

Foundations of Neonatal Resuscitation

What you will learn

- Why neonatal resuscitation skills are important
- Physiologic changes that occur during and after birth
- The format of the Neonatal Resuscitation Program® Algorithm
- Communication and teamwork skills used by effective resuscitation teams
- How implementing quality improvement methods can improve outcomes



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Key Points

- Most newborns make the transition to extrauterine life without intervention.
- f.) Before birth, pulmonary blood vessels in the fetal lungs are tightly constricted, and the alveoli are filled with fluid, not air.
- Q Newborn resuscitation is usually needed because of respiratory failure.
- 9 The most important and effective step in neonatal resuscitation is to ventilate the baby's lungs.
- 0 Very few newborns will require chest compressions or medication.
- Teamwork, leadership, and communication are critical to successful resuscitation of the newborn.

The Neonatal Resuscitation Program

The Neonatal Resuscitation Program (NRP[®]) will help you learn the cognitive, technical, and teamwork skills that you need to resuscitate and stabilize newborns. Most newborns make the transition to extrauterine life without intervention. Within 30 seconds after birth, approximately 85% of term newborns will begin breathing. An additional 10% will begin breathing in response to drying and stimulation. To successfully transition, approximately

- Five percent of term newborns will receive positive-pressure ventilation (PPV).
- Two percent of term newborns will be intubated.
- One to 3 babies per 1,000 births will receive chest compressions or emergency medications.

The likelihood of requiring these lifesaving interventions is higher for babies with certain identified risk factors and those born before full term. Even though the majority of newborns do not require intervention, the large number of births each year means that timely intervention can save many newborn lives. Because the need for assistance cannot always be predicted, health care providers need to be prepared to respond quickly and efficiently at every birth.

During your NRP course, you will learn how to evaluate a newborn, make decisions about what actions to take, and practice the steps involved in resuscitation. As you practice together in simulated cases,

your team will gradually build proficiency and speed. The most gratifying aspect of providing skillful assistance to a compromised newborn is that your efforts are likely to be successful. The time that you devote to learning how to resuscitate newborns is time very well spent.

Why do newborns require a different approach to resuscitation than adults?

Most often, adult cardiac arrest is a complication of coronary artery disease. It is caused by a sudden arrhythmia that prevents the heart from effectively circulating blood. As circulation to the brain decreases, the adult victim loses consciousness and stops breathing. At the time of arrest, the adult victim's blood oxygen and carbon dioxide (CO_2) content is usually normal and the lungs remain filled with air. During adult resuscitation, chest compressions maintain circulation until electrical defibrillation or medications restore the heart's function.

In contrast, most newborns requiring resuscitation have a healthy heart. When a newborn requires resuscitation, it is usually because respiratory failure interferes with oxygen and CO_2 exchange.

- Before birth, fetal respiratory function is performed by the placenta instead of the fetal lungs. When the placenta is functioning normally, it transfers oxygen from the mother to the fetus and carries CO_2 away from the fetus to the mother. A healthy fetus makes breathing movements, which are important for normal lung growth.
- When placental respiration fails, the fetus receives an insufficient supply of oxygen and CO_2 cannot be removed. Acid increases in the fetal blood as cells attempt to function without oxygen and CO_2 accumulates.
- Fetal monitoring may show a decrease in activity, loss of heart rate variability, and heart rate decelerations. If placental respiratory failure persists, the fetus will make a series of reflexive gasps followed by apnea and bradycardia.
- If the fetus is born in the early phase of respiratory failure, tactile stimulation may be sufficient to initiate spontaneous breathing and recovery. If the fetus is born in a later phase of respiratory failure, stimulation alone will not be sufficient and the newborn will require assisted ventilation to recover. The most severely affected newborns may require chest compressions and epinephrine. At the time of birth, you may not know if the baby is in an early or a late phase of respiratory failure.

- After birth, the baby's lungs must take over respiratory function. They must be filled with air to exchange oxygen and CO_2 . Respiratory failure can occur if the baby does not initiate or cannot maintain effective breathing effort.
- If respiratory failure occurs either before or after birth, the primary problem is a lack of gas exchange. Therefore, *the focus of neonatal resuscitation is effective ventilation of the baby's lungs.*

Many concepts and skills are taught in this program. Establishing effective ventilation of the baby's lungs during neonatal resuscitation is the single most important concept emphasized throughout the program.

