

AUTHOR

Audrey Bowen, MD, FAAP,

Assistant Professor of Pediatrics,
University of Central Florida,
Attending Physician, Florida
Hospital, Children's Emergency
Center, Orlando, FL

Winslade Bowen, MD, FAAP,

Attending Neonatologist, Florida
Hospital Memorial Center, Daytona
Beach FL

PEER REVIEWER

**Christopher J. Haines, DO,
FAAP, FACEP,** Chief Medical

Officer, Children's Specialized
Hospital, New Brunswick, NJ;
Associate Professor of Pediatrics
and Emergency Medicine,
Drexel University College of
Medicine, Attending Physician, St.
Christopher's Hospital for Children,
Philadelphia, PA

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Emergent Delivery and Neonatal Resuscitation

Emergency department physicians infrequently encounter an imminent delivery, but the correct management of these situations is critical to optimize the outcome of not one, but two patients. This article focuses on the delivery and resuscitation of the newborn.

— Ann M. Dietrich, MD, FAAP, FACEP, Editor

Labor and Delivery in the ED

The management of the female who presents to the emergency department (ED) in active labor is stressful and overwhelming. Ideally, the ED has a plan in place, based on hospital resources, for the imminent delivery of a newborn. Decisions regarding delivery in the ED or transferring the patient to labor and delivery are based on a variety of factors. Knowledge of the possible complications of delivery will provide anticipatory guidance to improve maternal and fetal outcomes. See Table 1 for important components of assessing and managing the pregnant patient.^{1,2}

Maternal complications during the peripartum period include placenta previa, placental abruption, cord prolapse, pre-eclampsia, eclampsia, and HELLP (hemolysis, elevated liver enzymes, and low platelets) syndrome. Supportive therapy and urgent referral for delivery of the infant may be required.

The presence of placenta previa is a contraindication to a digital or speculum examination. Emergency cesarean section may be required, and urgent obstetric referral is warranted. Placental abruption, which has an incidence of 1% of all pregnancies, may be due to trauma, drug use, advanced maternal age, or smoking. The patient may present with abdominal pain and vaginal bleeding. Intravenous access, CBC, coagulation studies, and urgent obstetric consultation are required. Pre-eclampsia is hypertension with a blood pressure > 140/90, with proteinuria, and with or without peripheral edema. The patient may complain of headaches, abdominal pain, and extremity swelling. Eclampsia is the presence of seizures in a patient with hypertension or pre-eclampsia. The treatment of severe pre-eclampsia and eclampsia involves administration of magnesium sulfate 4-6 g over 15 minutes and then 1-2 g per hour, antihypertensive medications, and delivery of the infant.³ Factors that increase the risk of neonatal complications include prematurity, multiple fetuses, and abnormal presentations such as breech, shoulder, or cord. Specific neonatal complications, such as respiratory distress syndrome and meconium aspiration, are discussed in the section on neonatal resuscitation.

The palpation of the abdomen may help in assessing the position and presentation of the fetus. An abnormal presentation may be confirmed by a quick

EXECUTIVE SUMMARY

- The decision to deliver the infant in the ED is determined by several factors, including the stage of labor, the parity of the pregnant patient, and the proximity to labor and delivery/obstetrical services.
- A woman in active labor with painful contractions has an emergent medical condition. If there is insufficient time for transfer before delivery or if the transfer poses a risk to the health or safety of the fetus, this patient, per EMTALA, may not be transferred from the ED.
- Delivery of an infant in the ED or an infant presenting from an out-of-hospital delivery needs rapid assessment and possible resuscitation.
- The “golden minute,” or first 60 seconds, is the time frame in which resuscitation should be initiated if required.
- The management of infants with meconium aspiration syndrome is dependent on whether the infant is term, preterm, vigorous, or limp at birth.
- An infant requiring resuscitation and stabilization after delivery must be transferred to a unit for close monitoring and further management.

bedside ultrasound, if available. Fundal height also may be used to approximate gestational age. (See Figure 1.) The presence of multiple gestation also can be ascertained by ultrasound.

Pelvic examination is important to determine whether the membranes are intact and if meconium is present. Vaginal bleeding is a contraindication to pelvic exam and should prompt an ultrasound evaluation to exclude placenta previa. Speculum or digital examination is contraindicated in the presence of vaginal bleeding. If there is no vaginal bleeding and rupture of membranes (ROM) is suspected, the patient should be evaluated with a sterile speculum, and a nitrazine test should be done to confirm ROM. Amniotic fluid turns the yellow strip dark blue. Lubricant may produce a false-positive nitrazine test and its use should be avoided. Digital examination increases the risk of infection with ROM and should be avoided if possible.

Digital examination is important to assess the dilatation, station, and effacement of the cervix and to determine fetal presentation (occiput, breech, shoulder, face, brow, compound, or cord). The station indicates the position of the presenting part of the fetus in the pelvis. The maternal ischial spines are the reference point for assessing the station. A negative station refers to the presenting part lying above the spines, 0 station at level of the ischial spines, and +1, +2, +3 below the spines; the latter is consistent with the scalp being visible at the introitus.

Stages of Labor

The first stage of labor is the onset of

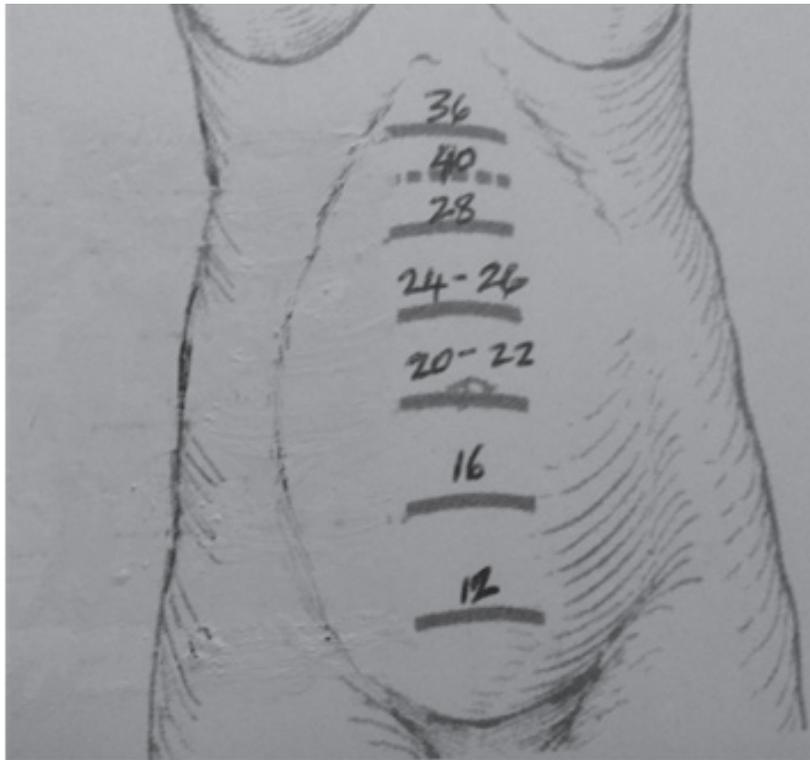
contractions to the complete dilation of the cervix (10 cm). The duration of labor varies with factors such as size of pelvis,

size of fetus, and parity. The duration of the first stage of labor in the primiparous patient ranges from 6–18 hours

