Abstract:
Successful transition from the intrauterine to extrauterine environment is dependent on several significant physiologic changes that must occur within minutes of birth. Most infants effectively transition at delivery without requiring any special assistance. However, about 10% of infants will require some level of intervention, and 1% will require extensive resuscitative measures at birth. The focus of this article is on the preparation for and management of an unexpected delivery in the emergency department. We will highlight the unique aspects of newborn resuscitation, as well as recent changes to the Neonatal Resuscitation Program from the 2015 American Heart Association Guidelines.

Keywords:
neonatal; neonatal resuscitation; newborn; unexpected delivery; precipitous delivery; delivery; emergency department

*Department of Pediatrics, Division of Neonatology, Feinberg School of Medicine, Northwestern University, Chicago, IL; †Department of Pediatrics, Division of Emergency Medicine, Feinberg School of Medicine, Northwestern University, Chicago, IL.
Reprint requests and correspondence: Arika G. Gupta, MD, 225 East Chicago Ave., Box 45, Chicago, IL, 60611.
arika.gupta@northwestern.edu

1522-8401

Management of an Unexpected Delivery in the Emergency Department

Arika G. Gupta, MD*, Mark D. Adler, MD†

For those who do not routinely care for newborn infants in the immediate postdelivery period, facing a sudden unexpected need to fill the role can be anxiety provoking, particularly if the infant requires care beyond the routine. Successful transition from the intrauterine to extrauterine environment is dependent on several significant physiologic changes that must occur at the time of birth. Most (approximately 90%) infants successfully transition at delivery without requiring any special assistance from medical providers. However, the remainder of infants will require some level of intervention, and less than 1% will require extensive resuscitative measures at birth.[1,2] In this article, we will focus on the preparation for and management of a newborn who unexpectedly delivers in the emergency department (ED) and has approximately a 1 in 10 chance of requiring intervention.

CASE PRESENTATION

A 15-year-old patient is brought to the ED by her parents for a complaint of severe abdominal pain at home. She has received care at your institution before for orthopedic issues and thus chose to come to your hospital for this issue as well. She has had episodic abdominal pain that has been recurring every 3 minutes, nausea, and a report of recent weight gain. She cannot tell you her last menstrual period. Your examination quickly reveals what the history strongly suggested: she is pregnant and in active labor. You have staff with ultrasound training on the unit and their examination reveals an intrauterine fetus. On pelvic examination, the patient is fully

dilated, and the fetus is crowning. You immediately begin preparing for a precipitous delivery in the ED and make arrangements for the appropriate teams to be notified.

Some of the most important considerations in this situation include the following:

1. What are the key questions to ask to prepare for the impending delivery of a neonate?
2. What needs to be prepared for the resuscitation of this infant?
3. What are the principles and steps behind resuscitation of a newborn infant?

PREPARING FOR AN UNEXPECTED DELIVERY

First, take a deep breath and remember that 90% of babies require no assistance at birth and transition to the extrauterine environment appropriately all on their own.[1,2] However, given that the remaining 10% of neonates require some intervention at birth, we must ensure we are prepared to support any newborn that requires assistance. In some instances, there may be time to discuss an impending delivery with a neonatologist; however, in other cases, the ED team must respond rapidly and rely exclusively on their own expertise.

To prepare efficiently and effectively, it is helpful to know what questions you must ask the patient before the delivery. These questions include the following:

1. Did the patient receive prenatal care? Was the pregnancy known to the patient?
2. How many babies are expected to be delivered?
3. Approximate gestational age in weeks or date of last menstrual period?
4. Any major complications during the pregnancy or labor (eg, gestational diabetes, gestational hypertension, concerns about fetal growth, maternal infection or fever, prolonged rupture of membranes)?

On the basis of this information (or lack thereof), you can begin preparing the appropriate number of team members and resuscitation supplies. If time permits, it is helpful to prebrief with the team to review the plan for resuscitation, assign roles, and delegate tasks. In addition, obtaining further history can be valuable, such as finding out if there were any known anatomic abnormalities on prenatal ultrasound. There are certain prenatal abnormalities, such as congenital diaphragmatic hernia, congenital heart disease, anterior abdominal wall defects, or lumbosacral defects, to name a few, which would affect your immediate evaluation and resuscitation of the infant and prompt more immediate consultation with a neonatologist.