Ventilation of the newborn's lungs is the single most important and effective step in neonatal resuscitation.

What happens during the transition from fetal to neonatal circulation?

Understanding the basic physiology of the cardiorespiratory transition from intrauterine to extrauterine life will help you understand the steps of neonatal resuscitation.

- Before birth, the fetal lungs are filled with fluid, not air, and they do not participate in gas exchange. All of the oxygen used by the fetus is supplied from the mother's blood by diffusion across the placenta. The oxygenated fetal blood leaves the placenta through the umbilical vein (Figure 1.1).
- Blood vessels in the fetal lungs (pulmonary vessels) are tightly constricted and very little blood flows into them. Instead, most of the oxygenated blood returning to the fetus from the placenta via the umbilical vein flows through the foramen ovale or ductus arteriosus and bypasses the lungs. Because blood flows directly from the right side of the heart to the left side without entering the lungs, it is called a *right-to-left shunt*. In utero, this right-to-left shunt allows the most highly oxygenated blood to flow directly to the fetal brain and heart.
- After birth, a series of events culminate in a successful transition from fetal to neonatal circulation.
 - As the baby takes deep breaths and cries, fluid is absorbed from the air sacs (alveoli) and the lungs fill with air (Figure 1.2).
 - Air in the lungs causes the previously constricted pulmonary vessels to relax so that blood can flow to the lungs and reach the alveoli where oxygen will be absorbed and CO_2 will be removed (Figure 1.3).