Table 1. Assessment of Pregnant Patient in the ED

History
<ul style="list-style-type: none"> • Sexual activity: This may be denied in the pediatric population • Signs of pregnancy: Missed period, morning sickness, weight gain, urinary frequency, breast enlargement, and abdominal enlargement • Sexually transmitted diseases • Last menstrual period: This aids in determining gestational age if the patient has regular menstrual cycles. The expected date of confinement or delivery or due date is calculated using the first day of the last normal period, adding 9 months and 1 week (Naegele rule), or by using a pregnancy wheel • Past pregnancies, miscarriages or abortions, gravidity (the total number of pregnancies including the current pregnancy), and parity (the number of deliveries after 20 weeks). • Problems in prior or current pregnancies • Prenatal care • Blood type if known: Rh-negative mother may need RhoGAM • Allergies • Past medical history • Group B strep status • Medications or drug use • Signs of active labor • Rupture of membranes • Signs of imminent delivery
Physical Exam
<ul style="list-style-type: none"> • Vital signs • Temperature: Elevation may indicate maternal infection such as chorioamnionitis • Blood pressure: Elevation may indicate pre-eclampsia. Seizures and elevated BP indicate eclampsia. Hypotension may indicate blood loss in placental abruption or other hemorrhage. • Heart rate: Evaluate maternal and fetal heart rate. Fetal heart rate is best heard with a Doppler. This should be evaluated with each contraction. It is best heard between the umbilicus and the symphysis. A fetal heart rate < 100 or > 180 may indicate fetal distress. • Examination of the abdomen may help with assessing the gestational age of the fetus. Gestational age can be approximated based on fundal height.

Figure 1. Approximate Gestational Age Based on Fundal Height



and from 2-10 hours in the multiparous patient.⁴

ROM is timely if it occurs at the end of the first stage of labor. It is premature if it occurs before labor begins. Early ROM occurs with rupture before cervical dilatation to 6 cm is achieved.³

The second stage of labor is the period between complete dilatation of the cervix and delivery of the newborn. Contractions occur every 2-3 minutes and last about 1 minute. The second stage varies with the parity of the mother. The median duration of the second stage is about 50 minutes in the primiparous patient (about 20 pushes) and 20 minutes (a few pushes) in the multiparous patient.^{4,5}

The third stage of labor is the period between the birth of the newborn and the expulsion of the placenta. The duration is about 10-30 minutes.

Management

The decision to deliver an infant in the ED is determined by several factors, including the stage of labor, the parity of the pregnant patient, and the proximity to labor and delivery/obstetrical

services.

True labor must be distinguished from false labor. False labor is represented by Braxton Hicks contractions, usually in the lower abdomen, which are brief, irregular, and ineffective in producing changes in the cervix.

If the patient has the urge to push or defecate, the second stage of labor should be suspected. Contractions occur at regular intervals, with abdominal or back pain, and are associated with dilatation and effacement of the cervix.^{3,6}

The assignment of tasks to the team caring for the mother and the team caring for the infant is important prior to the delivery. Equipment needed for an emergency delivery includes sterile gloves, sterile towels and drapes, surgical scissors, hemostats, cord clamps, gauze sponges, syringes, needles, suction bulb, placenta basin, and supplies for resuscitation of the neonate. A radiant warmer or incubator should be available to keep the infant warm. The neonatal and obstetrical team, if available, should be alerted and present as soon as possible to help in the care of the infant and the mother, respectively.

Supplemental oxygen and intravenous fluids should be administered to the mother if fetal distress is suspected. Lateral positioning is recommended to prevent compression of the vena cava, which can occur in the supine position. This can produce maternal hypotension and decreased blood flow to the fetus.

When considering transport of a pregnant patient to labor and delivery, the following factors must be considered: the stage of labor, the parity of the patient, the transit time to an intramural or extramural facility, and availability of qualified transport personnel. Obstetric consultation should be obtained as early as possible.

The pregnant patient must be examined and deemed stable for transfer to a facility with obstetric facilities or labor and delivery. Informed consent is necessary prior to transfer. An appropriate transfer is one in which the transferring facility provides care within its capacity, while minimizing the risks to the patient's health and the unborn child. The receiving facility must have an available bed and qualified personnel, and must agree to take the transfer. See Emergency Medical Treatment and Labor Act (EMTALA) for specific guidance.^{5,7}

A woman in active labor with painful contractions has an emergent medical condition. If there is insufficient time for transfer before delivery or if the transfer poses a risk to the health or safety of the fetus, this patient, per EMTALA, may not be transferred from the ED.

A multiparous patient in the second stage of labor likely will need to be delivered in the ED. A cervix that is fully dilated and effaced, or the presence of the infant's head in the vagina, suggests that delivery will occur within minutes, so transferring to labor and delivery is not recommended.

The pregnant patient is encouraged to take slow deep breaths, and oxygen may be administered to maximize oxygenation of the fetus. The second stage of labor has the highest risk for hypoxia. Intravenous access is recommended.

The dorsal lithotomy position is the usual position for delivery of the infant. The perineum may be cleansed with betadine if time permits. The

area should be draped. A sterile towel is placed over the lower part of the perineum. The medical personnel should be appropriately attired.

The perineum is protected by controlled gradual delivery of the head; the back of the head is supported with the left hand and the right hand guides the head from the perineum. The mouth and nose should be suctioned as soon as the head is delivered. The perineum stretches as the newborn passes through. If cord prolapse is discovered during the bimanual examination, the hand should remain in the vagina to elevate the presenting fetal part to prevent cord compression while being transported to the operating room for an emergency cesarean section.

