

INITIAL ASSESSMENT OF THE CRITICAL NEONATE

Jon Palmer, VMD, New Bolton Center, University of Pennsylvania

Neonates with inconsistent or complete lack of nursing behavior, who are weak or develop progressive weakness and become recumbent during the first 48 hours after birth, are critically ill and require immediate intervention with supportive therapy. In our tertiary care practice, 70-80% of neonatal admissions are within the first 48 hours after birth. Of the neonates that we can't save, 70% die within this initial 48 hour period. Neonates who become weak and recumbent during this critical period require immediate attention with assessment of essential organ function and immediate directed, supportive therapy. Although, in some cases, the level of care needed can be delivered on the farm, the ability of the busy practitioner to dedicate the time needed without compromising the rest of his practice, the availability of sufficient trained help on the farm with the energy and dedication to deliver care and the lack of adequately equipped facilities on the farm significantly limits this possibility.

The initial step in delivering lifesaving care, whether treatment is to be dispensed on the farm or at a referral center, is recognizing the seriousness of the problem. The foal that is weak from birth or initially seems normal and then fades during the first 48 hours of life may have a number of different underlying problems. These problems can be generally classified as those secondary to fetal distress/maladaptation (including prematurity/postmaturity), those secondary to sepsis/infection and those secondary to trauma/hemorrhage/anemia. Problems associated with fetal distress/maladaptation include the Neonatal Syndrome which includes neonatal encephalopathy (aka neonatal maladjustment syndrome), neonatal nephropathy, neonatal enteropathy (NEC), neonatal metabolic/endocrine maladjustment (hypo/hyperglycemia, hypo/hypercalcemia, poor insulin response, autonomic failure, vasopressin deficiency, cortisol deficiency, etc.), neonatal cardiovascular failure (hypoperfusion secondary to lack of adrenergic sensitivity, vasoplegia, central failure; myocardial dysfunction) or prematurity/dysmaturity, IUGR, sick cell syndrome, etc. Problems associated with sepsis/infection include SIRS, generalized sepsis, septic encephalopathy, localized or systemic infection (bacteremia, aspiration pneumonia, umbilical infections, etc.), infectious enteritis (clostridiosis, salmonellosis), coagulopathies, immune dissonance, MODS (ARDS, NEC, etc.), severe sepsis, septic shock, etc. Finally those problems associated with trauma/hemorrhage/anemia include birth trauma (fractured ribs with associated damage, gastrocnemius rupture), anemia (umbilical hemorrhage, fractured rib associated hemorrhage, gastrocnemius associated hemorrhage, femoral fractures), etc. In reality, there is rarely one problem but a combination of problems with varying severities. In fact there is a seemingly endless array of possibilities.

Fortunately, it is not necessary to identify the exact cause of the underlying problem to successfully treat the neonate. Instead, the clinician should identify which vital organ functions

have been disrupted and institute therapeutic interventions which support normal function while simultaneously attempting to control any infection which is present. With these 2 goals met, the foal has the opportunity to heal and recover. So the object of the initial assessment of the critically ill foal is to identify organ dysfunction and then to tailor therapy toward supporting vital organ function. The questions which need to be answered by the initial assessment of the neonate include: is there evidence of sepsis; is cardiovascular support necessary to insure tissue perfusion and if so to what degree; is respiratory support required; will enteral nutrition and fluid maintenance be possible or is parenteral nutrition and fluid administration necessary; will assisted thermoregulation be necessary; what type of intervention will be necessary to control behavioral abnormalities; what level of metabolic/endocrine support is to be expected; will renal support be necessary; and are there requirements for other specific supportive care (assisting to stand, musculoskeletal physical therapy, special restraint, etc.). With a careful, complete physical examination and with simple laboratory analysis (e.g. patient side glucose and lactate determination), the practitioner can rapidly make an assessment of what level of supportive therapy is necessary and whether or not this level will require local hospitalization or referral to a tertiary support facility.

CARDIOVASCULAR SYSTEM

Evaluating perfusion and volemia is essential in managing sick neonates. The distinction should be made between volemia and hydration. Hydration refers to the adequacy of cellular fluid volume and to a lesser extent, cellular reserves (interstitial fluid volume). Volemia refers to adequacy of circulating volume. Almost universally, neonates are born hyper-hydrated, having a higher percent total body water than adults. With fetal distress, the neonate is born with even more body water secondary to greater fluid shifts from the fetal fluids to the interstitium. So rehydration is almost never required except in rare circumstances such as after extensive external hemorrhage. However, hypovolemia is common in ill neonates resulting in hypoperfusion. In such cases, hypovolemia needs to be addressed aggressively.