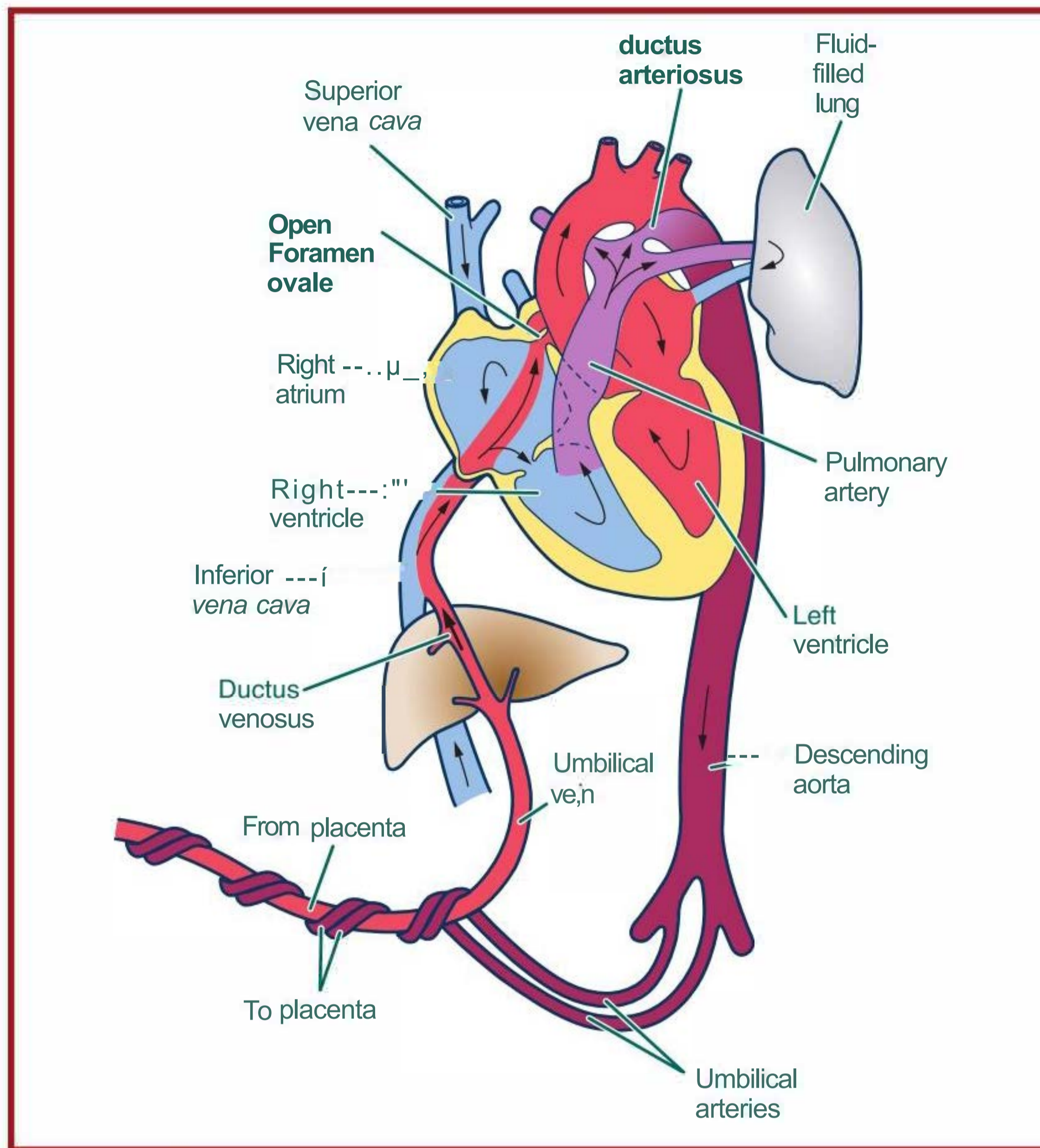


Figure 1.1. Fetal Circulation Path: Oxygenated blood (red) enters the right atrium from the umbilical vein and crosses to the left side through the foramen ovale and ductus arteriosus. Only a small amount of blood flows to the lungs. There is no gas exchange in the fluid-filled lungs.