Episiotomy is not routinely recommended. The head should be lowered to facilitate the birth of the shoulders, with gentle traction. The infant's body is lifted over the symphysis onto the mother's abdomen. One should check for a nuchal cord and loosen if necessary, prior to delivering the infant. The umbilical cord is clamped in two places about 4-5 cm from the infant's abdomen. The cord is then cut between the two clamps. A plastic clamp is then placed 2-3 cm from the infant's abdomen. Document the exact time of arrival of the infant. The infant is dried and stimulated and kept warm under a radiant warmer or on the mother's abdomen.^{1,3,4} The infant is examined to assess the condition after birth and the need for resuscitation.⁸ (*See section on resuscitation for more specific details.*)

The third stage of labor occurs between the delivery of the infant and the expulsion of the placenta by the uterus. Gently remove the placenta after separation to prevent ripping and retained products of conception. Examine the placenta to make sure that it is complete. The massage of the uterus is performed to promote contractions and reduce bleeding. Observe the patient carefully for excess uterine bleeding. Oxytocin (10-20 units in normal saline intravenously or 10 units intramuscularly) may be administered to prevent hemorrhage after delivery by promoting uterine contractions.

RhoGAM 300 mcg IM should be administered to the Rh-negative mother

with an RH-positive infant within 72 hours of delivery.⁹ The infant should receive ophthalmic prophylaxis with erythromycin ointment 0.5% and vitamin K (0.5 mg to 1 mg) IM within 1 hour of delivery.^{8,9}

Breech Presentation

Breech presentation occurs in 3-4% of term pregnancies and is associated with increased morbidity and mortality. Complications include entrapment of the head and cord prolapse. Urgent obstetric consultation is necessary for breech presentations. Frank or complete breech may dilate the cervix as a cephalic presentation, so the delivery may proceed without complications. Avoid handling the fetus until the cord is visible. The fingers of the examiner should be placed medial to each thigh and the thigh pushed out laterally to deliver the legs. Rotate the fetus to a position with the sacrum anterior. When the scapula is visible, gently rotate until the right arm is delivered, then rotate counter-clockwise until the other arm is delivered. The examiner should then place the middle and index finger over the lower jaw of the fetus to keep the head flexed and assist the delivery of the infant. The footling or incomplete breech is unsafe for vaginal delivery, and every effort should be made to obtain the expertise of an obstetrician.³

Shoulder Dystocia

Complications of shoulder dystocia include brachial plexus injury and hypoxia. If the shoulder is impacted, the mother should be placed in the extreme lithotomy position, the bladder drained, and suprapubic pressure applied. An episiotomy is recommended to facilitate the delivery. Grasping the posterior scapula and rotating the shoulder girdle 180 degrees in the pelvic outlet may deliver the shoulder (Wood's maneuver). If this is unsuccessful, the examiner may place his hand in the vagina to grasp the posterior arm. The elbow is flexed and the arm and posterior shoulder are delivered, followed by the anterior shoulder.³

Multiple Fetuses

The presence of more than one fetus

requires additional delivery kits and staff to deliver and care for the infants.

Cesarean Section for Maternal Cardiac Arrest

In cases of maternal cardiac arrest with a viable fetus, a perimortem emergency cesarean section is warranted. If performed within 5 minutes of maternal arrest, the prognosis for the infant is good. The ED physician may be required to perform this procedure in the absence of a more qualified individual, such as an obstetrician or surgeon.

Maternal CPR should be performed before and throughout the cesarean section.^{10,11,12} It is not necessary to check for fetal viability prior to the procedure.

A classic midline incision is made about 5 cm below the xiphoid process to the pubic symphysis. Blunt dissection of the rectus muscle and then incision of the peritoneum is performed to expose the uterus. An incision is made in the uterus from the fundus to where the bladder adheres to the uterus. The fetus is removed and resuscitated. The placenta is removed and the uterus is repaired with chromic 0 or 1 running suture. The skin of the abdominal wall is then closed. The infant should be transferred to a neonatal unit after resuscitation and stabilization.

Newborn Resuscitation

Delivery of an infant in the ED or an infant presenting from an out-of-hospital delivery needs rapid assessment and possible resuscitation. (*See Table 2.*) The maternal history, pregnancy history, presence of gestational hypertension or diabetes, presence or absence of prenatal care, maternal age, and history of medications or drug use during pregnancy are important. Gestational age may be approximated based on the LMP of the mother or based on ultrasounds done earlier in the pregnancy. Birth events such as a precipitous delivery, presence of a nuchal cord, and excessive blood loss may provide important information in predicting the outcome of the infant. The Ballard score assesses gestational age based on neuromuscular maturity (posture, square window, arm recoil, popliteal angle, scarf sign, and heel to ear) and physical maturity (skin, lanugo, plantar surface, breast, eyes, ears, and

Table 2. Normal Vital Signs in the Newborn

Heart rate	120-160 beats per minute
Respiratory rate	40-60 breaths per minute
Blood pressure	based on gestational age
Core temperature	36.5-37.5° C rectal

genitalia).¹³

A newborn is assigned an Apgar score at birth based on heart rate, respiratory effort, muscle tone, reflex irritability, and color.¹⁴ (See Table 3.) The values are added to determine the Apgar score at 1 minute and 5 minutes. If the score at 5 minutes is ≤ 7 , the infant should be assigned a score every 5 minutes up to 20 minutes.

At birth, newborns transition from intrauterine to extrauterine life and the majority do not require resuscitation. However, a quick assessment of three main characteristics will usually identify the need for resuscitation.

- 1) Is the infant term?
- 2) Is the infant crying or breathing?
- 3) Does the infant have good muscle tone?

If all the above are true, the infant does not usually need resuscitation. The infant should be dried and placed on mother's chest for warmth. If the answer is no to any of the above questions, the infant requires resuscitation. (See Tables 4 and 5.)

Meconium Management

The presence of meconium in the amniotic fluid may result in meconium aspiration syndrome. (See Figure 2.) The management of these infants is dependent on whether the infant is term, preterm, vigorous, or limp at birth.¹⁴ A vigorous (strong respiratory efforts, good muscle tone, and heart rate > 100 bpm) term infant with meconium-stained fluid is treated by providing warmth and clearing the mouth and nose of secretions with a bulb syringe or suction catheter. The infant is then dried, stimulated, and given to the mother. A term infant who is limp (depressed muscle tone and/or heart rate < 100 bpm) at birth in the presence

Table 3. Apgar Scores

Score	0	1	2
Heart rate	Absent	< 100 bpm	> 100 bpm
Respiratory effort	Absent/irregular	Weak cry	Strong cry
Muscle tone	Limp	Some flexion	Active
Reflex irritability	No response	Grimace	Cry/active withdrawal
Color	Blue or pale	Acrocyanosis	Pink

Table 4. The 2010 American Heart Association Guidelines for Neonatal Resuscitation

The "golden minute," or first 60 seconds, is the time frame in which resuscitation should be initiated if required.¹⁵

