

# The Equine Neonatal Cardiovascular System in Health and Disease



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## KEYWORDS

- Prenatal to postnatal adaptation • Dysrhythmia • Cardiac trauma • Cardiac infection
- Pericarditis • Congenital cardiac disease • Echocardiography
- Computed tomography

## KEY POINTS

- The neonatal foal is in a transitional state from prenatal to postnatal circulation, and cardiac murmurs are common in neonates because of the flow through shunts.
- Dysrhythmias are present in many foals shortly after birth, but these are usually transient and of little clinical significance.
- The neonatal foal is prone to infection and cardiac trauma, both of which may require intensive monitoring and therapy.
- Echocardiography is the main tool used for valuation of the cardiovascular system, although angiography, nuclear scintigraphy, and computed tomography have important roles.
- Congenital disease represents an interesting diagnostic challenge for the neonatologist, but surgical correction is not appropriate for most equids.



Videos pertaining to the equine neonatal cardiovascular system accompany this article at <http://www.vetequine.theclinics.com/>

## PRENATAL TO POSTNATAL ADAPTATION

During the first few days of life, the foal, like other neonates, is in a state of transition from intrauterine to extrauterine life; this includes adaptation from fetal to neonatal circulation. Fetal hemoglobin has a higher affinity for oxygen than adult hemoglobin allowing diffusion of oxygen to the fetus in the placenta. The oxygenated blood is carried to the fetus by the umbilical vein, ductus venosus, and caudal vena cava. Oxygenated blood entering the right atrium via the caudal vena cava is directed out of the right side toward the left heart to supply the body, and the flow is diverted away from the noninflated lung. To achieve this, blood flows from the right atrium to the left atrium via the foramen ovale,

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a fenestrated tubular structure connecting the atria. Additionally, a proportion of blood that passes through the right ventricle (RV) to the pulmonary artery (PA) bypasses the lung by flowing through the ductus arteriosus into the aorta, a process that depends on the high vascular resistance within the fetus's noninflated lung.

In the newborn, the resistance in the pulmonary vasculature decreases with the onset of breathing. The pressure in the left atrium increases relative to the pressure in the right atrium decreasing flow in the foramen ovale. The decrease in circulating prostaglandins that accompanies perinatal adaptation allows closure of ductus arteriosus.

The timing of and mechanisms underlying these events have been extensively studied in other species, particularly lambs and babies, but are relatively unexplored in equids. Flow within the ductus arteriosus is visible in young foals<sup>1</sup> and can be visualized through the foramen ovale in some foals for several weeks after birth.<sup>2</sup> Structural studies have shown that obliteration of the foramen ovale occurs over the first few weeks of life.<sup>3</sup> Ductal closure is initially physiologic, because of constriction of the vessels, and subsequently becomes anatomic as closure with muscular elements occurs.<sup>3,4</sup> Perinatal hypoxia can delay or reverse ductal closure, leading to persistent fetal circulation.<sup>5</sup>

### CLINICAL FINDINGS IN THE HEALTHY FOAL

Healthy neonates typically have a heart rate of around 80 beats per minute (bpm), with a regular rhythm, pink mucous membranes, and strong arterial pulses palpable at several sites, including the facial, submandibular, axillary, metatarsal, and coccygeal arteries. The heart rate can vary considerably with excitement during veterinary examination. The transition from a prenatal to postnatal pattern of circulation accounts for findings on cardiac auscultation, and cardiac murmurs are very commonly found in healthy equine neonates.<sup>1,6</sup> Flow within the ductus arteriosus creates a machinery murmur high and cranially over the left heart base that usually disappears within the first few days of life.<sup>1</sup> Systolic murmurs are also common in young foals. Some of these may be due to flow through the foramen ovale but some likely relate to flow in the great vessels, the most common cause of physiologic murmurs in adults. The foal's relatively thin body wall means these physiologic murmurs are very easy to detect and they can often be quite loud. In foals with loud murmurs shortly after birth that show no other signs of cardiovascular compromise, it is often appropriate simply to monitor the foal over the next few weeks to ensure that the cardiac murmur becomes less prominent.<sup>1,6</sup> Cardiac disease should be suspected in foals with loud, widely radiating murmurs, particularly if they are associated with a precordial thrill. Foals with heart disease may be stunted or fail to gain weight and have other more specific cardiovascular signs, such as dependent edema, jugular distension and pulsation, pleural effusion, ascites, weakness, and collapse.

### CARDIAC DYSRHYTHMIAS IN THE NEONATE

Dysrhythmias are common in the newborn foal. Atrial fibrillation, supraventricular tachycardia, ventricular premature depolarizations, ventricular tachycardia, idioventricular rhythm, and second-degree atrioventricular block have all been documented transiently within 15 minutes of birth.<sup>7</sup> These dysrhythmias are not usually identified in healthy foals except where parturition is closely supervised by a veterinarian; but if they are detected, generally the most appropriate course of action is simply to monitor the rhythm for a few minutes. An electrocardiogram (ECG) is required to characterize the specific rhythm disturbances and antidysrhythmic therapy, if required, should adhere to guidelines available for adults.<sup>8</sup> For sustained, rapid, unstable ventricular tachycardia, appropriate antidysrhythmic drugs include intravenous (IV)

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