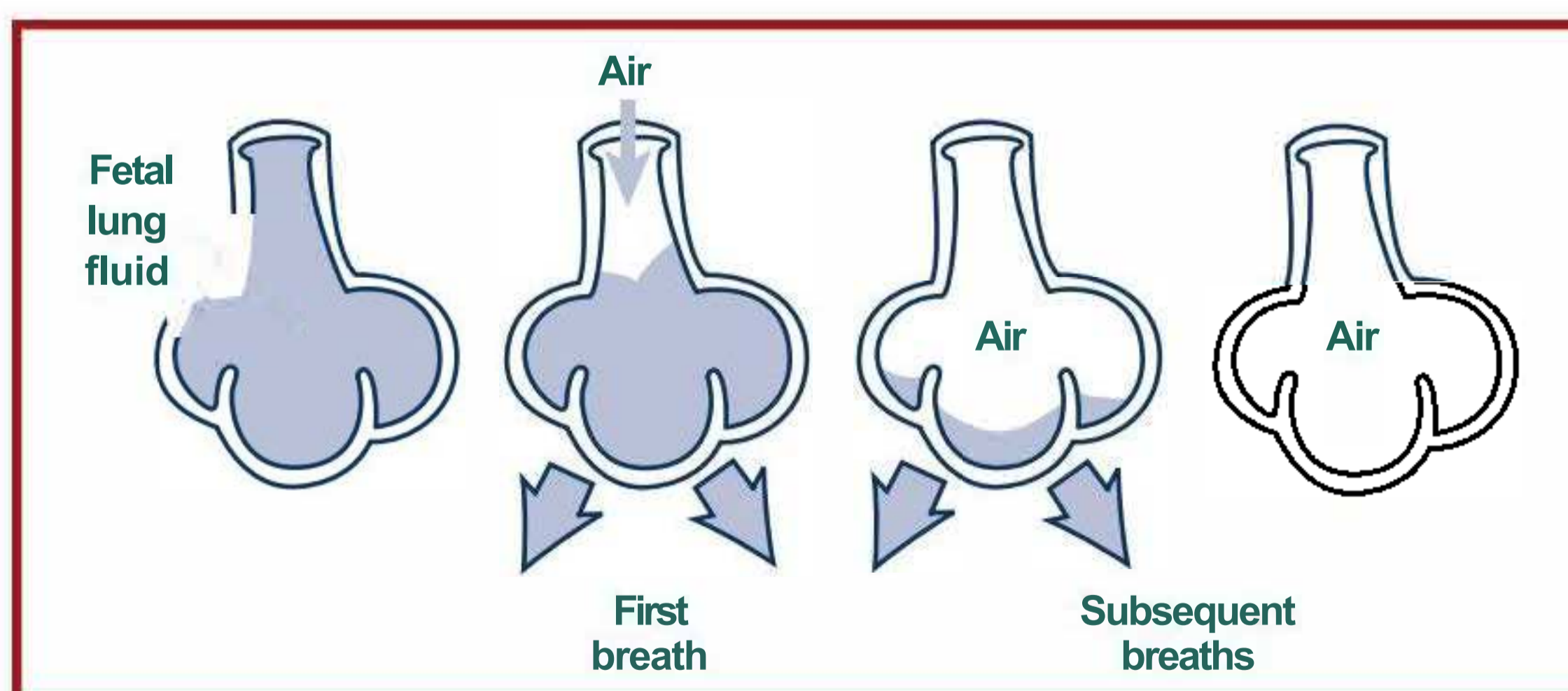


Figure 1.2. Air replaces fluid in the alveoli.

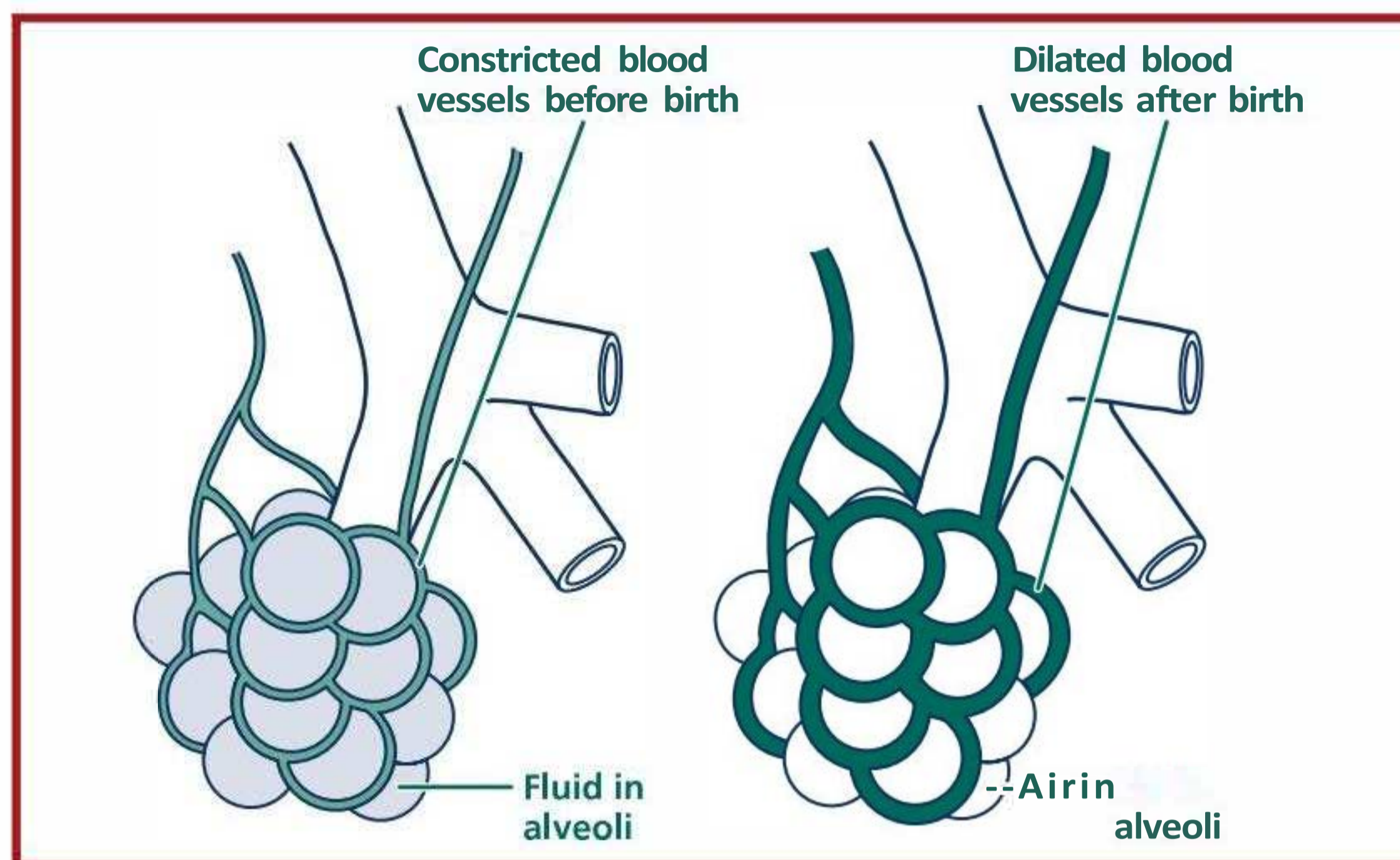


Figure 1.3. Blood vessels in the lungs open.