It is critical to have separate teams with predesignated roles, with one team to manage the mother and the other team for the newborn. The focus of this article is on preparing for and managing the neonate; the care of the mother, including maternal labor or delivery complications, will not be discussed. Given the low-frequency, high-stakes nature of an unexpected delivery in the ED, a standardized checklist of supplies and equipment for a newborn resuscitation is helpful to ensure that all necessary items are prepared and checked before delivery. Table 1 provides a list of recommended supplies and equipment for an impending delivery.[3] Because of the rarity of such events, the supplies and equipment may be more difficult to find or may be missing, unlike frequently used ED equipment. It is useful to identify where these supplies are kept and have a process to ensure they are checked and stocked on a regular basis. Unplanned deliveries are sufficiently challenging without this additional distractor.

PRINCIPLES AND STEPS OF NEWBORN RESUSCITATION

The American Heart Association (AHA) published updated guidelines on neonatal resuscitation in November 2015.[4] These guidelines are meant to apply to newly born infants who require assistance

TABLE 1. List of equipment needed for neonatal resuscitation.

Radiant warmer
Warm blankets/towels
Hat
Plastic wrap (such as NeoWrap)
Thermal mattress
Bulb suction, suction catheter, and suction tubing
Neonatal face mask (all sizes)
Endotracheal tubes (all neonatal sizes: 2.5, 3.0, 3.5, and 4.0), stylet (optional)
Laryngoscope blades (all neonatal sizes: 00, 0, 1 Miller)
Bag valve mask device (ideally flow-inflating bag; however, self-inflating bag would be adequate)
Laryngeal mask airways (size 1 neonatal)
Oxygen source and blender
O_2 saturation probe and monitor
Cardiac leads and monitor
CO_2 detector
Tape
Umbilical line kit
Stethoscope

in making the transition to the extrauterine environment but are also applicable to neonates who require resuscitation in the first few weeks after birth. Neonatal cardiac arrest is predominantly caused by asphyxia; as a result, initiation of effective ventilation remains the mainstay of initial neonatal resuscitation, whether in the delivery room or in the few weeks after birth.

A summary of these guidelines, with an emphasis on the key aspects relevant to the immediate management of an unexpected delivery in the ED, will be reviewed here. Please refer to Figure 1 for a stepwise approach to neonatal resuscitation.[4]

The most important 3 questions to ask upon delivery of the neonate include the following:

1. Term gestation?
2. Good tone?
3. Breathing or crying?

If all 3 questions are answered "yes," then the newborn may stay with the mother and receive routine newborn care, which entails keeping the newborn warm to avoid hypothermia. Infants that are born precipitously either at home or on the way to the hospital should be triaged similarly to the infant born in the ED by asking the same 3 questions.

If any of the above questions are answered "no," then the infant should be immediately placed under a preheated radiant warmer for a full assessment by the infant's resuscitation team. The steps to be performed (see Figure 1) are summarized here and then detailed further below:

1) Initial stabilization: includes warming and drying the infant, positioning the airway, clearing secretions from the airway (if needed), and stimulating the infant, including flicking the soles of the feet or rubbing the infant's back.
2) If heart rate (HR) is below 100 beats per minute (bpm) at the first assessment (by 1 minute of life) or if the infant has inadequate respiratory effort (apnea, gasping, hypopnea), then effective ventilation and oxygen delivery must be delivered, via bag valve mask (BVM). Multiple corrective measures to ensure effective ventilations must be attempted, including endotracheal tube (ETT) or laryngeal mask airway (LMA) placement, if necessary.
3) If HR is below 60 bpm, despite adequate ventilation (including advanced airway placement), initiate chest compressions/breaths at a ratio of 3:1. Note the difference between this rate and the pediatric advanced life support algorithm with a 15:2 ratio.[5] You may need to be explicit with your team if they are not familiar with the neonatal resuscitation recommendations.
4) If HR remains below 60 bpm, despite intubation, effective ventilation/oxygenation, and chest compressions, intravenous epinephrine (see access approaches below) should be administered, followed by consideration of other causes of hemodynamic compromise, including hypovolemia, tension pneumothorax, or cardiogenic shock.

