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Foal Care from Birth to 30 Days: A Practitioner's Perspective (21-Nov-2003)

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1. Introduction

This paper is a basic review of the care of the foal from birth to 30 days of age. It is based on my experience in caring for foals in central Kentucky for the past 18 yr. It is not meant to be an in-depth paper on each abnormality but is meant to be a general review of the most common problems seen in our practice and the manner in which they are routinely handled. Most of the topics can be reviewed in more depth in neonatal texts [1-3]. These opinions are based on the author's years of experience in central Kentucky, where he has been responsible for the routine care of 300 - 500 newborn foals each year since 1985. Most of these foals stay on the farms, where they are weaned and raised as yearlings to be sold.

2. Immediate Post-Partum Examination

The immediate post-partum examination is very important. Early detection of problems and prompt veterinary care are critical in the overall outcome of the compromised foal. Because the first examination is usually performed by a lay person, farm manager, or night watchman, farm personnel should be knowledgeable about foal delivery and should be able to recognize post-foaling abnormalities. Farms should be equipped with an emergency kit, and personnel should have a basic knowledge of pulmonary resuscitation of the newborn foal. Most foaling attendants in my practice are given a description of how to perform basic CPR of the foal, and they are supplied with an emergency handout reviewing the emergency procedure (Table 1). Many times, a brief administration of nasal oxygen will make a great difference in the immediate health of compromised foals.

Table 1. Resuscitation of the Compromised Foal
(A - Airway; B - Breathing; C - Circulation)

1. Clear the airway
   Remove the membranes and debris from the nostrils
   If fluid is present in the nostrils, suction with a catheter-tipped syringe
2. Ventilate the foal
   Either:
   a. Mouth to nose
      1. Extend neck
      2. Clear nostrils
      3. Occlude (hold off) down nostril
      4. Put mouth on up nostril and deliver 20 - 30 breaths/min (size of breath should cause foal's chest to visibly expand)

Or

   b. Mask to nose
      1. Extend neck
      2. Clear nostrils
      3. Apply mask to the nose with oxygen and ambu bag attached
      4. One breath every 2 sec with oxygen set initially at 10 - 15 l
      5. After 3 - 5 min, reduce oxygen to 5 - 6 l/min
3. Circulation
   Chest compression at a rate of 100 - 120 compressions/min (there is a potential for complication if the foal has rib fractures. If the foal is very compromised, the benefits outweigh the risks)
   If no pulse is present after 2 min, give 1 cc epinephrine (1:1000) intravenously if possible

Immediately after delivery of the foal, respiration should be assessed. Respiratory movements usually begin within 30 sec of birth. Initially, the respiratory rate is 60 - 70 breaths/min. The mucous membranes should become pink within the first minute after delivery, and the capillary refill time should be 2 sec or less, which indicates adequate peripheral circulation. Infrequent or shallow respiration is usually followed by pale or cyanotic mucous membranes and hypoxemia. In this instance, 3 - 5 min of nasally administered oxygen will assist oxygenation. The normal foal responds to external stimuli, and a suckle reflex begins within 5 min of birth. The newborn foal will also respond to noise and may whinny or nicker. Heart rate and strength can be evaluated by watching the palpations of the heart or by watching for the heart beat through the thoracic wall. Normal heart rate for the newborn foal is 60 - 120 beats/min. Foals with heart rates of <60 beats/min should be regarded as potentially abnormal and should be continuously observed. The umbilical cord should be allowed to break on its own; it should then be immediately dipped in 0.5% chlorhexidine or undiluted povidone solution. The cord usually ruptures within 5 - 6 min. Exam gloves are recommended for handling the umbilicus to decrease bacterial contamination.

