

# Transition from Fetus to Newborn



Jonathan R. Swanson, MD, MSc, Robert A. Sinkin, MD, MPH\*

## KEYWORDS

- Neonate • Transition • Resuscitation • Physiology • Neonatal resuscitation program
- Fetal circulation

## KEY POINTS

- The fetus to newborn transition is complex and depends on several factors, including maternal health and chronic medical conditions, the status of the placenta, gestational duration, presence of fetal anomalies, and delivery room care.
- Although the vast majority of infants do well, approximately 10% require intervention to facilitate the transition from fetus to newborn.
- Clinicians caring for newborns should be well-versed in the recommendations of the Neonatal Resuscitation Program.

## INTRODUCTION

The adaptation from the intrauterine to extrauterine environment is complex and likely among the most remarkable and difficult physiologic transitions known, all the more noteworthy because it is also a normal and required process for our species. Although all systems of the human body undergo extensive changes, the initial and most crucial adaptations occur in the pulmonary and cardiovascular systems (**Box 1**). Clinicians who take care of newborns during this transition must be prepared to help neonates having difficulty during this changeover. Maternal medical and fetal conditions can have a profound effect on a successful transition. Understanding how these issues affect a neonate's ability to adapt ex utero are essential for informing a clinician's ability to shepherd a newborn through this process. Up to 10% of newborns require some clinical intervention during birth, and approximately 1% require more extensive resuscitation.<sup>1</sup> It is imperative that clinicians be prepared to provide needed interventions and understand why some neonates have difficulty transitioning.

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Disclosures: None.

Division of Neonatology, Department of Pediatrics, University of Virginia Children's Hospital, Box 800386, Charlottesville, VA 22908, USA

\* Corresponding author.

E-mail address: [rsinkin@virginia.edu](mailto:rsinkin@virginia.edu)

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**Box 1****Requirements for a normal fetal to newborn transition**

- Fetal lung fluid resorption
- Expansion of lungs and establishment of functional residual capacity
- Increased systemic vascular resistance
- Decreased pulmonary vascular resistance and increased pulmonary blood flow
- Closure of right to left shunts

**FETUS TO NEWBORN TRANSITION PHYSIOLOGY**

The fetus to newborn physiologic transition begins in utero. This transition depends on several factors, including maternal health and chronic medical conditions, the status of the placenta, gestational duration, and the presence of fetal anomalies. The physiology of this transition is complex and requires an understanding of the cardiovascular and pulmonary systems in utero and ex utero.

***Fetal Cardiopulmonary Physiology***

In utero, the fetus depends on the placenta for all gas exchange and nutrient delivery from the maternal circulation. The placenta has low vascular resistance and receives approximately 40% of fetal cardiac output.<sup>2</sup> Because the fetal lungs are not required for gas exchange, only approximately 10% of cardiac output passes through the pulmonary circulation.<sup>3</sup> Blood flows through the umbilical artery to the placenta, where it is oxygenated and then delivered back to the fetus through the umbilical vein with an oxygen saturation of approximately 80% (PaO<sub>2</sub> 30–35 mmHg).<sup>4</sup> Blood in the umbilical vein is mixed with portal venous blood from the fetus, and reaches the right atrium via the inferior vena cava with an oxygen saturation of about 67%.<sup>4</sup> Owing to the dynamics of blood flow and the anatomic location of the foramen ovale, this relatively well-oxygenated blood is preferentially shunted across the foramen into the left atrium and subsequently pumped from the left ventricle into the aorta. This fetal shunt allows for the favored delivery of more highly oxygenated blood to the brain (carotid arteries) and heart (coronary arteries). Similarly, blood returning to the heart via the superior vena cava is directed to the right ventricle, where it is pumped into the pulmonary artery. Owing to relative fetal hypoxia, the pulmonary arteries are vasoconstricted, resulting in high pulmonary vascular resistance. Secondary to this high resistance and the low systemic resistance (secondary to the placenta), the majority of red blood cells traverse the ductus arteriosus to the descending aorta where they are delivered to the placenta for reoxygenation.

Fetal lung growth and maturation revolve around fetal lung fluid. This fluid is detected as early as the first trimester, although secretion depends on gestational age until its significantly reduced production before labor.<sup>5,6</sup> The active transport of chloride has been elucidated as the mechanism of fetal lung fluid secretion.<sup>7</sup> Owing in part to closed vocal cords, the secretion of fetal lung fluid results in increased bronchoalveolar intraluminal pressure, allowing developing lung airway structures to stay open while also contributing to elevated pulmonary vascular resistance.

***Fetus to Newborn Cardiovascular and Pulmonary Changes***

Many textbooks promote the incorrect belief that the fetus to newborn transition begins when the umbilical cord is clamped or cut; however, transition is initiated before

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