SPECIAL CONSIDERATIONS AT THE TIME OF DELIVERY

Delayed Cord Clamping

On the basis of data from a recent systematic review,[6] delayed umbilical cord clamping is now recommended for both term and preterm infants who do not require resuscitation at birth, when possible. Delayed umbilical cord clamping is defined as clamping the umbilical cord approximately 30 to 60 seconds after birth. Delayed umbilical cord clamping has been associated with less all-grade intraventricular hemorrhage (IVH), higher blood pressure and blood volume, decreased need for postnatal transfusion, and lower incidence of necrotizing enterocolitis. Delayed umbilical cord clamping has not been shown to decrease mortality or incidence of severe IVH. The only adverse consequence of delayed umbilical cord clamping found was a slightly increased level of bilirubin, associated with more need for phototherapy.[7]

Thermoregulation

Hypothermia is known to cause an increase in oxygen consumption and metabolic demand and is independently associated with increased morbidity and mortality in the neonate of all gestational ages. Low–birth weight and preterm infants, in particular, are at increased risk of hypothermia due to rapid loss of body heat due to their large body surface: body mass ratio, thinner skin, and decreased subcutaneous fat. Therefore, it is vital to take all measures to ensure appropriate thermoregulation after birth. It is recommended that the temperature of a newly born infant be maintained between 36.5°C and 37.5°C (97.7°F-99.5°F) through stabilization. There is a commensurate increase in mortality for temperatures below 36.5°C.[8,9] Strategies to ensure thermoregulation

