

Intensive Care Nursery House Staff Manual

Resuscitation of Newborn Infants

BASIC RESUSCITATION OF ALL HIGH-RISK INFANTS:

1. Preparation of Resuscitation Room (“Set-Up Room”)

- A. Notify Charge Nurse, Neonatology Fellow, Respiratory Therapy (RT), and Neonatal Laboratory of impending delivery.
- B. Check equipment for proper functioning:
 - Oxygen & air sources and blender: for most cases, set blender to deliver **40% O₂**
 - Bag system: check pop-off for maximal pressure (25 cmH₂O)
 - Suction pressure and catheters
 - Face masks for bag and mask ventilation
 - Endotracheal tubes & laryngoscope (#1 blade for term infant, #0 for preterm)
- C. With Nurse, “wet down” UAC tray.
- D. Have blood in room for known fetal anemia (*e.g.*, Hemolytic Disease of Newborn).

2. Duties of Team Members

- A. **Member A** - Physician or Neonatal Nurse Practitioner (NNP)
 - Assess infant
 - Perform assisted ventilation
 - Manage airway and intubate trachea
 - Stabilize ET tube while RT secures it
- B. **Member B** - MD, NNP or RN
 - Assess heart rate; give compressions PRN (unable to ↑ heart rate with ventilation).
 - Auscultate chest and abdomen for proper position of ET tube.
 - Insert umbilical catheter(s) under sterile technique (MD or NNP only).
 - Assess perfusion, draw blood for culture and pH and blood gas tensions.
 - Administer fluids and drugs.
- C. **Member C** - RN, MD or NNP
 - Dry infant, apply ECG leads and attach SpO₂ and CO₂ monitors.
 - Assist with ET tube suctioning and adjust FiO₂.
 - Assist Member B by providing medications in sterile syringes.
 - Monitor temperature and capillary blood glucose.
 - Record resuscitation, including vital signs, Apgar scores, procedures, all infusions and medications, and lab results, and times of each.

3. Goals of resuscitation are to assist adaptation to extra-uterine life by:

- Inflating lungs, establishing oxygenation and ventilation *to*
- Establish adequate pulmonary blood flow
- Support cardiovascular function.

4. Sequential steps in resuscitation:

- Maintain body temperature (dry infant and put under radiant warmer).
- Clear airway and initiate ventilation.
- Cardiac compressions, if needed.
- Attach ECG leads, pulse oximeter and CO₂ monitor and insert OG tube.
- Catheterize umbilical artery/vein and measure blood pressures.
- Give resuscitation drugs as needed.
- Assign Apgar scores at 1 and 5 min and q5 min until score is ≥ 7 .

RESUSCITATION OF THE ASYPHYXIATED INFANT:

1. Definition: Asphyxia (from the Greek, *asphuxia*, stopping of the pulse) produces hypoxia and respiratory and metabolic acidosis that, in turn, cause peripheral and pulmonary vasoconstriction with hypertension and bradycardia. If allowed to persist, asphyxia leads to myocardial failure, hypotension, bradycardia and elevated CVP.

2. Conditions that place newborn infants at ↑ risk for asphyxia:**A. Maternal conditions:**

- Diabetes Mellitus
- Anemia
- Antepartum hemorrhage
- Previous neonatal death
- Systemic Lupus
- Pre-eclampsia, hypertension, chronic renal disease
- Blood type incompatibilities
- Drug or alcohol ingestion
- PROM with evidence of amnionitis
- Maternal cardiac disease

B. Labor and delivery conditions:

- Forceps or vacuum extraction
- Cesarean section
- Cord prolapse/compression
- Breech or abnormal presentation
- Cephalo-pelvic disproportion
- Maternal hypotension or hemorrhage

C. Fetal conditions:

- Premature/postmature birth
- Abnormal heart rate pattern
- Oligo- or polyhydramnios
- Macrosomia
- Hydrops fetalis
- Multiple births, especially:
 - Discordant twins
 - Twin-twin transfusion syndrome with stuck twin
 - Mono-amniotic twins
- Meconium in amniotic fluid
- Fetal cardiac dysrhythmia
- Fetal growth retardation
- Fetal malformations
- Low biophysical profile
- Sepsis

3. Phases of resuscitation: Follow sequence above in **Basic Resuscitation, Part 4.****A. Phase I: Clinical assessment of severity of asphyxia and treatment**

