While a comprehensive history and systems-based physical examination are integral to evaluation of any veterinary patient, there are unique aspects to evaluation of the neonatal foal.

**Evaluation of the Neonatal Foal (Birth to 1 Month of Age)**

**History:** A thorough history should cover the mare’s prepartum health and care, any problems with previous foals, and all peripartum events (e.g. expected due date, timing of udder development, presence of any prepartum milk leakage, duration of labor, and the condition of the fetal membranes and the time passed after foaling). In addition, note the foal's immediate post-partum behavior. In general, healthy foals are able to maintain sternal recumbency within minutes, stand unassisted within 1 hour, and nurse unassisted within 2 hours of parturition. The fetal membranes should be passed within 3 hours of parturition, but complete passage of the membranes with the foal is not normal and may indicate premature placental separation. The fetal membranes should be evaluated carefully, and submitted for histopathologic examination if any gross abnormalities – excessive or insufficient weight (~10% of the foal's weight is normal), necrotic or exudative areas, or regions of villous atrophy – are noted.

**General condition:** Assessment of the foal’s general body condition and gestational maturity is important. While most foals are in light body condition at birth, very poor body condition suggests premature parturition and/or placental insufficiency. Other signs of prematurity include small size, floppy ears, a domed forehead, silky hair coat, and flexor tendon laxity. Full term or overdue foals that were subject to placental insufficiency may be dysmature and exhibit some or all of these signs. By a few hours of age, healthy foals should be able to easily get up and down and nurse aggressively several times per hour, and usually resent handling and restraint. A foal that is exceptionally quiet, is frequently recumbent, or is unable to rise, lay down, or nurse without assistance is not normal and should be examined more closely.

**Vital Parameters:** Normal rectal temperature = 37.5°C to 38.8°C (100-102°F); normal heart rate = 80-120 beats per minute; normal respiratory rate = 20-40 breaths per minute.

**Mucous membranes and Integument:** Foals may have mildly pale or cyanotic membranes during or immediately after parturition, but if this persists for more than a few minutes, cardiorespiratory disease should be considered. Hyperemic, injected or sometimes icteric mucous membranes are often seen in septicemic foals, and hyperemia of the skin in lightly pigmented areas may also be noted. Petechial or ecchymotic hemorrhages on the oral mucosa, sclerae, vulva, or pinnae are also often present in foals with septicemia, and are most likely due to a sepsis-associated vasculitis rather than a concurrent coagulopathy. Foals with neonatal isoerythrolysis (NI) often present with markedly icteric mucous membrane, though the absence of clinical icterus does not exclude the potential of NI. Liver disease may also cause icterus in the newborn foal, though this is much less common than NI. Decubital ulcers over bony protuberances are common in foals that have been predominantly recumbent.
**Cardiovascular System:** Assessment of the capillary refill time (CRT), jugular fill, and peripheral pulse quality are important to determine the hemodynamic status of the foal. Foals in hypovolemic and/or septic shock have cool or cold extremities, weak peripheral pulses (best assessed at the dorsal metatarsal artery), and prolonged CRT. Hyperemic mucous membranes with a rapid (<1 second) CRT is often associated with early hyperdynamic shock. Cardiac murmurs are frequently ausculted in the neonatal foal and are not always pathologic. Immediately after parturition, a loud continuous murmur associated with a patent ductus arteriosus is frequently noted, though in most cases this resolves within a few days. During the first few weeks of life, a non-pathologic physiologic flow murmur is frequently heard in foals. This is most often a soft grade 1-3/6 systolic murmur with the point-of-maximal-intensity over the left heart base. The most common congenital cardiovascular anomaly in neonatal foals is a ventricular septal defect, which is characterized by a variably graded bilateral systolic murmur that is often louder on the right side. An echocardiogram should be performed in any foal with a loud or bilaterally auscultable murmur, a quieter murmur that persists beyond a few weeks of age, or clinical signs of cyanosis, syncope, or cardiac failure.

**Respiratory System:** Premature foals or foals with neonatal encephalopathy may exhibit brief periods of apnea or an irregular respiratory pattern. Normal bronchovesicular sounds are more easily ausculted in the foal than the adult due to the foal's thin chest wall. However, abnormal lung sounds are frequently absent even in severe pulmonary disease in foals, so further evaluation of the respiratory system is warranted in any foal with tachypnea or increased respiratory effort. Upper respiratory noise or stridor is uncommon but may be observed in foals with congenital anomalies of the upper airway, pharyngeal weakness/dysfunction associated with selenium deficiency (“White Muscle Disease”), or rarely in foals with hyperkalemic periodic paralysis (HYPP).