- Oxygenated blood returning from the baby's lungs helps to fill the baby's heart and ensure that the heart and brain will receive adequate blood flow once the umbilical cord is clamped (Figure 1.4).

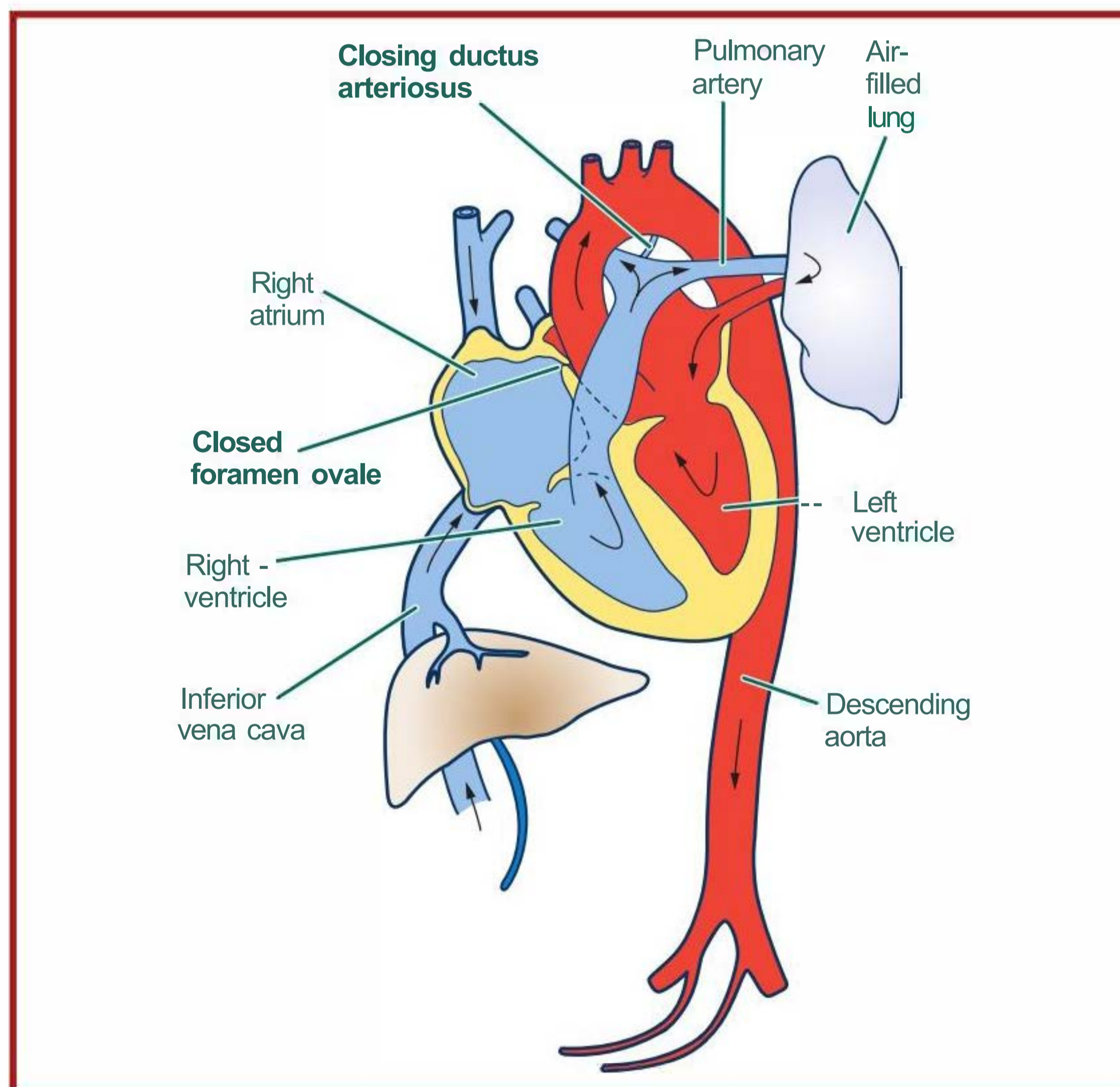


Figure 1.4. Transitional Circulation Path: The baby breathes, pulmonary vessels relax, and blood flows to the air-filled lungs. Blood returning to the left side of the heart from the lungs has the highest oxygen saturation.