- Term infant, breathing or crying, good tone: Stay with mother
- Preterm, not breathing or crying, poor tone: Warm, clear airway, dry, stimulate
- Labored breathing, persistent cyanosis: Clear airway, SpO₂ monitor, consider continuous positive airway pressure
- Heart rate < 100 , gasping or apnea: PPV, SpO₂ monitor
- Heart rate < 60 : ventilation corrective steps, consider intubation, chest compressions, positive pressure ventilation
- Heart rate still < 60 : Give epinephrine (0.01 to 0.03 mg/kg IV or 0.05 to 0.1 mg/kg via ETT)
- If heart rate still < 60 : Consider hypovolemia (give normal saline bolus 10 mL/kg) and pneumothorax (needle decompression for tension pneumothorax)

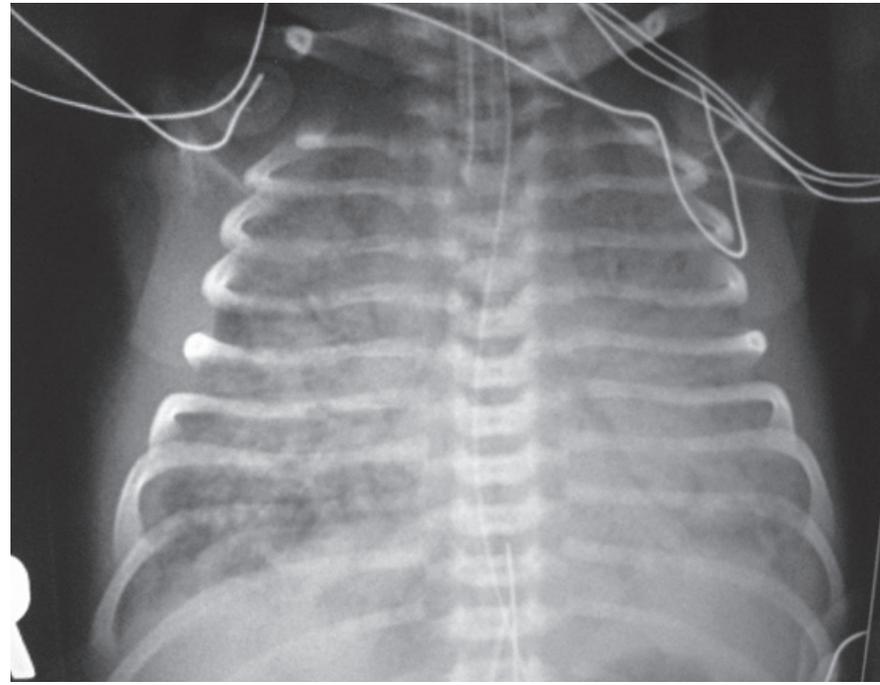
Table 5. Neonatal Resuscitation Equipment and Supplies

- Suction equipment: Bulb syringe, mechanical suction and tubes, suction catheters 5F-14F, 8F feeding tube and 20 mL syringe, and meconium aspirator
- Bag and mask equipment: Device for delivering positive pressure ventilation capable of giving 90-100% oxygen, term and preterm newborn masks, oxygen source, compressed air source, oxygen blender (for flow rates up to 10 L/min), pulse oximeter, and probe
- Intubation equipment: Laryngoscope with straight blades (size 0 for preterm and 1 for term); endotracheal tube (ETT) sizes 2.5, 3.0, 3.5, 4.0; stylet; scissors; tape for securing ETT; ET CO₂ detector; and laryngeal mask airway
- Medications: Epinephrine 1:10,000 (0.1 mg/mL), isotonic crystalloid fluid such as normal saline or Ringer's lactate (100 mL bag), dextrose 10%, and normal saline flushes
- Umbilical vessel catheterization supplies: Sterile gloves, scalpel, betadine or other antiseptic solution, umbilical tape, umbilical catheters (3.5F, 5F), 3-way stop-cock, syringes (1 mL, 3 mL, 5 mL, 10 mL, 20 mL, 50 mL), and needles (18, 21, and 25 gauge)
- Miscellaneous: Radiant warmer, firm padded surface for resuscitation, timer, warm blankets, ½- or ¾-inch tape, stethoscope, cardiac monitor and electrodes, oropharyngeal airways (0, 00, 000 sizes), plastic wrap, and transport incubator

of meconium-stained fluid should be placed under a radiant warmer to keep the infant warm. The infant is placed

on his/her back with the neck slightly extended in the "sniffing" position to open the airway. The oropharynx is

Figure 2. Meconium Aspiration Syndrome



cleared of meconium and the trachea is intubated and suctioned. Suctioning the trachea is achieved by inserting a laryngoscope and using a 12F or 14F suction catheter to clear the mouth and posterior pharynx. An endotracheal tube (ETT) is inserted into the trachea and attached to a suction source via a meconium aspirator. Suction is applied for several seconds while the tube is in the trachea. The tube is slowly removed (counting 1-one thousand, 2-one thousand, 3-one thousand, withdraw). This is repeated until minimal meconium is present in the airway or until the infant's status changes, requiring further resuscitation methods. If the heart rate is < 100 bpm despite stimulation and there is gasping or apnea, then positive pressure ventilation (PPV) is initiated.

Assisted Ventilation and Supplemental Oxygenation

If there is labored breathing and persistent cyanosis, the airway should be cleared, followed by initiating SpO_2 monitoring and considering continuous positive airway pressure. Infants in the normal transition from intrauterine to extrauterine life may take a few minutes

to increase their oxygen saturation SpO_2 from about 60% (normal intrauterine state) to $> 90\%$. The values may be slightly lower for infants delivered by cesarean section compared with vaginal delivery. The perception of cyanosis after several minutes may be confirmed using a pulse oximetry probe. This should be placed on the right arm, which receives blood before it reaches the ductus arteriosus. The ductus may remain open for hours after birth, so the blood in the aorta past the ductus may mix with blood with low oxygen levels from the pulmonary artery via the ductus arteriosus. Oxygen may be supplied to the infant to achieve the targeted saturation values.¹⁵ (See Table 6.)