The object of the cardiovascular examination is to assess effectiveness of perfusion. A prominent physical examination sign of hypoperfusion are cold legs as blood is shunted centrally. The cold limbs should not be treated with active warming as this will defeat the circulatory compensation. The ears and nose may also be cool to cold and hypoperfusion can result in depressed mental status and decreased borborygmi. Urine production is a very good sign of renal perfusion. However, it should be remembered that unlike neonates of other species, foals usually don't urinate for the first 12 hours after birth. Lack of urine production in the foal that is only hours old, even in the face of fluid therapy cannot be taken as evidence of poor renal perfusion.

Other physical findings that relate to perfusion are pulse quality, arterial tone and arterial fill. Careful assessment of pulse quality can help determine pulse pressure (difference between systolic and diastolic pressure). Arterial wall tone is assessed by the amount of finger pressure required to feel the pulse and the amount required to eliminate the pulse. If the pulse can only be felt by a very light touch, there's little tone to the arterial wall. On the other hand if even with firm pressure the pulse still can be felt there may be increased arterial wall tone. This quality roughly corresponds to blood pressure and responsiveness to adrenergic tone. Arterial fill is assessed by feeling the size of the artery's lumen as finger pressure is applied. Arterial fill

relates to the blood volume on the arterial side of the circulation. These clues can relate much information about perfusion. Dry oral membranes are an unreliable aid in determining hydration status since many ill foals keep their mouths open allowing the mucous membranes to dry. Likewise, capillary refill time is not particularly helpful since it may be determined more by the state of mucous membrane injection and venous pressure/return than by volemia. Skin turgor is an unreliable sign in the neonate.

The heart rate should be appropriate for the state of perfusion. When perfusion is poor and blood pressures low, a high heart rate is appropriate. When perfusion is good and blood pressures adequate, a low heart rate is appropriate. If the heart rate is not appropriate, the cause of the discrepancy (e.g. level of discomfort, abnormal central control, excitement or primary myocardial disease) should be identified. Inappropriate bradycardia is a frequent finding in critically ill neonates and may relate to retention of fetal physiology as bradycardia is an important part of the response to fetal distress. The rhythm should be carefully evaluated since it is common to have arrhythmias in the neonatal period secondary to primary myocardial disease, trauma from fractured ribs and metabolic abnormalities. Transient cardiac arrhythmias which spontaneously resolve are not unusual during the first hours after birth. Cardiac murmurs are almost universally present during the neonatal period (first 30 days of life). It is a widely held misconception that these are from a patent ductus arteriosus. Most neonatal murmurs, even during the first 24 hours of life, are in fact flow murmurs which often change character as the foal's body position or heart rate changes. Murmurs associated with significant cardiac anomalies are often course whereas flow murmurs are generally soft. The presents of a persistently loud, coarse murmur should raise the suspicion of a significant congenital defect which will require further investigation.

MUCOUS MEMBRANE EVALUATION

Mucous membranes should be carefully evaluated for signs of icterus, injection (including large vessel injection where individual vessels are easily identifiable and small vessel injection caused by generalized capillary filling), petechia (oral, aural, scleral), erythema (lingual, periocular, nasal, nasal septum, aural, segmental oral) and coronitis. The presence of icterus suggests sepsis/SIRS, retained meconium, hemolytic disease (isoerythrolysis) or hemorrhage (internal umbilical remnant, fractured ribs, thrombocytopathies, intestinal bleeding associated with NEC, etc.). Large vessel injection is associated with excitement, hypoxic ischemic disease, local irritation, drying injury and occasionally sepsis/SIRS. Small vessel injection is associated primarily with sepsis/SIRS but also equally with hypoxic ischemic disease with loss of vascular control. Oral, aural and scleral petechia may all be induced by birth trauma but are more commonly associated with a local coagulopathy secondary to sepsis/SIRS. When examining the foal for petechia, care must be taken not to mistake the end-on vessels in the oral mucous membranes for petechia. These vessels, when engorged, resemble petechia (I refer to them as "pseudopetechia"), but can easily be differentiated since they blanch when pressure is applied. Also, although *Culicoides* may occasionally cause bleeding aural petechia, similar bleeding petechia can be caused by sepsis/SIRS. Palpable petechia are not common and when identified should direct attention towards unusual coagulopathies. Erythema is most often identified around the head affecting the lingual, aural, periocular, nasal skin, nasal septum and oral membranes. Lingual erythema is most commonly associative with neonatal encephalopathy but occasionally is striking even in normal foals when they initially begin to suckle. Aural,

periocular and nasal skin erythema are primarily associated with uncontrolled SIRS. Nasal septum erythema may be associated with sepsis/SIRS or with hypoxic ischemic syndrome. Regional erythema of the oral membranes may be striking because of the sudden transition from normal to erythematous membranes. Although on casual inspection, these areas may look like submucosal hemorrhage, the fact that they can disappear within hours rules out this possibility. It is more likely the result of regional loss of vascular control associated with neonatal encephalopathy. Finally, coronitis is also a sign associated with sepsis/SIRS and occasionally severe hypoxic ischemic syndrome. Initially, coronitis is more noticeable on non-pigmented hooves, especially beginning at the heels. The hemorrhagic line will become more noticeable as the foal's disease progresses and over and several days it makes a transition to a purple, bruised appearance. Care must be taken not to over interpret the normal red line caused by normal blood flow seen in nonpigmented hooves.