- Clamping the umbilical cord increases the baby's systemic blood pressure, decreasing the tendency for blood to bypass the baby's lungs.

Although the initial steps of transition occur within a few minutes of birth, the entire process may not be completed for hours or days. For example, it may take up to 10 minutes for a healthy term newborn to achieve an oxygen saturation greater than 90%. It may take several hours for fluid in the lungs to be completely absorbed, and complete relaxation of the pulmonary blood vessels occurs gradually over several months.

How does a newborn respond to an interruption in normal transition?

If normal transition does not occur, the baby's organs will not receive enough oxygen, acid will accumulate in tissues, and blood vessels in the baby's intestines, kidneys, muscles, and skin may constrict.

Temporarily, a survival reflex maintains blood flow to the baby's heart and brain to preserve function of these vital organs. If inadequate gas exchange continues, the heart begins to fail and blood flow to all organs decreases. The lack of adequate blood flow and oxygen may lead to organ damage. Table 1-1 summarizes some of the clinical findings associated with an interruption in normal transition.

Table 1 • Clinical Findings of Abnormal Transition

- Irregular breathing, absent breathing (apnea), or rapid breathing (tachypnea)
- Slow heart rate (bradycardia) or rapid heart rate (tachycardia)
- Decreased muscle tone
- Pale skin (pallor) or blue skin (cyanosis)
- Low oxygen saturation
- Low blood pressure

How is the Neonatal Resuscitation Program Algorithm structured?

The NRP Algorithm (Figure 1.5) describes the steps that you will follow to evaluate and resuscitate a newborn. It is divided into 5 blocks beginning with birth and the initial assessment. Throughout the Algorithm, hexagons indicate assessments and rectangles show actions that may be required. Although it is important to work quickly and efficiently, *you must ensure that you have adequately performed the steps of each block before moving on to the next block.* Assessments are