Free-flow oxygen can be given to an infant breathing spontaneously by several methods: an oxygen mask, a flow inflating bag and mask, a T-piece resuscitator, or oxygen tubing held close to the infant's mouth and nose. The mask should not be held tightly against the face, as this may cause excess pressure to build up inside the mask. It is important to have the right size of mask, which should rest on the chin and cover the mouth and the nose, but not the eyes. Oxygen supplementation is adjusted and should be gradually decreased as the

Table 6. Targeted Preductal SpO_2 After Birth

1 minute	60-65%
2 minutes	65-70%
3 minutes	70-75%
4 minutes	75-80%
5 minutes	80-85%
10 minutes	85-95%

pulse oximetry levels improve to $> 85-90\%$ on room air. If there is persistent cyanosis with oxygen saturations $< 85\%$ despite oxygen administration, a trial of PPV is indicated. Effective ventilations should produce bilateral breath sounds and chest wall movement. PPV may be discontinued if the heart rate rises > 100 bpm, if there is improvement in oxygen saturation, and if there is onset of spontaneous respirations. If cyanosis persists despite adequate ventilation, the presence of a cyanotic congenital heart disease or persistent pulmonary hypertension may exist. If PPV has to be continued for several minutes, an orogastric tube (size 8F feeding tube) may be necessary to avoid abdominal distention, which may place upward pressure on the lungs and prevent full lung expansion or may result in regurgitation of stomach contents and aspiration.

Chest Compressions

Chest compressions are indicated when the heart rate is < 60 bpm despite stimulation and at least 30 seconds of PPV.¹⁶ The compressions should be performed to the lower third of the sternum, and the pressure is applied vertically using one of two techniques:

Thumb technique: Two thumbs are used to compress the sternum. The hands encircle the torso with the fingers supporting the spine. This is the preferred method because it is easier to control the depth of compression and provide more consistent pressure.

Two-finger technique: Two fingers (middle finger and index or ring finger) of one hand are used to depress the sternum. The other hand is used to support the infant's back. The sternum should be depressed to a depth of approximately

one-third of the anteroposterior diameter of the chest. There should be complete chest recoil during the relaxation phase of the chest compression. Chest compressions and ventilation should be coordinated: one ventilation for every third compression, a total of 30 breaths and 90 compressions every minute. After 45–60 seconds of chest compressions and ventilations, the heart rate should be checked. When the heart rate is > 60 bpm, chest compressions may be stopped and ventilations may be increased to a rate of 40–60 breaths per minute. If spontaneous respirations occur and the heart rate is > 100 bpm, ventilation PPV may be stopped. If the heart rate is < 60 bpm, the infant must be intubated.

Intubation

Indications and equipment for intubation are listed in Table 7.¹⁶ Complications include esophageal intubation or perforation, bradycardia due to a vagal response from the laryngoscope or the suction catheter, pneumothorax, soft-tissue contusions, obstruction, or infection.

LMA Mask Placement

Laryngeal mask airways (LMAs) are masks that fit over the laryngeal inlet. TA size 1 is used in the newborn. This may be an alternative when PPV is ineffective and endotracheal intubation is unsuccessful or not feasible. The device is inserted into the infant's mouth using the index finger to guide the device along the hard palate until the tip almost reaches the esophagus. When it is fully inserted, the cuff is inflated with 2 to 4 mL of air via the inflation valve. Its use is limited in cases of prolonged ventilation or meconium aspiration, and it may be ineffective if high ventilation pressures are required. The smallest size available is 1, and it is not intended for use in newborns < 2 kg. Complications include soft-tissue trauma and gastric distention.

Umbilical Vessel Catheterization

The umbilical venous catheter provides intravascular access when peripheral intravenous access is not possible.¹⁴ The umbilical arterial catheter allows

Table 7. Indications for Intubation

- The presence of meconium in an infant who has depressed respiratory effort, muscle tone, or heart rate. The trachea is intubated as the first step to allow suctioning of the meconium, thus decreasing the possibility of meconium aspiration syndrome.
- Intubation will improve ventilation efforts when there is prolonged need for positive pressure ventilation.
- When chest compressions are necessary, intubation facilitates the coordination of compressions and ventilations.
- Special situations such as extreme prematurity, requiring surfactant administration, the presence of a congenital diaphragmatic hernia, and when positive pressure ventilation is not the ventilation method of choice.

Emergent intubation for apnea and presence of meconium is often performed without premedication. Supplies and equipment needed include:

- Laryngoscope
- Blades (No. 1 for a term infant, No. 0 for preterm newborn, No. 00 for the extremely preterm infant); straight blades are preferred over curved blades
- Endotracheal tubes (size 2.5, 3.0, 3.5, 4.0 mm).
- A stylet (optional)
- Carbon dioxide monitor or detector
- Suction and suction catheters (sizes 5F, 6F, 8F for ETT suctioning and size 10F for suctioning the pharynx).
- Tape (waterproof) and scissors or endotracheal tube securing device
- Oral airway
- Meconium aspirator
- Stethoscope
- Positive pressure device and tubing to deliver air and oxygen; self-inflating bags should have an oxygen reservoir and pressure gauge.
- Pulse oximeter and a neonatal probe
- Laryngeal mask airway masks (size 1) with a 5 mL syringe

invasive and continuous arterial pressure monitoring and access for arterial blood gas sampling. (See Table 8.)

Technique: Clean the umbilical cord and surrounding skin with antiseptic solution and cover the skin with drapes. Hold the cord clamp and tie the umbilical tie around the base of the cord, tight enough to prevent blood loss. Cut the umbilical cord with a scalpel 0.5 cm and 1 cm above the tape. The umbilical cord usually has three vessels: two arteries with thick walls and one vein with a large thin wall. If there is bleeding while cutting the cord, pull the tie tighter and swab the cord gently to prevent contraction of the arteries.

Umbilical vein catheter: The lumen is dilated with fine forceps. Flush the catheter with normal saline prior to insertion. The catheter is introduced into the lumen; after it passes the skin, it is advanced toward the patient's

neck. In the ED, the catheter may be advanced sufficiently in the vessel 3–5 cm below the umbilical ring until blood is aspirated. Radiographic confirmation is not necessary for administration of resuscitation medications and fluids. The catheter may be secured using a string suture at the base of the cord.

Pneumothorax

Pneumothorax is air in the pleural cavity resulting in partial or total collapse of one lung. This occurs in 0.5–2% of term infants; about 10% are symptomatic. The incidence in preterm infants is 3–10%. Up to 10% of newborns receiving PPV may develop a pneumothorax. Risk factors for a pneumothorax include respiratory distress syndrome, meconium aspiration, pulmonary hypoplasia, congenital diaphragmatic hernia, pneumonia (especially staphylococcal pneumonia),

Table 8. Supplies for Umbilical Vessel Catheterization

- 2 mL syringes x 2
- 3-way stopcock
- Normal saline flushes (sterile)
- Heparin solution (1 U/mL)
- Catheters: 3.5F (preterm infant); 5F (term infant); single-lumen, double-lumen, or triple-lumen catheter for umbilical vein; single-lumen end-hole catheter for umbilical artery
- Scalpel
- Umbilical tape
- Suture and tape for fixation
- Two anatomical forceps, surgical forceps, two or three pointed anatomical forceps
- Fine probe
- Sterile gauze pads, drapes, gown, gloves, mask, and cap
- Antiseptic solution

lobar pulmonary emphysema, congenital cystic lung malformations, and procedures such as mechanical ventilation, endotracheal suctioning, dilation of tracheal strictures, and cardiopulmonary resuscitation. A tension pneumothorax may present with respiratory distress, retractions, tachypnea, cyanosis or pallor, tachycardia or bradycardia, poor or absent breath sounds on the affected side, asymmetric chest movement, heart sounds shifted to the right (in a left-sided pneumothorax), jugular venous distension, subcutaneous emphysema, and respiratory acidosis.