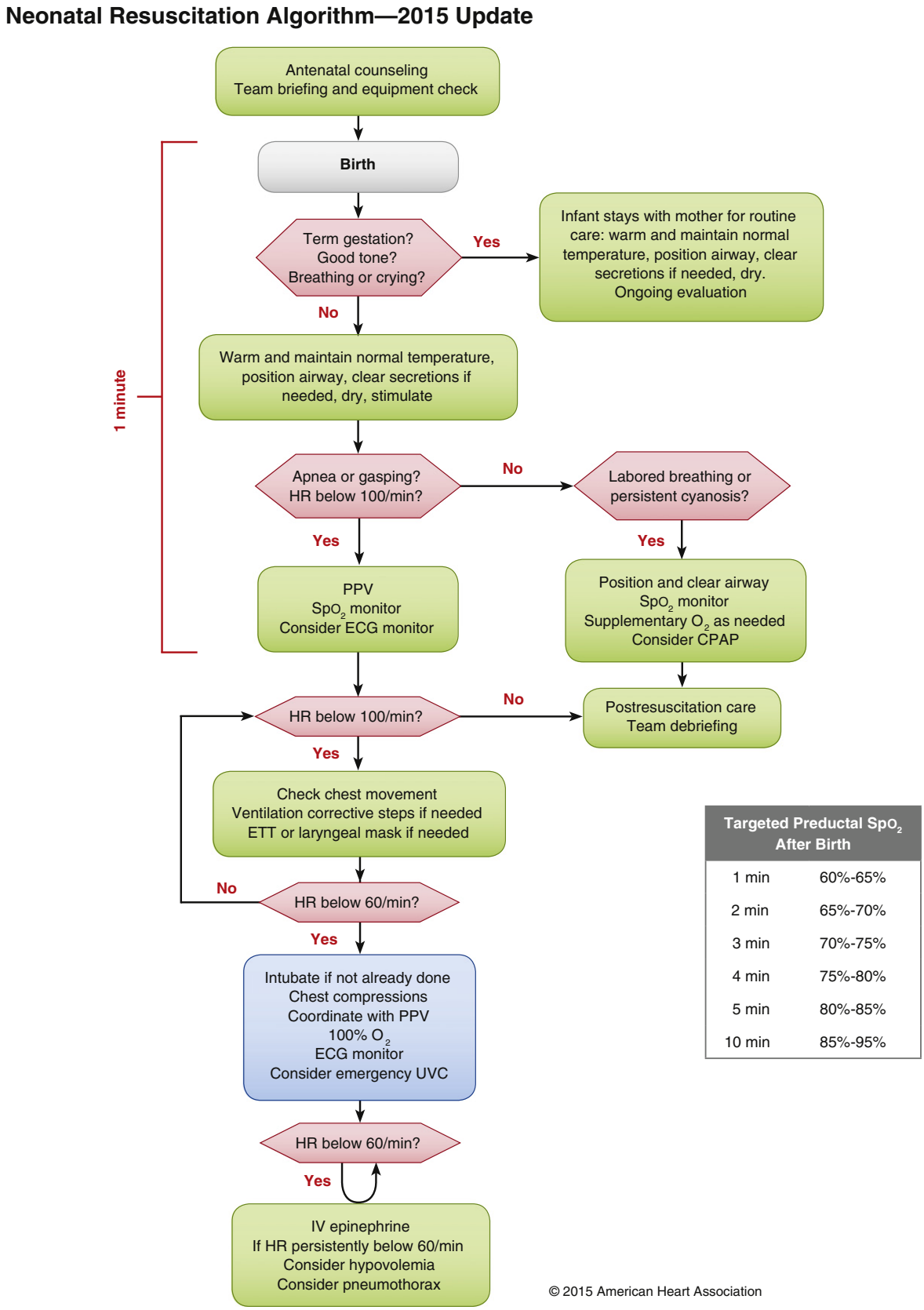

Figure 1. 2015 Neonatal Resuscitation Algorithm. Reprinted with permission from *Circulation* (2015;132:S543-S560).[4] Copyright 2015, AHA.

Figure 2. Premature neonate wrapped in plastic wrap immediately after delivery to optimize thermoregulation.

in the delivery room, or in this case the ED, include use of a preheated radiant warmer, plastic wrap for preterm neonates (Figure 2), warm and dry linens to dry and swaddle infant, hat, increased room temperature, thermal mattresses, and use of warmed humidified resuscitation gases.

ELEMENTS OF NEONATAL RESUSCITATION

Airway

If a newborn is demonstrating signs of airway obstruction or inadequate ventilation requiring positive pressure ventilation (PPV), it is appropriate to open the mouth, if needed, adjust the airway (using chin tilt or jaw thrust), and/or suction secretions from the airway. However, it is recommended that unnecessary suctioning of the nasopharynx be avoided given the risk of inducing a vagal response and reflexive bradycardia. In addition, the most recent AHA guideline no longer recommends routine tracheal intubation in the setting of a depressed newborn with meconium-stained amniotic fluids, as had previously been recommended.[4] The focus in these patients should be on initiating ventilation within the first minute of life if the infant remains depressed and is not breathing or ineffectively breathing.

Major update: it is no longer recommended to immediately tracheal suction nonvigorous newborns with meconium stained amniotic fluid.

Breathing

Despite the initial steps of drying, stimulation, and airway maneuvers, if the infant's HR is under 100 bpm at the first assessment at about 1 minute of life, it is essential to promptly begin PPV via BVM at a rate of 40 to 60 breaths per minute. This applies to all newly born infants, regardless of the amniotic fluid appearance. If PPV is initiated, the team should consider placing a pulse oximetry probe on the right upper extremity (preductal) to monitor oxygen saturations. Resuscitation of all infants, including preterm infants, should be initiated with low oxygen concentrations (21% ideally, but up to 30% for preterm infants is reasonable). The oxygen concentration should subsequently be titrated to achieve target preductal oxygen saturations based on minutes of life, as seen in Figure 1. It is appropriate for a newborn with normal transition to have a preductal saturation ranging between 60 and 70% in the first minute of life with a gradual increase until about 10 minutes of life when the preductal saturations typically increase to 85 to 95%.[4] If a blender device that allows the fine titration of FiO_2 is not available, it is reasonable to initiate PPV with room air and increase to 100% FiO_2, if resuscitation is necessary. The AHA recommendation to avoid administration of excessive oxygen is an attempt to limit the potential deleterious effects of hyperoxia.

Throughout the resuscitation, once PPV has been initiated, the team should be consistently reevaluating the infant's HR, spontaneous respiratory effort, effectiveness of assisted ventilation, and the preductal oxygen saturations. Ventilation corrective measures should be considered if assisted breaths are not effective or HR does not quickly begin to rise. An increase in the newborn's HR is one of the most sensitive indicators we have during a resuscitation of the effectiveness of ventilation. If despite effective ventilations, the HR does not rise, the team should consider placement of an advanced airway, including an ETT or LMA. Laryngeal mask airways may be considered as an alternative to tracheal intubation in infants ≥ 34 weeks or ≥ 2 kg when tracheal intubation is unsuccessful or not feasible.[4]

When administering PPV, it is critical to assess the following frequently:

- Heart rate
- Spontaneous respiratory effort
- Effectiveness of assisted breaths
- Preductal oxygen saturations

If chest compressions are necessary, it is recommended that an advanced airway be placed prior, to ensure effective ventilation as well as to optimize compression performance. In addition, if compressions are being given, it is appropriate to increase the FiO_2 to 100% until the HR recovers and then titrate down the oxygen concentration once the HR improves.