In my experience, each foal will stand and nurse at different times, ranging from 20 min - 3 h. Most foals stand within 1 h of birth. In general, if a foal is not standing within 2 h, it should be considered potentially abnormal and carefully examined for abnormalities. Big, awkward foals may need extra assistance standing to avoid wounds on their hocks from abrasions created by struggling to rise. Most foals nurse within 2 h. In our practice, farm personnel are instructed to call for veterinary attention if a foal has not nursed within 5 h of birth. At this time, the foal is given colostrum with known immunoglobulin concentration and no red cell antibodies through a nasogastric tube. Most foals in our practice are given an enema, either a human, commercially available sodium phosphate enema or a warm water and soap enema to assist meconium evacuation. The mare's udder should be examined for the presence of adequate milk. At this time, colostrum quality can be evaluated by using a Colostrometer [a] to measure specific gravity. Foals whose dams have a colostral specific gravity under 10.60 are given donor colostrum using a bottle or nasogastric tube. One should also make sure that the mare's temperament allows the foal to nurse. Many primiparous mares will require sedation with acepromazine during the post-partum period to allow the foal to nurse.

The veterinarian's initial examination is usually performed the morning after delivery, when foals are a few hours old. The clinical examination is the most important part of the examination. First, the foal is visually inspected. The foal's general condition, strength, mental status, and ability to nurse are evaluated. One may observe the foal urinating and defecating. If the foal has difficulty performing these two functions, one should consider the presence of abdominal pain, meconium impaction, ruptured bladder, or some other abnormality. A brief conformational examination is performed while watching the foal walk around the stall. The heart is auscultated for the presence of a heart murmur, and the lungs are auscultated for normal lung sounds with special attention to respiratory rate and character. The thorax is carefully palpated for fractured ribs. The umbilicus is examined for size and bleeding and the presence of an umbilical hernia. The mucous membrane color and capillary refill time are observed. The eyes are examined for lid abnormalities, debris within the conjunctival sac, and opacities of the lens or cornea. Examination of the sclera for icterus helps in detection of neonatal isoerythrolysis or septicemia. The hard palate is palpated for the presence of a cleft palate; however, I have had two foals with cleft palates in my practice that have not been palpable and were diagnosed after an endoscopic examination. Signs of aspiration pneumonia led to the diagnosis.

If the foal is at least 12 h of age or 6 - 8 h post-first suckle, blood is drawn for a complete blood count (CBC) and immunoglobulin G (IgG) concentration. In our practice, the required IgG concentration minimum is 400 mg/dl. Foals at risk for illness because of pregnancy or farm history of disease need to have an IgG concentration of 800 mg/dl. In our practice's laboratory, we use the Cobas Mira Plus Analyzer [b] (chemistry analyzer) method for a quantitative IgG determination; however; many "stall side" kits are available. If the IgG concentration is inadequate in foals <12 h of age, a second sample is drawn later in the day. All foals have IgG concentrations determined between 12 and 18 h of age, because if failure of passive transfer has occurred, the risk of sepsis increases, and the opportunity for passive transfer of antibody is lost. We have had numerous foals 24 - 36 h of age with septic arthritis in numerous joints secondary to complete failure of passive transfer. IgG concentrations were found to be <200 mg/dl on clinical presentation of the septic arthritis. These foals are very difficult to save, reenforcing the importance of determining the IgG concentration within 24 h of age. Foals with an IgG concentration <400 mg/dl are given IV fresh frozen plasma. Most foals will receive 1 l of plasma; however, foals with an IgG concentration <200 mg/dl will usually require 2 l. The second liter of plasma is given over 30 min (30 - 40 ml/min) to avoid anaphylactic reactions. Many foals are given 1 mg/kg flunixin meglumine before IV plasma to help prevent reactions.