A small pneumothorax is usually asymptomatic. Supplemental oxygen is administered.

Needle Decompression/ Chest Tube Insertion

For a symptomatic pneumothorax or a tension pneumothorax, emergency decompression with needle aspiration and chest tube placement is indicated. Needle decompression supplies include betadine or other antiseptic, 22- or 24-gauge angiocatheter or butterfly catheter, and three-way stopcock. The catheter is inserted above the third rib in the midclavicular line. The needle is removed and a three-way stopcock is

attached to the catheter. Air is aspirated using 10 mL or 20 mL syringes. The procedure may be repeated until no more air is aspirated. Chest tube placement is then indicated.

Supplies for chest tube placement include sterile gloves, towels, gauze pads, scalpel, betadine or other antiseptic solution, chest tube, suction drainage system or pleurovac, sutures and needle holder, tape, and a local anesthetic such as lidocaine.

Chest tube French sizes 10 or 12 are appropriate for neonates. The smaller size, 10 F, is more suitable for premature neonates.

Congenital Diaphragmatic Hernia

Congenital diaphragmatic hernia (CDH) is caused by a defect in the diaphragm that allows herniation of abdominal viscera into the chest cavity. (See Figure 3.) It occurs in about one in 2200 births and is often associated with pulmonary hypoplasia.¹⁷ The defect may be small or large, with varying degrees of severity in clinical presentation. On examination, the patient may have a barrel-shaped chest, a scaphoid abdomen, and absence of breath sounds on the affected side, and the heartbeat may be displaced to the right. CDH is often on the left side, but the right side is affected in 11%, and it occurs bilaterally in 2%.¹⁷ The respiratory distress is determined by the size of the herniation and the degree of pulmonary hypoplasia.

Diagnosis is often made on prenatal ultrasound. A chest X-ray in the affected infant will reveal abdominal contents in the hemithorax. If a feeding tube is placed in the stomach, it will appear in the chest cavity on X-ray. If the infant has a right-sided CDH, the X-ray may reveal a large thoracic mass with absent intra-abdominal liver shadow. Immediate management for CDH includes intubation and ventilation with low peak pressures. Bag valve mask and PPV may cause intestinal distention and lung compression exacerbated respiratory distress. A delay in airway management may cause acidosis and development of persistent pulmonary hypertension (PPHN). A nasogastric tube should be placed to decompress the abdominal contents.

An umbilical venous catheter allows for fluid resuscitation and support and an arterial catheter allows for monitoring blood gases and blood pressure. Blood pressure support with fluids and inotropic agents, such as dopamine or dobutamine, may be needed. Extracorporeal membrane oxygenation, high-frequency ventilation, and nitric oxide¹⁸ are modalities often utilized for management of these patients.