- Use **Apgar** scoring as an assessment tool: the length of time it takes to reach a score of 7 is a rough indication of the severity of asphyxia.
- With **mild asphyxia**, **ventilate** using bag-mask with 40% O₂ to establish FRC in the following manner:
 - Slowly apply opening pressures of 20 cmH₂O for term and maintain pressure for 1-2 sec
 - Follow with a rate of 40-60/min with Ti of 0.25 to 0.4 sec
 - Insert NG tube to decompress stomach
- Intubation:** With **severe asphyxia** (or if there is not a prompt increase in heart rate with bag-mask ventilation) immediately intubate the trachea and begin assisted ventilation.
- Naloxone:** If infant does not subsequently make respiratory efforts and if mother has received narcotics within 1h of delivery, give naloxone hydrochloride (0.1 mg/kg IV, IM or SC) with the following precautions:
 - Do not give naloxone if there is persistent bradycardia.** This will delay appropriate resuscitative measures.

- If naloxone is given, remember that the **duration of action is shorter than narcotics** and, therefore, an additional dose of naloxone may be necessary.
- Treat persistent bradycardia** in the following sequence
 - Ventilate** and increase FiO_2 if baby does not respond quickly.
 - Cardiac compressions** using NRP guidelines
 - Epinephrine**
 - NaHCO₃ or THAM™ to treat severe metabolic acidosis** (pH <7.05 or base deficit of 15 mEq/L or more) with aims of (1) reversing myocardial failure and low cardiac output and (2) relieving pulmonary vasoconstriction.
 - i) **Calculation of dose:**

$$\text{Buffer (mEq)} = 0.3 \times \text{BW (kg)} \times \text{Base Deficit (mEq/L)}$$
 - ii) Use **NaHCO₃ only when infant is receiving adequate assisted ventilation.** With inadequate ventilation, NaHCO₃ will worsen respiratory acidosis ($\text{NaHCO}_3 + \text{H}_2 \rightarrow \text{Na}^+ + \text{H}_2\text{CO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2$)
 - iii) **Tham™** is for mixed acidosis as it buffers metabolic acid and lowers PaCO₂. However, it can cause **apnea and hypoglycemia.**
 - iv) **Infuse buffer at rate of 1 mEq/kg/min.**
 - Atropine and CaCl₂.**
 - Catheterize an umbilical artery (or vein if unable to get into an artery) for assessment of pH and PCO₂.** (See section on Intravascular Catheters, P. 25).
 - Drug doses** are on placard mounted on wall of Resuscitation Room.

B. Phase II: Evaluation after stabilization: Perform careful **physical examination** to detect:

- Major anomalies
- Neural tube defect is easy to miss in a supine infant
- Scaphoid abdomen and respiratory distress** should alert one to possibility of a **diaphragmatic hernia**
- Dysmorphic features
- Assessment of intrauterine growth
- Signs of infection
- Re-evaluate assisted ventilation**
 - Be alert for complications of tracheal intubation:** dislodgment of tube into esophagus, inadvertent advancement into right mainstem bronchus.
 - Continually assess for changes in pulmonary function**
 - i) **Hyperoxia** can occur as ventilation and perfusion are better matched. Manage by decreasing the inspired O₂ concentration.
 - ii) **Hypocarbica**, due to improved ventilation, can decrease cerebral and myocardial blood flow. Manage by **reducing ventilator rate or PIP.**
 - iii) **Hypotension:** As lung compliance improves, ventilatory pressures may become excessive and impede venous return causing hypotension. Test for this by briefly disconnecting the patient from positive pressure ventilation; if arterial pressure rises (usually within 5-10 sec), then reduce airway pressures.
 - iv) **Tension pneumothorax** may occur spontaneously or with assisted ventilation. It leads to hypoxia, hypercarbia, and, if large, it will obstruct cardiac return and lead to shock.

- **Assess circulatory status:** In most asphyxiated infants, blood volume is \geq normal and hypovolemic shock does not develop. However, it will develop in some asphyxiated infants. It is important to assess this carefully and accurately since giving volume to an asphyxiated baby who is not in shock can be harmful.

- **Signs of hypovolemia**

- Hypotension, narrow pulse pressure
- Falling hematocrit (Hct)
- Prolonged capillary filling time
- Persistent metabolic acidosis
- Cold extremities
- Low PvO₂ with normal PaO₂

- **Treatment of hypovolemic shock:** See section on Neonatal Shock, P. 101.

Use great caution when giving volume expanders in an asphyxiated infant.

Dopamine is more appropriate for treating hypotension in an asphyxiated infant (starting dose: 5 mcg/kg/min).