In normal foals, the results of the CBC are variable. In our laboratory, the white blood cell (WBC) count reference range for neonatal foals is 6000 - 12,000 cells/µl. In my practice, the range of total WBC counts in clinically normal foals varies from 5000 - 20000 cells/µl. The cause of the elevated WBC counts in clinically normal foals are unknown, but in the author's experience, they often occur with placentitis, *in utero* fetal infections such as Leptospirosis, [4] trauma during birthing process, or delayed pulmonary clearing of fetal fluids. Occasionally, one will see WBC counts <5000 cells/µl, which suggest either impending diarrhea or systemic sepsis. In our experience, leukopenia can be a useful parameter to indicate that a foal is at risk for disease. Red cell parameters and the white cell differential, which indicate neonatal isoerythrolysis or overwhelming neutrophil demands, should stimulate further clinical assessment. We are careful not to be overly aggressive in

treating clinically normal foals with high or low WBC counts, and we primarily monitor these foals clinically for abnormalities. A CBC should not replace a thorough clinical examination, which will detect early neonatal abnormalities. Common sense and clinical impression, not the blood work, usually prevail in the decision to treat an individual. In normal foals with neutrophilia, a CBC is repeated the next day when another physical examination is performed. If the WBC count is abnormal on the next day, a third CBC is performed in 3 - 4 days. In my experience, most of the abnormal WBC counts in clinically normal foals are normal by day four. In normal seeming foals with abnormal WBC counts, the farm personnel observe the foals closely for abnormalities such as lack of nursing, depression, lameness, or diarrhea. The foal's temperature is taken twice daily. Most normal mares and foals are turned out into a small paddock the first day after birth. Turn out is restricted to 30 min - 1 h the first day, and the time is gradually increased over the next few days. Mares and foals are kept in their own paddock until the tenth to twelfth day. They are then turned out into a larger paddock with one or two other mares and foals. If foals require restricted turn out or when frequent treatments are indicated, a round pen or a portable pen about the size of a stall is used.

3. Common Abnormalities of Foals to 30 Days of Age

Fractured Ribs - Fractured ribs are a very serious problem in the neonate, because death can result from a fractured rib penetrating the heart or lungs. No foal should be turned out into a paddock until its ribs have been palpated. Fractured ribs are most common after a dystocia or in very large foals. If the foal has been determined to have fractured ribs, it should be restricted to a stall for approximately 3 wk. Usually, this length of time will allow for stabilization of the fracture site, and an adequate fibrous callous over the fracture will form. These cases are rarely sent to the clinic for further evaluation. Attempts to surgically correct severe fractures have been unsuccessful in my practice. Foals with less severe fractures are often difficult to detect on the initial examination. These foals may present as a mild colic after initiation of exercise, or one will observe an increased heart rate or rapid respiratory rate. A careful examination will reveal the presence of a fractured rib and mild edema over the affected ribs. In questionable cases, an ultrasound examination will confirm the presence of a fracture.

Entropion - Entropion is the most common ophthalmic abnormality. This abnormality is best treated with a SC injection of 3 ml of procaine penicillin G (PPG) in the affected eyelid. This injection inflates excess tissues and decreases tissue laxity, causing the lid to stay in its normal position. The mild inflammatory reaction within the SC tissues engorges the redundant tissue; thus, suturing of the eyelids is rarely necessary. Restraint is very important in this procedure to prevent the eye from being damaged with the needle. I have found that PPG injection is quicker than suturing and longer lasting than other injected materials. Additionally, there is less stress on the foal than surgical correction.

Heart Murmurs - Most murmurs are physiologic and resolve in 2 wk. However, if a murmur persists beyond 2 wk of age, a cardiac ultrasound examination should be performed, even in clinically normal foals. Septal defects may be inaudible on the initial examination (12 - 18 h after birth), but they will be evident the next day when the physiologic circulatory change from the high-pressure pulmonary vasculature of fetal circulation changes to the high pressure left ventricular outflow of extra-uterine life. Many of the physiologic murmurs in very excitable foals will go away when the foal is lightly tranquilized with xylazine (25 - 50 mg, IV). Most pathological murmurs will not diminish after tranquilization.

Umbilical Bleeding - Occasionally, an umbilical vein will hemorrhage if it has failed to close properly after rupture or if a foal is straining to defecate. The amount of bleeding may be significant. A commercially available umbilical clamp [c] or ligation of the umbilicus with a #2 monofilament suture material can be used to stop the bleeding. The umbilicus should be observed carefully over the next 2 - 3 wk, because these foals are more likely to have an infected cord, and they may require antibiotic therapy.