**Gastrointestinal System:** The mouth and palate should be examined for congenital malocclusion or cleft palate; however, endoscopic evaluation should be performed in any foal with nasal milk reflux to fully evaluate for palatal defects. Feces (meconium) should be passed within 8-12 hours after birth; however, failure to observe passage of meconium in a foal that is nursing well with no signs of colic of abdominal distension is usually not cause for concern. Neonatal foals should appear “thin-waisted” with a tucked-up flank; any gross abdominal distension in a neonatal foal is abnormal and should be investigated further. Key differential diagnoses for the neonatal foal with gross abdominal distension include meconium impaction, uroabdomen, strangulating intestinal obstruction (most commonly a small intestinal volvulus or intussusception), or ileus in severe enterocolitis (which can cause dramatic abdominal distension). In foals, abdominal pain is manifest by decreased nursing and more frequent recumbency, rolling into dorsal recumbency, bruxism, and occasionally by flagging of the tail and straining to defecate.

**Musculoskeletal System:** The foal’s limbs should be examined closely for any angular or flexural limb deformities. Mild flexor tendon contracture or laxity is not uncommon in normal foals, and typically resolves with exercise in the first few days of life. Foals with severe flexural deformities may be unable to stand. Severe flexor tendon laxity is often associated with prematurity or dysmaturity, but can also occur rapidly in normal foals from placement of support wraps or splints for other reasons. Many neonatal foals have some degree of carpal valgus which resolves as they grow and fill out; however, any flexural or angular limb deformities, even if very mild, should be monitored closely as opportunities for correction are
time-limited as the foal ages. In addition, all synovial structures should be assessed for effusion, and all long bones palpated for physeal enlargement/pain. Given the potential for and extreme morbidity and mortality associated with septic arthritis in the neonatal foal, even the slightest degree of synovial effusion, physeal enlargement, or lameness in a neonatal foal is cause for concern and warrants further investigation. Palpate the ribs carefully for any evidence of rib fractures; non-displaced rib fractures may be missed on palpation but can be identified with ultrasonography.

**Urogenital System:** First urination is typically observed within 12-18 hours after birth. Neonatal foals with uroperitoneum may be observed to strain to urinate, or may never be seen to urinate normally. However, many foals with uroperitoneum continue to produce a normal urine stream, so uroperitoneum should be considered in any neonatal foal with colic or abdominal distension even in the absence of dysuria. The umbilical stump should be evaluated for a patent urachus, which may only be evident when the foal urinates. In colts, both testicles are frequently descended at the time of parturition, but the timing of testicular descent can be quite variable and may occur as late as 12-24 months of age in certain breeds.

**Umbilicus:** The umbilicus should be evaluated for the presence of swelling, drainage (urine or purulent exudate), or associated hernias. Normal appearance of the external umbilical stump does not eliminate the possibility of disease affecting the deeper umbilical structures; complete evaluation of the umbilicus thus requires ultrasonographic evaluation.

**Eyes:** Neonatal foals do not exhibit the (learned) menace response until they are ~3 weeks old, so vision should be assessed by the ability of the pupils to respond to light and the foal’s ability to orient in its environment and track the mare. Corneal sensitivity and the blink reflex may be decreased in neonatal foals; thus, fluorescein staining should be performed in any recumbent foal to evaluate for corneal ulceration. Uveitis frequently occurs in septicemic foals, and is evidenced by miosis, fibrin accumulation in the anterior chamber, hypopyon, and/or hyphema. Ophthalmoscopic exam should be performed in every neonatal foal with suspected sepsis to evaluate for the presence of uveal inflammation.

**Laboratory Evaluation in the Neonatal Foal**

**Serum Immunoglobulin Concentration:** Adequate colostral transfer of passive immunity is evidenced by a serum IgG concentration > 800 mg/dl by 18-24 hours of age. In foals, serum IgG concentration can not be estimated from the plasma protein concentration and must be measured directly (a number of stall-side tests such as the Snap Foal IgG test from IDEXX are available to do so). It is important to remember that septic foals may rapidly consume large quantities of circulating IgG; thus, IgG concentration should be serially monitored in foals with suspected sepsis even if it is initially adequate.

**Complete Blood Count:** A complete blood count should be performed in any neonatal foal with risk factors for sepsis (placentitis or placental abnormalities in the mare, prematurity, dysmaturity, dystocia, failure of transfer of passive immunity, or other neonatal diseases such as uroabdomen, meconium impaction, neonatal encephalopathy, or NI) or clinical evidence of illness. Key points for CBC interpretation in the neonatal foal include:

- Normal foals have a high hematocrit (40-50%) in the initial 24-48 hours after
parturition, followed by a decrease to low or low normal levels (usually 25-30%) with a subsequent slow increase to adult levels by a few months of age.

