encouraged to see and touch their baby.

3. A full-term newborn had significant birth depression and required a complex resuscitation. The baby has continued respiratory failure with carbon dioxide retention and metabolic acidosis. Sodium bicarbonate (should)/(should not) be infused immediately after resuscitation.
4. Among babies who required complex resuscitation and have signs of neurologic injury, aggressive warming and hyperthermia (improves)/(worsens) the outcome and should be (encouraged)/(avoided).

### Answers

1. This baby <oes need frequent evaluation of respiratory effort and oxygenation during the immediate neonatal period.
2. The parent(s) should be encouraged to see and touch their baby.
3. Sodium bicarbonate should not be infused immediately after resuscitation.
4. Aggressive warming and hyperthermia worsens the outcome and should be avoided.