Umbilical Hernia - Umbilical hernias are easily palpated on the newborn examination; however, they are most obvious when the foal is a few weeks of age and the omental fat protrudes into the hernial sac. Umbilical hernias are rarely a problem in the neonate, and they are usually repaired at a later date.

Meconium Impaction - Meconium is the brown, black, or greenish brown feces that is composed of glandular secretions and digested amnion. Most is passed within 24 h after birth, and it is followed by typical yellowish-colored milk feces. Meconium retention is a common source of abdominal pain in the neonate, but is more common in colts. Affected foals are initially treated with warm water and soap enemas and a low dose of flunixin meglumine (0.5 - 1.0 mg/kg) along with 12 oz of mineral oil through a nasogastric tube. Foals who refract three enemas and continue to be in pain or foals who develop abdominal distention are referred to the hospital. Occasionally, the meconium is passed before or during delivery because of hypoxemia or asphyxiation (fetal distress). If significant amounts are passed into the amniotic fluid before foaling and the

fluids are fecal tinged, the amniotic fluid that enters the foal's lungs may be contaminated. This contamination leads to meconium pneumonia.

Scleral Hemorrhage - A common observation on the initial examination is episcleral hemorrhage. The exact cause is unknown, and no problems have been associated with this finding. It is probably associated with trauma during delivery. Occasionally, a septic foal could have a similar finding, but scleral hemorrhage of sepsis is usually petechial.

Head Tilt - A head tilt is seen in many clinically normal foals. No outward signs of ataxia or cranial nerve VII deficits are associated with this syndrome, and it is a transient condition that usually does not persist for more than 7 days. This is possibly associated with birth asphyxia or maturation of the nervous system. A careful clinical examination and a CBC should be performed to detect underlying disease.

Delayed Ossification of Cuboidal Bones - Many premature foals are affected with this problem. Even in term foals, crushing of the carpal or tarsal bones can be pre-disposed by conformational defects, primarily severe valgus deformity of the carpus or sickle hocked conformation of the tarsus. Radiographs should be taken to evaluate the cuboidal bones in all foals that are at risk. Foals with severe conformational defects or delayed ossification of their cuboidal bones are stall confined, and radiographs are taken weekly until cuboidal bone mineralization has occurred. Splinting may be required in the occasional severe case, especially with concurrent soft tissue laxity; however, it should be avoided if possible.

Congenital Papillomas - Foals may be born with papillomas (warts) on various sites of the body, most commonly on the head and legs. The growths are benign and rarely a problem; however, if the growths are traumatized, they will hemorrhage. Usually, the papillomas are pedunculated and can be easily ligated. If left alone, most will spontaneously regress.

Neonatal Maladjustment Syndrome or Hypoxic Ischemic Encephalopathy ("Dummy Foals") - This condition is a common abnormality. In our practice, this syndrome usually follows premature placental separation (red bag), dystocias, or non-elective C-sections. As an estimate, I see less than 2% of my foals affected with this condition. The clinical signs can vary in onset and clinical presentation. Most signs are apparent within 48 h of birth; however, in some rare cases, clinical signs are apparent as late as 5 days after foaling. Typically, the foal is slow to nurse or stand. Additionally, the foal may wander or have seizures. These foals are usually referred to the hospital.

Septicemia - Foals may be born with a bacterial septicemia. Sepsis is often apparent within the first few hours of life. Affected foals do not stand and nurse, and they have very discolored mucous membranes with poor perfusion. The total WBC count is often <3000 cells/µl. Then, the foal experiences septic shock with cardiovascular collapse. Prompt and early therapy is needed to save these foals. Treatment is often unrewarding. Depending on the offending organism, particularly *Salmonella sp.*, latent infection post-parturition is common. Despite aggressive treatment early in life, many foals will develop septic arthritis and osteomyelitis later. Many foals septic at birth are associated with a bacterial placentitis. The most common pathogens in our practice are *Salmonella sp.*, *E. coli*, and *Actinobacillus equuli*. In our practice, the ratio of gram-positive to gram-negative positive systemic bacterial cultures in septic foals is 50:50. Typically, these foals are referred to the hospital. On occasion, foals are born with equine herpes virus type-1 (EHV-1) infections. Despite aggressive therapy, these foals usually die. We also see the occasional foal born with leptospirosis. Most of the time, these foals are small but mature. Aggressive treatment will sometimes be successful in these foals.