If at any point in the resuscitation, the HR is greater than 100 bpm and the neonate is breathing spontaneously, but is demonstrating signs of respiratory distress (labored breathing or grunting) or has persistent cyanosis, the team should consider initiation of continuous positive airway pressure. In the setting of the ED, continuous positive airway pressure is probably most easily provided using a flow-inflating bag with the positive end-expiratory pressure set to 5 to 6 cm H_20.

Circulation

As noted above, a newborn's HR is evaluated frequently throughout a resuscitation and is the most sensitive indicator of effective ventilation, whether from the infant's spontaneous respiratory effort or delivered mask ventilations. Typically, either auscultation of the HR or palpation of the pulse at the base of the umbilicus is the most effective method used to evaluate HR in the first minute of life. Previously, it was recommended to use pulse oximetry to supplement this assessment if the infant requires interventions. However, the newest recommendation is to use a three-lead electrocardiogram for monitoring HR during a resuscitation, in addition to continuous pulse oximetry for evaluation of oxygen saturation.[4,10,11]

If the HR remains less than 60 bpm despite adequate ventilation, including placement of an advanced airway, chest compressions should be initiated at a ratio of 3 compressions: 1 breath for a total of 120 events per minute. Compressions and ventilations should be coordinated to avoid simultaneous delivery, allowing the chest to fully recoil between compressions and optimize lung expansion during assisted ventilation. Note that this differs from pediatric advanced life support in which compressions and breaths are not coordinated after intubation.[5] In terms of technique, the two-thumb technique is the preferred method for compressions, as it has been shown to be more effective and is associated with less rescuer fatigue.[12,13] The two-thumb technique involves encircling the newborn's torso with the thumbs placed on the lower third of the sternum and the fingers under the infant's back, supporting the spine.

> Major update: the 2-thumb technique for compressions is the preferred cardiac compression method in a newborn

Medications and Fluids

Given that most cases of neonatal cardiac arrest or bradycardia are secondary to inadequate ventilation, establishing adequate ventilation remains the foundation of neonatal resuscitation. However, in situations in which the HR remains below 60 bpm despite adequate ventilation with an advanced airway and 100% FiO_2 and chest compressions, it is appropriate to administer either epinephrine or a volume expander, or both. For persistent bradycardia, intravenous epinephrine at a dose of 0.01 to 0.03 mg/kg, of 1:10 000 concentration, may be considered. If venous access is not available, the resuscitation team may consider a dose of endotracheal epinephrine at a dose of 0.05 to 0.1 mg/kg, until intravenous access is established. In such circumstances, once intravenous access has been obtained, an intravenous dose of epinephrine should be given immediately, irrespective of when the endotracheal dose was given. Options for emergency intravenous access in a neonate include placement of a peripheral intravenous catheter, low-lying umbilical venous catheter (UVC), or intraosseous line (IO).[14–17] In situations requiring emergent access, the peripheral venous system can often be difficult to catheterize due to peripheral vasoconstriction. Therefore, UVC or IO placement may be more practical until the neonate is effectively resuscitated and stabilized. The decision of which (UVC vs. IO) to place emergently should ultimately be guided by the clinician's experience and comfort level with each of the procedures. The specific procedural steps or indications and contraindications of these various lines are beyond the scope of this article.

When there is a known history of blood loss during delivery and/or signs of hypovolemic shock in the newborn, volume expansion may be considered when the infant has failed to respond to all other resuscitative measures. Appropriate volume expanders include isotonic crystalloid solution or emergency blood, at a dose of 10 mL/kg. In premature infants, it is recommended to avoid giving these volume expanders rapidly, as this may be associated with increased risk of IVH.[18]

POSTRESUSCITATION CARE, MONITORING, AND EVALUATION

After initial assessment and resuscitation of the newborn, it is important to ensure that the appropriate monitoring, treatment, and stabilization are provided while arrangements are made for transfer to an appropriate level of nursery.