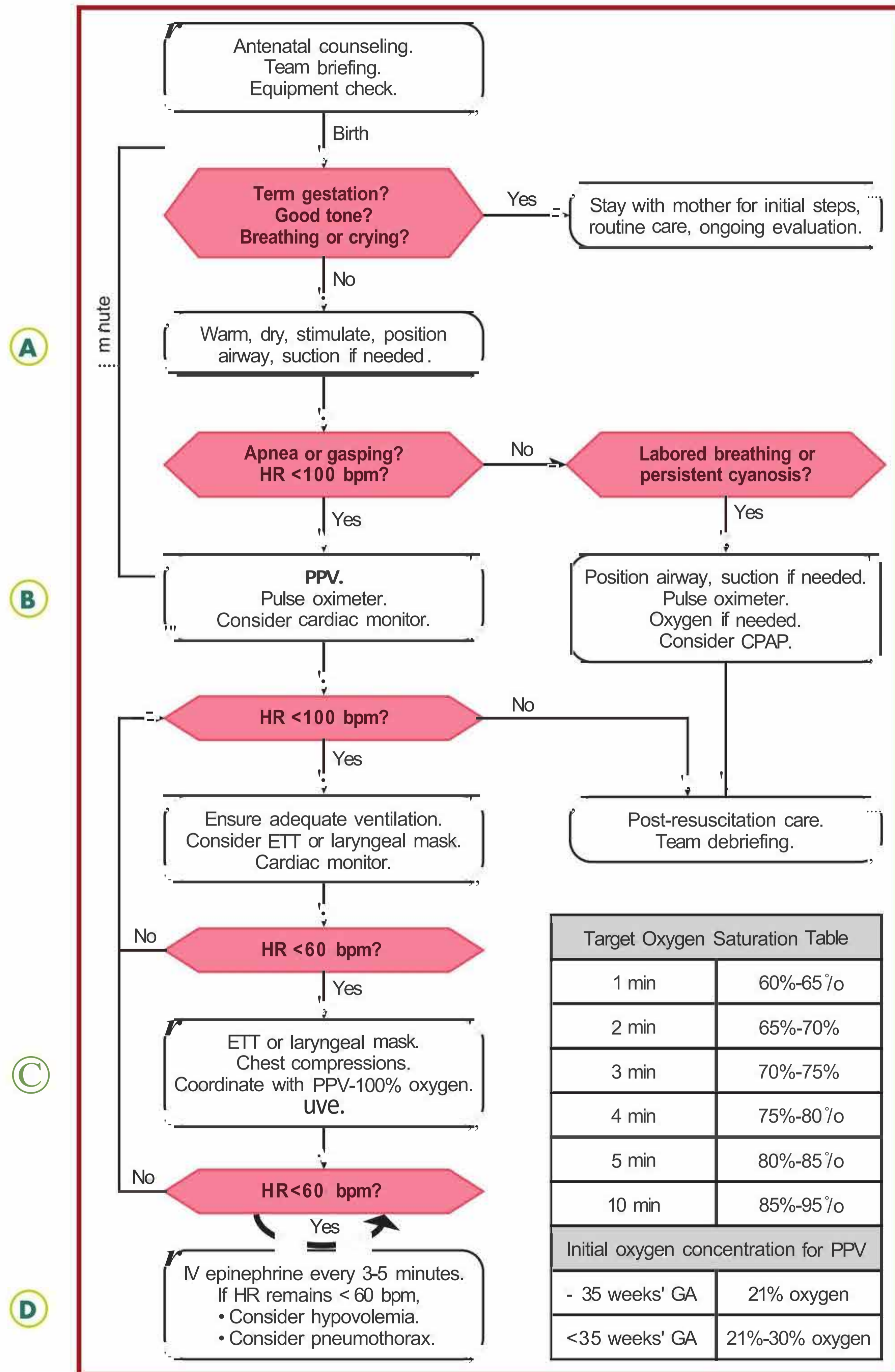


Figure 1.5. Neonatal Resuscitation Program Algorithm

repeated at the end of each block and will determine if you need to proceed. The details of each block are described in subsequent lessons.

- **Rapid Evaluation:** Determine if the newborn can remain with the mother or should be moved to a radiant warmer for further evaluation.
- **(A) Airway:** Perform the initial steps to establish an open Airway and support spontaneous respiration.
- **(B) Breathing:** Positive-pressure ventilation is provided to assist Breathing for babies with apnea or bradycardia. Other interventions (continuous positive airway pressure [CPAP] or supplemental oxygen) may be appropriate if the baby has labored breathing or low oxygen saturation.
- **(C) Circulation:** If severe bradycardia persists despite assisted ventilation, Circulation is supported by performing chest compressions coordinated with PPV.
- **(D) Drug:** If severe bradycardia persists despite assisted ventilation and coordinated chest compressions, the Drug epinephrine is administered as coordinated PPV and chest compressions continue.

Take a moment to familiarize yourself with the layout of the NRP Algorithm (Figure 1.5). Neonatal Resuscitation Program Essentials learners will focus on the Rapid Evaluation, Airway, and Breathing steps of the Algorithm. Neonatal Resuscitation Program Advanced learners will study the entire Algorithm.

Why are teamwork and communication emphasized throughout this program?

Effective teamwork and communication are essential skills during neonatal resuscitation. A Joint Commission investigation found that poor teamwork and communication were the most common root causes for potentially preventable infant deaths in the delivery room. During a complex resuscitation, providers need to perform multiple procedures without delay. Confusion and inefficiency may occur because several teams of caregivers are working in a confined space at the same time. Even though each individual may have the knowledge and skills to perform a successful resuscitation, each person's skills will not be used optimally without effective coordination.