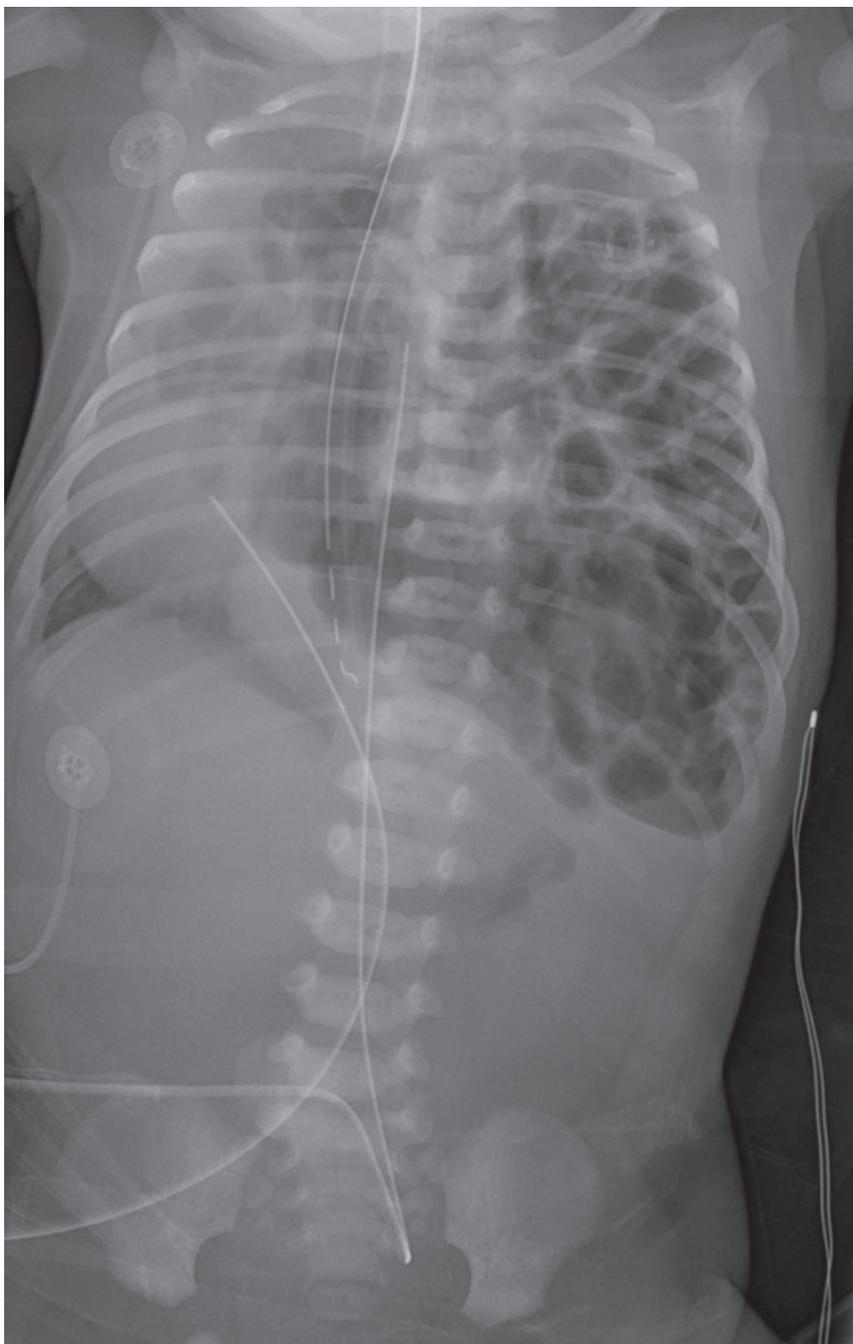
Omphalocele/ Gastroschisis

Omphalocele/gastroschisis are defects in the abdominal wall. The omphalocele is midline and contains bowel and other intra-abdominal organs herniating through the defect. It occurs in about 2-3 per 10,000 births and may be associated with intrauterine growth retardation, pulmonary hypoplasia, and heart disease. Eighty percent of these infants have associated anomalies such as heart disease, genitourinary abnormalities, craniofacial anomalies, and limb anomalies. Beckwith-Wiedemann syndrome may involve hemihypertrophy, hypoglycemia, macroglossia, and omphalocele. Gastroschisis, which is often caused by a defect lateral to the umbilicus, occurs in 1-2 per 10,000 births.¹ The sac may be intact or ruptured.¹⁶ Other gastrointestinal problems that may be associated include volvulus, atresias, stenosis, or perforations. Extra-intestinal anomalies are infrequent. Latex-free gloves should be used to handle the infant. The bowel should be encased in a bowel bag or covered with warm saline-soaked gauze. This is then wrapped in Kling gauze, then a plastic wrap to support the bowel. Caution is recommended during this procedure to prevent compromise of the mesenteric blood supply. No attempt should be made to reduce the sac, as this may result in compromise of the blood supply. Continuous nasogastric suctioning is recommended. The infant should be kept warm. Antibiotics such as ampicillin and gentamicin should be administered. Omphalocele and gastroschisis in a newborn requires urgent surgical consultation.

Choanal Atresia

Choanal atresia is caused by the persistence of the bucconasal membrane

Figure 3. Diaphragmatic Hernia



or bony septum in the posterior nares. Since infants are obligate nose breathers, if choanal atresia is present and the nasal passage has meconium or secretions, the infant may have significant respiratory distress. The presence of choanal atresia is suspected by the inability to pass a small suction catheter 5–8 Fr through the nares into the pharynx. Bilateral choanal atresia presents shortly after birth, sometimes with intermittent

cyanosis worsened with feeds and relieved by crying. The unilateral type may not present until the infant develops an upper respiratory infection. The placement of an oral airway may alleviate respiratory distress, and endotracheal intubation may be required if the latter is unsuccessful. A CT scan with intranasal contrast that reveals narrowing of the posterior nasal cavity confirms the diagnosis of choanal atresia.

Table 9. Indications for Transfer to NICU

- Prematurity
- Birth weight < 1500 g
- Respiratory distress syndrome requiring ventilator support, respiratory failure, or persistent pulmonary hypertension
- Congenital heart disease and cardiac arrhythmias
- Congenital anomalies or inborn errors of metabolism
- Hypoxic ischemic injury or seizures
- Infant of a diabetic mother
- Requiring services, such as extracorporeal membrane oxygenation or surgery, that are not available at referring hospital

Table 10. Factors for Preparing for Transfer to NICU

- Maintain an appropriate thermal environment for the infant
- Provide adequate ventilation and oxygenation
- Stabilize blood pressure and volume status with fluids and inotropes if needed
- Ensure adequate blood glucose levels
- Obtain cultures and start appropriate antibiotics if necessary
- An infant with a small pneumothorax requires chest tube placement prior to air transport. Gases in closed spaces expand as altitude increases and barometric pressure decreases. A small pneumothorax may become a tension pneumothorax
- Insert a nasogastric tube to decompress the stomach, especially prior to air transport
- If indicated, obtain umbilical venous and arterial access
- Obtain a copy of the chart, labs, radiological studies, and appropriate consents from parents for transfer

Preparing for Transfer to Newborn Nursery or NICU

An infant requiring resuscitation and stabilization after delivery must be transferred to a unit for close monitoring and further management. (See Table 9.) Transfer may be within the same institution or to another facility by ground or air transport. Air transport may be fixed wing (aircraft) if the distance is > 150 miles each way or rotor wing (helicopter) if 100-150 miles each way. The appropriate facility to transfer the infant must be identified. The hospital classification by level of NICU care is: Level I (no NICU), Level II (intermediate NICU), and Level III (tertiary NICU).¹⁹

The ED physician should stabilize the infant prior to transfer¹⁸ and discuss further recommendations with the accepting neonatologist. See Table 10 for factors to address prior to transfer.

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CME Questions

- The guidelines for neonatal resuscitation include all of the following *except*:
 - The Golden Minute refers to the first 60 seconds in which resuscitation should be initiated if necessary.
 - Chest compressions are indicated for an initial heart rate < 60 bpm per minute.
 - Chest compressions are indicated for a heart rate of < 60 bpm per minute after adequate ventilation and oxygenation after 30 seconds.
 - Epinephrine (0.01 mg/kg IV) is indicated if the heart rate is < 60 bpm per minute, after adequate ventilation and chest compressions.
- A term newborn infant is delivered in the emergency department prior to transfer to an obstetrics unit. The patient's heart rate remains < 60 bpm despite adequate oxygenation and ventilation. Which of the following interventions should be provided immediately?
 - Examination of the airway and suctioning of meconium if present.
 - Drying the infant and vigorous stimulation to initiate deeper breathing.
 - Assessment of glucose level at the bedside.
 - Chest compressions.
 - Placement of IV or IO and fluid resuscitation with 20 mL/kg NS.
- A term infant has a preductal oxygen saturation of 90%, 10 minutes after birth. Which of the following is true?
 - Oxygen supplementation is necessary.
 - Cyanotic heart disease is suspected.
 - The normal oxygen saturation for this infant 10 minutes after birth is 85-95%.
 - The normal oxygen saturation for this infant 10 minutes after birth is 95-100%.
- A term infant is limp, cyanotic, and apneic at birth. Resuscitation is required. Which of the following statements is true regarding the resuscitation of this infant?
 - Chest compressions are indicated for the heart rate < 60 bpm, despite stimulation and at least 30 seconds of PPV.
 - The thumbs technique is preferred.
 - The chest compression to ventilation ratio is 3:1.
 - If the heart rate is < 60 bpm after 60 seconds of compressions and PPV, the infant must be intubated and epinephrine 0.01 mg/kg given intravenously.
 - All of the above
- A term infant is delivered in the emergency department. The amniotic fluid is meconium stained. Which of the following is true regarding the management of this patient?
 - If the infant is vigorous, the infant is kept warm and the mouth and nose are cleared with a bulb syringe or suction catheter.
 - If the infant is vigorous, the infant is kept warm and the trachea intubated with an ETT to suction the meconium.
 - If the infant is limp and cyanotic, the infant is kept warm, the mouth and nose are cleared with a bulb syringe or suction catheter only.
 - If the infant is limp and cyanotic, the infant is kept warm, the mouth and nose are cleared with a bulb syringe or suction catheter, and the trachea intubated for suctioning of the meconium from the trachea.
 - (A) and (B).
 - (B) and (C)
 - (A) and (D)
 - All of the above.