- Thermoregulation—Hypothermia is associated with increased neonatal morbidity and mortality, including increased risk of respiratory problems, metabolic derangements, IVH, and late-onset sepsis.[19–21] Likewise, hyperthermia should be avoided in neonates, as it can be associated with an increase in mortality and morbidity, including meconium aspiration syndrome, respiratory distress syndrome, neonatal seizures, and need for assisted ventilation.[22] Therefore, the target temperature for a normal newborn, independent of gestational age, is between 36.5°C and 37.5°C (97.7°F-99.5°F).
- Therapeutic hypothermia—In special circumstances for infants ≥36 weeks gestation who have suspected moderate to severe hypoxic-ischemic encephalopathy, induced therapeutic hypothermia should be offered and implemented at a neonatal intensive care unit or other intensive care unit with the appropriate resources, monitoring, and nursing staff for this treatment protocol. If the newborn meets criteria for therapeutic hypothermia, treatment should ideally be initiated by 6 hours of life, when possible. Induced therapeutic hypothermia, when used in this special circumstance, has been associated with reduced mortality and major neurodevelopmental disability to 18 months of age.[23]
- Glucose monitoring—Infants who require resuscitation or have other risk factors for dysregulated glucose levels (such as infants who are growth restricted, who are small for gestational age, who are large for gestational age, have exposure to gestational diabetes, have suspected sepsis, or are born prematurely), require close monitoring of their glucose levels to ensure glucose homeostasis in the first several hours after birth. Symptoms of hypoglycemia in a neonate include lethargy, poor feeding, hypothermia, apnea, irritability, hypotonia, tremors, jitteriness, or seizures. In neonates, the majority of circulating glucose is used by the brain; therefore, prompt administration of intravenous dextrose, in the setting of hypoglycemia, is critical to optimize a newborn's neurodevelopment.[24] If hypoglycemia is present, a bolus of intravenous D10% water solution is given at a volume of 2 mL/kg, followed by initiation of intravenous dextrose-containing fluids, not saline-based fluids. Typically, a D10% water solution is used as the maintenance fluid in a newly born infant to provide a dextrose infusion rate of about 4 to 6 mg/kg/min, which is equivalent to total fluids of 60 to 80 mL/kg/day. Frequent reassessment of blood glucose measurements should be taken until the newborn's glucose level has normalized, and adjustments in fluids or administration of additional boluses should be provided, as necessary. In fact, any neonate that is critically ill at birth who will require intensive care monitoring and will remain Nil per os (NPO) for a period should be initiated on D10%-containing intravenous fluids to avoid dehydration and hypoglycemia.
- Critical prenatal labs—When an infant deliveries precipitously and unexpectedly, the mother's medical and obstetrical history may not be known at the time of delivery. For all newborn infants, it is critical to know the following maternal lab results as soon as possible after delivery: hepatitis B status, human immunodeficiency virus status, syphilis testing results, and blood type and antibody testing. These laboratory tests, in addition to other routine prenatal labs, are performed in all pregnant women who receive prenatal care, as the results of these tests may affect the outcome of the pregnancy for the mother and or/the fetus. Refer to Table 2 for a list of these critical prenatal labs and immediate actions to be taken, based on maternal lab results.[25–27] There are other prenatal labs that are not reviewed in Table 2, but are also important for the newborn care provider to be aware of, including group B streptococcal culture, chlamydia testing, gonorrhea testing, rubella screening, and gestational diabetes screening.
- Erythromycin eye ointment—In the United States, it is mandatory that all newborns receive prophylaxis against gonococcal eye infection by administration of ophthalmic antibiotic agents shortly after birth, ideally within the first hour of life. The current standard treatment, recommended by the American Academy of Pediatrics and Centers for Disease Control and Prevention, is 0.5% erythromycin ophthalmic ointment, with application of a 1-cm ribbon in each eye, in

TABLE 2. Important time-sensitive prenatal labs to verify and immediate actions to be taken.[25–27]

Maternal Lab Testing	Results	Immediate Action to be Taken
HIV testing		
	Positive	Bathe and suction infant as soon as possible to remove maternal blood contamination; obtain CBC and initiate antiretroviral therapy based on infant's risk level
	Unknown	Rapid HIV antibody test on mother (preferably) or infant
	Negative	None
Hepatitis B testing		
	Positive	HBIG and hepatitis B vaccine (within 12 h of birth)
	Unknown	Test mother immediately; if no results within 12 h, give Hepatitis B vaccine; give HBIG if no results within 7 d
	Negative	Give hepatitis B vaccine at birth or before discharge
Syphilis testing		
	Positive	If maternal VDRL/RPR and treponemal test are both positive, mother should receive treatment during pregnancy; treatment of infant depends on adequacy of mother's treatment response: Adequate treatment response: obtain RPR on infant and treat based on results Inadequate treatment response or no treatment: infant should undergo a full evaluation for congenital syphilis including long bones and CSF
	Unknown	Obtain maternal RPR or VDRL testing as soon as possible
	Negative	None
Maternal blood type and antibody testing		
	Blood type O	Obtain blood type and Coombs on cord blood or infant
	RH negative	Obtain blood type and Coombs on cord blood or infant
	Unknown	Obtain mother's blood type and antibody testing
	Antibody positive	Obtain blood type and Coombs on infant as well as cord bilirubin level or serum bilirubin on infant