Neonatal Resuscitation Program Key Behavioral Skills

The 10 NRP Key Behavioral Skills, described in Table 1-2, are adapted from previously described models of effective teamwork (Center for

Table 1-2. Neonatal Resuscitation Program Key Behavioral Skills

Behavior	Example
Know your environment.	<ul style="list-style-type: none"> • Know the location of resuscitation equipment and how to access it. • Know how to call for help and who is available.
Use available information.	<ul style="list-style-type: none"> • Know the prenatal and intrapartum history, including maternal complications, maternal medications, and other risk factors.
Anticipate and plan.	<ul style="list-style-type: none"> • Perform a pre-resuscitation team briefing to ensure all team members know the clinical situation. • Assign roles and responsibilities. • Discuss an action plan in the event of complications.
Clearly identify a team leader.	<ul style="list-style-type: none"> • Identify the team leader before the birth. • Effective leaders <ul style="list-style-type: none"> - Clearly articulate goals. - Delegate tasks as appropriate while monitoring the distribution of workload. - Include other team members in assessment and planning. - Think out loud. - Maintain situation awareness. - Hand over leadership to another team member if they must become involved in a procedure.
Communicate effectively.	<ul style="list-style-type: none"> • Call team members by name. • Share information actively. • Inform your team if you identify a problem, error, or patient safety concern. • Order medications by name, dose, and route. • Use concise, clear language. • Use closed-loop communication. • Verify information. • Ensure that changes in information or assessments are shared with all team members. • Include family members in communication as appropriate.
Delegate workload optimally.	<ul style="list-style-type: none"> • Do not duplicate work or use more resources than necessary. • Change task assignments depending on skill sets and what is required at the moment. • Do not allow one person to become overloaded with tasks. • Do not allow the team to become fixated on a single task.
Allocate attention wisely.	<ul style="list-style-type: none"> • Maintain situation awareness by scanning and reassessing the clinical situation frequently. • Monitor each other's skill performance to ensure patient safety.
Use available resources.	<ul style="list-style-type: none"> • Know what personnel are available. • Know what additional or special supplies are available and how to access them.
Call for additional help when needed.	<ul style="list-style-type: none"> • Anticipate the need for additional team members based on risk factors and the progress of the resuscitation. • Call for additional help in a timely manner. • Know how you will call for additional help and the process for getting the right kind of assistance.
Maintain professional behavior.	<ul style="list-style-type: none"> • Use respectful verbal and nonverbal communication. • Actively seek and offer assistance. • Support and promote teamwork. • Respect and value your team.

Advanced Pediatric & Perinatal Education [CAPE], Lucile Packard Children's Hospital at Stanford University). In each of the lessons that follow, we will highlight how effective teams use these behavioral skills.

Improving your teamwork and communication requires deliberate practice under conditions that are as realistic as possible. As you review each lesson and participate in simulation, think about how these behavioral skills can be used to improve your own team's performance. Remember that every member of the team has a responsibility to speak up to inform the leader and other team members of observations or information that will improve the resuscitation in progress.

How can quality improvement methods improve the outcome for newborns that require resuscitation?

The NRP course helps you acquire the knowledge and skills that you need to save babies' lives, but knowledge alone does not guarantee improved outcomes. Completing an NRP course is only the first step in improving the quality of care that you give.

- Making a difference in clinical outcomes requires a commitment to quality improvement (QI). Providers who are committed to quality improvement set goals, measure outcomes, identify areas for improvement, and make changes that improve care.
- Carefully look at the systems and processes used in your own delivery room setting to determine how best to put your knowledge and skills into practice.
- As you read the lessons in the textbook, think about opportunities to improve care in your own delivery room setting. In the lessons that follow, note the measurable processes and outcomes that may identify opportunities for improvement. Additional QI resources are included in Supplemental Lesson 14.

LESSON 1 REVIEW

1. Before birth, the alveoli in the fetal lungs are filled with (fluid)/ (air).
2. Before birth, oxygen is supplied to the fetus by (the placenta)/ (the fetal lungs).
3. Before birth, most fetal blood (enters the fetal lungs)/(bypasses the fetal lungs).

4. After birth, air in the alveoli causes vessels in the baby's lungs to (constrict)/(relax).
5. When resuscitating newborns, chest compressions and medication are (rarely)/(frequently) needed.
6. Members of an effective resuscitation team (share information)/(work quietly and independently).

Answers

1. Before birth, the alveoli in the fetal lungs are filled with fluid.
2. Before birth, oxygen is supplied to the fetus by the placenta.
3. Before birth, most fetal blood b_{yp} assesses the fetal lungs.
4. After birth, air in the alveoli causes vessels in the baby's lungs to relax.
5. When resuscitating newborns, chest compressions and medication are rarely needed.
6. Members of an effective resuscitation team share information.