- **Conditions that can be mistaken for hypovolemic shock**

- **Vasoconstriction of asphyxia**

Findings: \downarrow pH, \uparrow blood pressure (BP), peripheral pallor

Action: Correct acidosis

Response: BP \downarrow to normal, perfusion \uparrow

- **Asphyxial cardiomyopathy**

Findings: \downarrow pH, \downarrow BP, \uparrow central venous pressure (CVP)

Action: Correct acidosis, hypoxia, and hypocalcemia, if present

Response: BP \uparrow , CVP \downarrow , perfusion improves

- **Obstruction of venous return**

Findings: \downarrow BP, \uparrow CVP, pallor

Action: Relieve pneumothorax or decrease airway pressures

Response: BP \uparrow , perfusion improves

- **Hypocarbica**

Findings: \downarrow BP

Action: Reduce ventilation so PaCO₂ >30-35 mmHg.

Response: BP \uparrow

C. Phase III: General management. This is the period of time where the mildly affected infant will begin to improve rapidly and the severely affected infant will start showing signs of end organ damage.

- **Ventilation:** Adjust to meet changes in pulmonary function. Give surfactant if RDS is suspected; RDS, congenital pneumonia and post-asphyxial respiratory distress may be indistinguishable.
- Use **Dopamine** to treat post-asphyxial cardiomyopathy. Hypotension may persist for 1-2 d and may be distinguished from hypovolemia by \uparrow CVP.
- **Persistent Pulmonary Hypertension of the Newborn** may coexist with asphyxial cardiomyopathy. Avoid treating PPHN with hypocarbica, as it will \downarrow myocardial (and cerebral) blood flow.
- **Coagulopathy** is almost always transient. Administer platelets and clotting factors as needed (see section on Administration of Blood Products, P. 40).
- **Hypoglycemia** may occur after resuscitation. Treat with continuous glucose infusion to maintain normal serum glucose; monitor for hypoglycemia and hyperglycemia
- **Fluids and electrolytes**

- Carefully monitor renal function with measurements of intake, urine output, creatinine, proteinuria, and hematuria.
- Monitor electrolytes (serum and urine). Replace Na^+ , K^+ , Cl^- and Ca^{++} as needed, as electrolyte losses may be high in diuretic recovery phase.
- Gastrointestinal:** Delay feeds to prevent NEC secondary to reduced blood flow to the gut during asphyxia.
- Observe for hypoxic-ischemic encephalopathy.**

RESUSCITATION OF INFANT WITH MECONIUM ASPIRATION: See section on Management of Infants Born through Meconium Stained Amniotic Fluid (P. 8).

RESUSCITATION OF THE VERY LOW BIRTHWEIGHT INFANT: See section on Very Low Birthweight Infant (P. 65). Factors to be considered when resuscitating a VLBW or ELBW infant:

1. Respiratory Care: The majority of ELBW infants (*i.e.*, <1,000 g) will require **intubation at birth** (to assist in their cardiopulmonary adaptation to extra-uterine life) and assisted ventilation for a prolonged period. They require close attention with frequent measurements of pH and blood gas tensions. In addition to **surfactant deficiency**, they are at risk for respiratory failure because of:

- Weak chest wall
- Smaller alveoli (\uparrow tendency to atelectasis)
- Weak muscles of respiration
- Decreased central respiratory drive

Indications for endotracheal intubation at birth include any of the following for infants ≤ 27 weeks gestation:

- Apnea
- Need to maintain airway
- Need for $\text{FiO}_2 \geq 0.4$
- $\text{PaCO}_2 \geq 60$ mmHg
- Arterial pH ≤ 7.25

Surfactant is to be given immediately after birth to preterm infants as indicated in **Table 1 of the section on RDS (P. 79).**

Provide adequate PEEP or CPAP to prevent atelectasis after FRC has been established and lung compliance improves. It is rare that these infants will do well with PEEP or CPAP < 5 cmH₂O.

2. Oxygenation: Maintain oxygen saturation (SpO_2) in the range 85-92% to limit the damaging effects of hyperoxia

3. Insensible water loss and temperature maintenance: See section on VLBW and ELBW Infants (P. 65).

RESUSCITATION OF MULTIPLE BIRTHS

A. Complications of multiple births include: increased incidence of preterm labor and delivery, intrapartum asphyxia, congenital anomalies in monozygotic twins, IUGR, twin-twin transfusion and stuck twin syndrome (see section on Multiple Births, P. 170).

B. Special situations:

- Twin-to-Twin Transfusion Syndrome (TTTS).** Delivery room management will vary with the clinical picture. Management is based on measurements of their hemoglobin/hematocrits and arterial and venous pressures.

