The Equine Neonatal Intensive Care Laboratory: Point-of-Care Testing

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KEYWORDS

• Hematologic • Blood gas • Point-of-care testing devices
• Neonate

Critically ill equine neonates are increasingly being treated by trained specialists at equine neonatal intensive care units (eNICUs) throughout the world. Treatment at these units is costly but sought after for equine neonates of high economic or personal value. Knowledge regarding the care, treatment, and prognosis of these small patients is increasing, and awareness of the differences between, and needs of, these patients and the adult horse is important to obtain a good outcome, meaning not just survival but preserving the athletic potential. Delivery of intensive care to critically ill neonates of veterinary species requires both age-specific and species/breed-specific knowledge for appropriate interpretation of results of clinical laboratory tests. In addition, because close and frequent monitoring of several clinical laboratory parameters is needed to deliver appropriate intensive care to critically ill neonates, additional specific knowledge relating to the performance capabilities of various point-of-care (POC) clinical laboratory monitors is also required. This article provides an overview of the age-specific differences expected in clinical laboratory testing for critically ill equine neonates and also discusses the potential confounders that may exist when POC devices developed for use in one species are used in another. Horse is the veterinary species in which most work has been done, specifically to evaluate some of these issues. Techniques used in different laboratories on different normal reference populations frequently result in different reference values. Therefore, rather than focusing on specific laboratory values the author focuses on the differences between

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age and maturity groups and on the effects of important disorders in foals in the eNICU in this article.

HEMATOLOGIC DIFFERENCES IN THE NEONATE

Normal hematologic values in children, and foals, differ significantly from those in adults, and even among children there are substantial variations in different age groups.[1–3] These differences are more pronounced at birth and during the neonatal period. Although neonatal samples in laboratories generally constitute a small proportion of the overall laboratory load, they bring considerable preanalytic, analytic, and postanalytic challenges that should be known and understood for proper testing and result interpretation.

The unique characteristics of fetal hematopoiesis and the changes that occur at and around birth are important for understanding the differences between neonatal and adult blood. Experimental animal studies support a model in which 3 waves of erythroid progenitors emerge in the mammalian embryo.[4] The first wave consists of primitive erythroid progenitors that originate in the yolk sac and generate erythroid precursors that mature in the bloodstream. The second wave is transient and consists of definitive erythroid precursors that originate in the yolk sac and seed the liver. The final wave consists of a continuous stream of definitive erythroid progenitors in the liver during late gestation and bone marrow during the postnatal period, which generate adult-repopulating hematopoietic stem cells. There is considerable overlap and gradual transition between the stages.

The hematologic values of 19 equine fetuses between 202 and 238 days' gestation were compared with those of their dams in one study.[5] The red blood cell (RBC) count, hemoglobin (Hb) concentration, hematocrit (HCT), and mean corpuscular Hb concentration were significantly lower in the fetal blood, whereas the mean corpuscular volume, mean corpuscular Hb, and RBC distribution width were significantly higher. Mares had a significantly higher nucleated blood cell count than fetuses, and in mares, all nucleated cells were leukocytes (white blood cells [WBCs]). The majority of WBCs in mare blood were segmented neutrophils and lymphocytes. In contrast, more than half of the nucleated cells in fetal blood were nucleated RBCs and the majority of WBCs in fetal blood were lymphocytes. Mares also had significantly higher plasma protein and fibrinogen concentrations than their fetuses. Mild macrocytosis and mild polychromasia were observed in most fetal blood samples but not in blood samples from mares. All fetal blood samples contained reticulocytes, and most samples contained Heinz bodies and Howell-Jolly bodies.

Specific values reported for equine neonates for components of the hemogram appeared in a recent review.[6] In general, the RBC count, Hb concentration, and HCT are maximal at birth, whereas the erythrocyte size and volume is variable because of different sites of production during the second half of gestation.[3,7] The premature foal will, as a consequence, have a lower RBC count and Hb concentration and a larger erythrocyte size.

There is no fetal Hb in the horse fetus, and the Hb structure of the fetus is identical to that of the adult.[8,9] Instead, oxygen diffusion across the placenta is facilitated by the lower fetal erythrocyte concentration of 2,3-diphosphoglycerate, shifting the oxyhemoglobin dissociation curve to the left,[9,10] and a counterplacental circulatory pattern.[11] While the HCT and Hb concentration increase transiently at birth, possibly because of placental blood transfusion during parturition, it is not unusual to see the packed cell volume (PCV) decrease by up to 10% in normal foals over the first day of