CBC indicates complete blood count; CSF, cerebrospinal fluid; HBIG, hepatitis B immune globulin; HIV, human immunodeficiency virus; RPR, rapid plasma reagin; VDRL, venereal disease research laboratory.

the lower eyelid. The ointment should be spread by gentle massage of the eyelids, and excess medication can be wiped away after 1 minute.[28] Evaluation of the eye, including the red reflex and pupillary response, can be difficult for several hours after administration of the ointment, so it is recommended to try and complete the eye examination before administration of this medication.

- Vitamin K administration—The American Academy of Pediatrics recommends vitamin K_1 be given to all newborns as a single intramuscular dose of 0.5 to 1 mg to prevent both early- and late-onset vitamin K deficient bleeding, previously referred to as hemorrhagic disease of the newborn.[29] This intramuscular medication is typically given in the anterolateral aspect of the proximal thigh. The gluteus and deltoid muscles are important to avoid in a neonate, due to concern for nerve injury and absorption at these sites. Administration of vitamin K_1 can be deferred to the destination hospital, if transferring, but it should be made clear to the receiving institution whether this has been given to avoid errors.
- Apgar scoring—The Apgar scoring system was first devised by Dr. Virginia Apgar and was designed to be a quick method to assess the clinical status of the newborn infant.[30,31] The Apgar score is composed of 5 components, each of which are given a score of 0, 1, or 2. Score components include: (1) color, (2) HR, (3) reflex irritability, (4) muscle tone, and (5) respiration. The patient is assessed, and the score is reported at 1 and 5 minutes after birth. However, if the 5-minute score is less than 7, then scoring

continues every 5 minutes thereafter (until 20 minutes of life) until the score is 7 or higher. This scoring system is a universally accepted and convenient standardized assessment tool of the newly born infant's status after birth, as well as their response to resuscitative efforts. However, this score should not be used to predict future outcomes, particularly mortality or adverse neurological outcomes.[32]

SUMMARY

This article focuses on the preparation and management of an unexpected delivery in the ED. Although most newborns transition appropriately without intervention, about 1% of newborns require extensive resuscitation at birth. Because of the unanticipated nature of such an event, it is critical to ensure that the ED has processes in place to effectively and efficiently manage a newborn resuscitation. We provide an itemized checklist of equipment needed for such a situation, discuss principles of neonatal resuscitation, review the neonatal resuscitation algorithm, and provide a brief overview of immediate postresuscitative care. In such low-frequency, high-stakes situations, such as an unexpected delivery outside of the delivery room, simulation-based training can be a useful adjunct to clinical experience, as it can provide a forum for learning, practicing, and perfecting complex medical management.