- If blood transfusion between twins has been **recent**, the **donor twin** will be anemic and will require volume as with any hypovolemic infant. The **recipient twin** will be polycythemic and will require a partial exchange transfusion to reduce the hematocrit (see section on Polycythemia-Hyperviscosity, P. 112).
- If blood transfusion between twins has been **chronic**, the **donor twin is usually SGA and anemic**, is likely to need **partial exchange transfusion with PRBCs** to treat the anemia because of low tolerance to blood volume expansion (which occurs with simple transfusion). If the donor twin dies there is danger of damage to the brain, kidneys and GI tract of the recipient, either from hypoperfusion or emboli. The **recipient twin** is usually AGA and may or may not be polycythemic. Hydrops fetalis **may develop in** either twin.

- Stuck Twin Syndrome** occurs in discordant, monochorionic twins with TTTS. There is oligohydramnios in the SGA fetus and polyhydramnios in the AGA fetus. The SGA fetus becomes compacted into a small volume within the uterus leading to lung growth restriction and pulmonary hypoplasia.

RESUSCITATION OF AN INFANT WITH BIRTH TRAUMA may be complicated by management of significant blood loss requiring blood volume and coagulation factors. Bleeding may be:

- Intra-abdominal:** Abdominal distension and discoloration may indicate ruptured liver, spleen, subcapsular liver hematoma or adrenal hemorrhage. These are more common with breech deliveries.
- Intracranial:** If bleeding is sufficient to cause hypovolemia, it will manifest in a bulging fontanel.
- Subgaleal:** Earliest sign of an expanding hemorrhage is pushing of the ears laterally and forward. Treatment is difficult and may require vigorous therapy.

RESUSCITATION OF AN INFANT WITH HYDROPS FETALIS: For causes, see section on Hydrops Fetalis (P. 168).

1. Problems that may complicate resuscitation of hydropic infant:

- Restriction of ventilation by **pleural effusions** and **ascites**
- Pulmonary edema
- Anemia (with some causes) resulting in reduced O₂ carrying capacity
- Hypoplastic lungs
- Circulatory abnormalities including:

-Hypovolemia	-Hypervolemia
-Myocardial failure	-Pulmonary vasoconstriction

2. Delivery room preparation:

- Discuss patient with Obstetrical staff (and, if possible, meet with parents) **antenatally** to learn as much as possible about possible **causes** of the hydrops.
- Have extra delivery room personnel assigned to do **thoracentesis and paracentesis**.

- Have **2 umbilical catheters prepared and already connected to transducers** for measurement of arterial and venous pressures.
- Have **PRBCs available** since many infants with non-immune hydrops are anemic.
- Be cognizant of the latest **fetal ultrasound** results and size of any **pleural effusions**.
- Designate someone to obtain an umbilical **cord blood and measure Hct immediately after birth**.

3. Post-natal management:

- Intubate** immediately and begin assisted ventilation. Respiratory failure and pulmonary vasoconstriction are common.
- Perform **paracentesis** if abdomen is distended and interfering with ventilation.
 - Insert needle/cannula in lower left abdomen lateral to rectus muscle to avoid puncturing possibly enlarged spleen.
 - Remove enough fluid to decompress abdomen thus allowing the diaphragm to move easily. Do not attempt to remove all of the ascitic fluid as this may lead to circulatory instability.
 - Perform **thoracentesis** if there are pleural effusions that are interfering with ventilation.
 - Insert **umbilical arterial and venous catheters** and measure vascular pressures. **Be certain that UVC is in right atrium before diagnosing elevated CVP.** Remember, pressure in the portal circulation is higher than CVP by a variable amount.
 - Transfuse PRBCs** if cord Hct shows anemia. Raise Hct to >30-35%. Resuscitation may not be effective until transfusion increases Hct to that level.
 - Obtain appropriate diagnostic laboratory tests. In an infant with non-immune hydrops who is not expected to live, obtain the following to help establish a diagnosis to provide counseling to the parents regarding future pregnancies:
 - Blood samples for karyotyping, TORCH infections, parvovirus B-19 and hemoglobin electrophoresis
 - Full body radiographic examination
 - Send placenta to Pathology
 - Obtain consent for autopsy and for post-mortem skin biopsy for karyotyping.

RESUSCITATION OF INFANT WITH PULMONARY HYPOPLASIA & CONGENITAL DIAPHRAGMATIC HERNIA: See section on Pulmonary Hypoplasia (P. 85).