- It is important not to disregard any leukogram abnormalities in neonatal foals. Foals with early sepsis often have a leukopenia characterized by a neutropenia with a left shift, but as disease progresses a neutrophilia often develops. The presence of a neutrophilia in the first day or so of life implies in utero infection, in which case the mare/placenta should be evaluated for evidence of placentitis. Stress leukograms are uncommon in the neonatal foals, so any degree of neutrophilia should not be overlooked.
- Plasma fibrinogen concentration rises rapidly in septic foals (with 2-3 days of infection). Trends in fibrinogen concentration are a very useful guide for tailoring antimicrobial therapy, and should be measured if at all possible.
- Sometimes foals with bacterial infections develop a moderate to severe lymphocytosis, especially with chronic infections. Lymphopenia is also common in foals with chronic infection, but severe lymphopenia may suggest congenital immunodeficiency and should be investigated if it persists.

**Biochemistry Profile:** Severe glucose, electrolyte and acid-base derangements can develop rapidly in sick foals, so it is especially important to monitor the biochemistry profile in foals with diarrhea, gastric reflux, or inappetance. Key differences in biochemical parameters between adult horses and foals include:

- Total protein concentration is lower, characterized by low globulin and low-normal albumin concentrations.
- Serum creatinine concentration is usually low or low-normal in foals due to their decreased muscle mass. An acute increase in creatinine concentration > 0.3 mg/dl or overt azotemia may indicate renal insufficiency and warrants further evaluation. However, placental insufficiency can result in transient, severe azotemia in the first day or so of life that is not clinically significant and resolves as the foal’s kidneys take over excretory function.
- Hepatocellular enzymes (GGT and SDH) and serum bile acid concentration are typically higher in foals due to hepatic immaturity, and often exceed adult reference ranges. Moderate increases in liver values should be followed over time, and usually return to adult levels by a few months of age.
- Glucose derangements are common in sick foals, and typically are manifest as hypoglycemia in septic or inappetant foals. However, transient insulin resistance can develop in sick foals and may result in severe hyperglycemia if foals are supplemented with IV dextrose.
- Foals have difficulty handling sodium loads and easily develop sodium derangements with fluid losses or IV fluid therapy. Serum potassium concentrations are also often slightly increased in normal foals due to large amounts of potassium in milk. Calcium and phosphorous concentrations are also often increased compared to adult levels due to mobilization for rapid bone growth.

**When to Worry and When to Refer**

Septicemia is the most common cause of morbidity and mortality in the neonatal foal. Signs of sepsis may be quite subtle initially, but can progress very rapidly. Severe sepsis and septic shock can result in death in a matter of hours without (and sometimes even in spite of)
aggressive therapy. Thus, owners should be instructed that any neonatal foal with the following signs warrants immediate evaluation by a veterinarian:

- Prematurity or dysmatURITY
- Dystocia or placental abnormalities (including retained placenta in the mare)
- Foals born to mares with prepartum milk leakage or poor milk production
- Difficulty standing or nursing after parturition
- Weakness, lethargy, poor nursing, or frequent recumbency
- Colic or abdominal distension
- Diarrhea
- Fever
- Lameness or synovial effusion

Many sick foals can be managed effectively on the farm with dedicated owners and frequent veterinary treatment and monitoring. Management strategies for specific conditions will be discussed in the following lectures, However, because many diseases in neonatal foals can progress very rapidly and the possible sequelae of septicemia and other common foal disease can be quite severe, referral may be warranted in the following situations:

- If examination by a veterinarian at least one to two times daily is not possible during initial treatment
- If septicemia is suspected and parenteral antimicrobials cannot be administered
- Foals with suspected septicemia that do not improve significantly within 24-48 hours of starting antimicrobial therapy
- Foals with evidence of septic shock – altered mentation, recumbency, hypothermia, cold extremities, weak peripheral pulses
- Foals with suspected severe neonatal encephalopathy (recumbency, coma, seizures)
- Foals with severe glucose, electrolyte or acid-base derangements requiring constant-rate intravenous fluid infusions and frequent laboratory monitoring
- Foals with persistent colic or gastric reflux that cannot tolerate enteral nutrition
- Foals with suspected uroabdomen
- Foals with suspected or confirmed meconium impaction that does not resolve with approximately 24 hours of aggressive management.
- **Any neonatal foal with synovial effusion, physeal enlargement/pain, or lameness!**

*References are available from the author.*