REFERENCES

1. Barber CA, Wyckoff MH. Use and efficacy of endotracheal versus intravenous epinephrine during neonatal cardiopulmonary resuscitation in the delivery room. Pediatrics 2006;118:1028-34.
2. Perlman JM, Risser R. Cardiopulmonary resuscitation in the delivery room. Arch Pediatr Adolesc Med 1995;149:20-5.
3. Colby C, Carey W. Neonatal emergencies. In: Yamamoto L, Fuchs S, editors. APLS: the pediatric emergency medicine resource, Ed 5. Burlington, MA: Jones & Bartlett Learning; 2012. p. 424-45.
4. Wyckoff MH, Aziz K, Escobedo MB, et al. Part 13: Neonatal resuscitation: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2015;132(Suppl 2):S543-60.
5. De Caen AR, Berg MD, Chameides L, et al. Part 12: Pediatric advanced life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2015;132(Suppl 2):S526-42.
6. Perlman JM, Wyllie J, Kattwinkel J, et al. Part 7: Neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Circulation 2015;132(Suppl 1):S204-41.
7. McDonald SJ, Middleton P, Dowswell T, et al. Effect of timing of umbilical cord clamping of term infants on maternal and neonatal outcomes. Evid Based Child Health 2014;9:303-97.
8. Watkinson M. Temperature control of premature infants in the delivery room. Clin Perinatol 2006;33:43-53.
9. da Mota Silveira SM, Gonçalves de Mello MJ, de Arruda Vidal S, et al. Hypothermia on admission: a risk factor for death in newborns referred to the Pernambuco Institute of Mother and Child Health. J Trop Pediatr 2003;49:115-20.
10. Kamlin COF, O'Donnell CPF, Everest NJ, et al. Accuracy of clinical assessment of infant heart rate in the delivery room. Resuscitation 2006;71:319-21.
11. Katheria A, Rich W, Finer N. Electrocardiogram provides a continuous heart rate faster than oximetry during neonatal resuscitation. Pediatrics 2012;130:e1177-81.
12. Udassi S, Udassi JP, Lamb MA, et al. Two-thumb technique is superior to two-finger technique during lone rescuer infant manikin CPR. Resuscitation 2010;81:712-7.
13. Christman C, Hemway RJ, Wyckoff MH, et al. The two-thumb is superior to the two-finger method for administering chest compressions in a manikin model of neonatal resuscitation. Arch Dis Child Fetal Neonatal Ed 2011;96:F99-101.
14. Ellemunter H, Simma B, Trawoger R, et al. Intraosseous lines in preterm and full term neonates. Arch Dis Child Fetal Neonatal Ed 1999;80:F74-5.
15. Abe KK, Blum GT, Yamamoto LG. Intraosseous is faster and easier than umbilical venous catheterization in newborn emergency vascular access models. Am J Emerg Med 2000;18:126-9.
16. Fisher R, Prosser D. Intraosseous access in infant resuscitation. Arch Dis Child 2000;83:87-92.
17. Rajani AK, Chitkara R, Oehlert J, et al. Comparison of umbilical venous and intraosseous access during simulated neonatal resuscitation. Pediatrics 2011;128:e954-8.
18. Kattwinkel J, Perlman JM, Aziz K, et al. Part 15: Neonatal resuscitation: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2010;122(Suppl 3):S909-19.
19. Costelloe K, Hennessy E, Gibson AT, et al. The EPICure study: outcomes to discharge from hospital for infants born at the threshold of viability. Pediatrics 2000;106:659-71.
20. Laptook AR, Salhab W, Bhaskar B. Admission temperature of low birth weight infants: predictors and associated morbidities. Pediatrics 2007;119:e643-9.
21. Miller SS, Lee HC, Gould JB. Hypothermia in very low birth weight infants: distribution, risk factors and outcomes. J Perinatol 2011;31:S49-56.
22. Petrova A, Demissie K, Rhoads GG, et al. Association of maternal fever during labor with neonatal and infant morbidity and mortality. Obstet Gynecol 2001;98:20-7.
23. Jacobs SE, Berg M, Hunt R, et al. Cooling for newborns with hypoxic ischaemic encephalopathy. Cochrane Database Syst Rev 2013;1:CD003311.
24. Salhab WA, Wyckoff MH, Laptook AR, et al. Initial hypoglycemia and neonatal brain injury in term infants with severe fetal acidemia. Pediatrics 2004;114:361-6.
25. Hepatitis B. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, editors. Red book: 2015 report of the Committee on Infectious Diseases, Ed 30. Elk Grove Village, IL: American Academy of Pediatrics; 2015. p. 400-23.
26. Human immunodeficiency virus infection. In: Kimberlin DW, Brady MT, Jackson MA, et al, editors. Red book: 2015 report of the Committee on Infectious Diseases, Ed 30. Elk Grove Village, IL: American Academy of Pediatrics; 2015. p. 453-76.

27. Arnold SR, Ford-Jones EL. Congenital syphilis: a guide to diagnosis and management. Paediatr Child Health 2000;5:463-9.
28. Prevention of neonatal ophthalmia. In: Kimberlin DW, Brady MT, Jackson MA, et al, editors. Red book: 2015 report of the Committee on Infectious Diseases, Ed 30. Elk Grove Village, IL: American Academy of Pediatrics; 2015. p. 972.
29. American Academy of Pediatrics Committee on Fetus and Newborn. Controversies concerning vitamin K and the newborn. Pediatrics 2003;112:191-2.
30. Apgar V. A proposal for a new method of evaluation of the newborn infant. Curr Res Anesth Analg 1953;32:260-7.
31. Apgar V, Holaday DA, James LS, et al. Evaluation of the newborn infant—second report. JAMA 1958;168: 1985-8.
32. American Academy of Pediatrics, Committee on Fetus and Newborn, American College of Obstetricians and Gynecologists, Committee on Obstetric Practice. The Apgar score. Pediatrics 2015;136:819-22.