RESPIRATORY SYSTEM

Careful auscultation of the lungs is important. Moist bronchovesicular sounds should be heard for the first few hours after birth as resorption of fetal fluids may take some time. Because of the stiff nature of neonatal lungs, fine crackles associated with collapsing and reinflation of alveoli should be expected. Recumbent foals, because of the compliant nature of their chest wall and the stiffness of the lungs, will consistently have rales in the recumbent lung. Sick, recumbent foals are particularly susceptible to aspiration resulting in pneumonia. Careful auscultation of non-recumbent lung with deep breaths is important in identifying pneumonia.

CENTRAL NERVOUS SYSTEM

When evaluating the nervous system of neonatal foals, it is important to evaluate strength, muscle tone, responsiveness and ability to arouse the foal. Clinicians commonly think about behavioral changes such as loss of suckle and search behaviors as well as loss of tongue control and coordination (hypertonic lingual dissociation). Other neurologic signs may be equally as important including the development of facial nerve paresis and vestibular signs, becoming hyperresponsive or hyporesponsive, developing hypertonus or hypotonus, becoming hyperactive or hyperkinetic or developing somnolence. Careful observation of respiratory patterns may show periodic apnea (>20 seconds without breathing), cluster breathing (several rapid breaths followed by a respiratory pause or apnea), apneustic breathing (breath holding) or ataxic (irregular) breathing. Severely affected foals will have seizures. Most of these are generalized tonic clonic activity centered on the front of the body (head, neck and front legs) or more generalized animated seizures with tonic clonic paddling motion (galloping). A dramatic sign sometimes present is abnormal vocalization which may mimic a barking dog but more often mimics a squealing pig.

GASTROINTESTINAL SYSTEM

Auscultation of the GI tract should reveal frequent but not constant borborygmi if the foal is receiving oral nutrition. The GI tract will often remain quiet when milk is being withheld. Identification of a good variety and frequency as well as quality of borborygmi is important in assuring gastrointestinal health. Foals with Neonatal Syndrome causing intestinal disease, such as necrotizing enterocolitis, frequently have quiet and distant borborygmi with occasional loud gas sounds.

ABDOMINAL PALPATION

Just as a careful rectal examination can be revealing in adults, careful and thorough abdominal palpation can be an important adjunct to the physical examination of the neonate. In order to be successful, the foal should be quiet and have a relaxed abdominal wall as occurs in depressed, septic foals, foals with hypoxic ischemic syndrome or normal foals in the somnolent postprandial state. Although the technique is often practiced on the quite, recumbent foal, it can be adapted to the standing foal. With practice, many structures can be readily identified and abnormalities recognized. The internal umbilical remnants, especially the umbilical triad (2 arteries and urachus) should be palpated to identify recent hemorrhage or inflammatory disease (omphalitis). Also, palpation of the umbilical arteries may reveal retained pulses and their juxtaposition will indicate whether or not the urinary bladder contains urine. The urinary bladder can often be identified and both luminal and bladder wall hematomas recognized. The intestines should be palpated to detect retained meconium (most often felt in the right colons just under the rib cage or in the caudal abdomen near the bladder). In cases of necrotizing enterocolitis, thickened intestinal wall, pneumatosis intestinalis and intussusceptions may all be palpated. The kidneys and the liver can be evaluated. Hepatomegaly is not an unusual finding in the critically ill neonatal foal. Identification of inguinal or umbilical hernias and other body wall defects can also be important.

BODY CONDITION

A thin to emaciated foal at birth suggests intrauterine growth restriction (IUGR). In this condition, abnormal placental metabolism, such as may occur with placentitis, results in an energy drain from the fetus producing fetal weight loss and emaciation. Alternately, fetal SIRS (FIRS) may result in the same outcome. Finding a small body frame with fine bones along with a fine, short hair coat, domed forehead and poor ear cartilage development suggests prematurity. A foal with a large body frame (large bones and large joints), with long hair coat suggests post maturity. A careful search for fractured ribs and other musculoskeletal abnormalities (fractures, gastrocnemius disruption, contracture, laxity, etc.) should be made.

SUMMARY

A careful physical examination will help the clinician detect major organ dysfunction indicating the seriousness of the condition. Further important information can be gained by dynamic monitoring of organ function and by laboratory analysis of blood samples. Simple monitoring, such as serial blood glucose levels can be easily achieved using inexpensive patient side monitors. But vital information, such as arterial blood gas, blood electrolyte and lactate levels require more sophisticated equipment which is better suited to be used in a hospital. Many therapeutic modalities, although possible on a farm, are much more manageable in a referral hospital practice. The most advanced therapeutic modalities, such as mechanical ventilation, are only possible in a tertiary referral center.