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CME Objectives

Upon completion of this educational activity, participants should be able to:

- recognize specific conditions in pediatric patients presenting to the emergency department;
- describe the epidemiology, etiology, pathophysiology, historical and examination findings associated with conditions in pediatric patients presenting to the emergency department;
- formulate a differential diagnosis and perform necessary diagnostic tests;
- apply up-to-date therapeutic techniques to address conditions discussed in the publication;
- discuss any discharge or follow-up instructions with patients.

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Practical, Evidence-Based Reviews in Pediatric Emergency Care

Emergent Delivery and Neonatal Resuscitation

Assessment of Pregnant Patient in the ED

History

- Sexual activity: This may be denied in the pediatric population
- Signs of pregnancy: Missed period, morning sickness, weight gain, urinary frequency, breast enlargement, and abdominal enlargement
- Sexually transmitted diseases
- Last menstrual period: This aids in determining gestational age if the patient has regular menstrual cycles. The expected date of confinement or delivery or due date is calculated using the first day of the last normal period, adding 9 months and 1 week (Naegele rule), or by using a pregnancy wheel
- Past pregnancies, miscarriages or abortions, gravidity (the total number of pregnancies including the current pregnancy), and parity (the number of deliveries after 20 weeks).
- Problems in prior or current pregnancies
- Prenatal care
- Blood type if known: Rh-negative mother may need RhoGAM
- Allergies
- Past medical history
- Group B strep status
- Medications or drug use
- Signs of active labor
- Rupture of membranes
- Signs of imminent delivery

Physical Exam

- Vital signs
- Temperature: Elevation may indicate maternal infection such as chorioamnionitis
- Blood pressure: Elevation may indicate pre-eclampsia. Seizures and elevated BP indicate eclampsia. Hypotension may indicate blood loss in placental abruption or other hemorrhage.
- Heart rate: Evaluate maternal and fetal heart rate. Fetal heart rate is best heard with a Doppler. This should be evaluated with each contraction. It is best heard between the umbilicus and the symphysis. A fetal heart rate < 100 or > 180 may indicate fetal distress.
- Examination of the abdomen may help with assessing the gestational age of the fetus. Gestational age can be approximated based on fundal height.

2010 American Heart Association Guidelines for Neonatal Resuscitation

The "golden minute," or first 60 seconds, is the time frame in which resuscitation should be initiated if required.¹⁵

- Term infant, breathing or crying, good tone: Stay with mother
- Preterm, not breathing or crying, poor tone: Warm, clear airway, dry, stimulate
- Labored breathing, persistent cyanosis: Clear airway, SpO₂ monitor, consider continuous positive airway pressure
- Heart rate < 100, gasping or apnea: PPV, SpO₂ monitor
- Heart rate < 60: ventilation corrective steps, consider intubation, chest compressions, positive pressure ventilation
- Heart rate still < 60: Give epinephrine (0.01 to 0.03 mg/kg IV or 0.05 to 0.1 mg/kg via ETT)
- If heart rate still < 60: Consider hypovolemia (give normal saline bolus 10 mL/kg) and pneumothorax (needle decompression for tension pneumothorax)

Neonatal Resuscitation Equipment and Supplies

- Suction equipment: Bulb syringe, mechanical suction and tubes, suction catheters 5F-14F, 8F feeding tube and 20 mL syringe, and meconium aspirator
- Bag and mask equipment: Device for delivering positive pressure ventilation capable of giving 90-100% oxygen, term and preterm newborn masks, oxygen source, compressed air source, oxygen blender (for flow rates up to 10 L/min), pulse oximeter, and probe
- Intubation equipment: Laryngoscope with straight blades (size 0 for preterm and 1 for term); endotracheal tube (ETT) sizes 2.5, 3.0, 3.5, 4.0; stylet; scissors; tape for securing ETT; ET CO₂ detector; and laryngeal mask airway
- Medications: Epinephrine 1:10,000 (0.1 mg/mL), isotonic crystalloid fluid such as normal saline or Ringer's lactate (100 mL bag), dextrose 10%, and normal saline flushes
- Umbilical vessel catheterization supplies: Sterile gloves, scalpel, betadine or other antiseptic solution, umbilical tape, umbilical catheters (3.5F, 5F), 3-way stop-cock, syringes (1 mL, 3 mL, 5 mL, 10 mL, 20 mL, 50 mL), and needles (18, 21, and 25 gauge)
- Miscellaneous: Radiant warmer, firm padded surface for resuscitation, timer, warm blankets, ½- or ¾-inch tape, stethoscope, cardiac monitor and electrodes, oropharyngeal airways (0, 00, 000 sizes), plastic wrap, and transport incubator

Indications for Intubation

- The presence of meconium in an infant who has depressed respiratory effort, muscle tone, or heart rate. The trachea is intubated as the first step to allow suctioning of the meconium, thus decreasing the possibility of meconium aspiration syndrome.
- Intubation will improve ventilation efforts when there is prolonged need for positive pressure ventilation.
- When chest compressions are necessary, intubation facilitates the coordination of compressions and ventilations.
- Special situations such as extreme prematurity, requiring surfactant administration, the presence of a congenital diaphragmatic hernia, and when positive pressure ventilation is not the ventilation method of choice.

Emergent intubation for apnea and presence of meconium is often performed without premedication. Supplies and equipment needed include:

- Laryngoscope
- Blades (No. 1 for a term infant, No. 0 for preterm newborn, No. 00 for the extremely preterm infant); straight blades are preferred over curved blades
- Endotracheal tubes (size 2.5, 3.0, 3.5, 4.0 mm).
- A stylet (optional)
- Carbon dioxide monitor or detector
- Suction and suction catheters (sizes 5F, 6F, 8F for ETT suctioning and size 10F for suctioning the pharynx).
- Tape (waterproof) and scissors or endotracheal tube securing device
- Oral airway
- Meconium aspirator
- Stethoscope
- Positive pressure device and tubing to deliver air and oxygen; self-inflating bags should have an oxygen reservoir and pressure gauge.
- Pulse oximeter and a neonatal probe
- Laryngeal mask airway masks (size 1) with a 5 mL syringe

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