Leg Edema - On the initial examination, many apparently normal foals have severe distal limb edema of two or four limbs. The CBC and IgG concentration are normal, and the foals are afebrile. The cause is unknown. Clinically normal foals are turned out into a small paddock and given 0.5 - 1.0 mg/kg of flunixin meglumine for 1 day. Most foals are normal the next day, and few require bandaging. All non-complicated foals with edema are normal within 48 h.

Failure of Passive Transfer - In our practice, a level of 400 mg/dl is recommended for all foals. High-risk foals must have an IgG concentration >800 mg/dl. Concentrations of IgG <200 mg/dl (total failure) are treated as an emergency situation in our practice. These foals are given 1 l or more of plasma intravenously to obtain an IgG concentration over 400 mg/dl. Foals with IgG concentrations between 200 and 400 mg/dl are given 1 l of plasma, and blood is drawn the next day for IgG determination. This ensures that a >400 mg/dl IgG concentration is obtained. In cases where the colostrum is known to be of poor quality (specific gravity <10.60) or the mare has lost her colostrum before delivery, the foal is given stored and tested colostrum within 12 h of birth.
Recently, some insurance companies have developed their own policies and requirements for IgG concentrations before

insuring foals for mortality. Some companies will accept the 400 mg/dl levels, whereas others require 800 mg/dl. One insurance company will not accept a level <800 mg/dl. If this concentration cannot be achieved by administration of IV plasma, the 800 mg/dl IgG concentration has to be reached by the oral route only, stressing the importance of early determination of the IgG concentration. Other insurance companies ask us to write a letter certifying a foal's health when the IgG concentration is <800 mg/dl as well as write an opinion on why they should accept a foal whose concentration is less than their required 800 mg/dl. These different policies can be confusing at times and can be an added expense to the client. There is also an increased risk of anaphylactic reactions when repeated IV plasma is given to the foal. Some clarification on the minimally accepted IgG concentration in the neonatal foal between insurance companies and veterinarians needs to occur.

Neonatal Isoerythrolysis - Neonatal isoerythrolysis (NNI) occurs when the foal inherits different blood antigens (types) from the stallion and the mare. As a result, the mare has produced antibodies to these antigens, which are concentrated in her colostrum. How the mare is exposed to the foal's blood is uncertain, but it is thought that repeated exposure to red cell antigens after numerous foalings or placental leakage of blood is most likely. The foal nurses the colostrum, and, depending on the concentration and type of antibodies, the foal develops hemolytic anemia within 24 - 96 h of age. Affected foals become icteric, depressed, and anemic. Red cell types Q and A are the most lethal antibodies. Occasionally, the types U, S, T, and, more rarely, other antibodies can induce NNI. Many mares have anti-C type antibodies, which do not induce NNI. Treatment consists of supportive care and blood transfusions.
Currently, clinical NNI is rare in the Thoroughbred population in central Kentucky because of widespread use of a red blood cell (RBC) antibody screen before parturition. A false negative test can occur when the sample is drawn before the last 30 days of gestation. Some mares have a rapid increase in anti-RBC antibodies very late in gestation. Therefore, if a mare has not foaled within 30 days of the RBC antibody screening, we perform another test. Foals born to mares with suspect titers are muzzled, and a cross match of the mare's colostrum and the foal's RBCs are done. This is performed in the laboratory so that the RBCs can be washed before testing, and the reaction evaluated microscopically. Foals born to mares with high antibody titers to RBC type Q or A or other types associated with NNI are immediately muzzled for 15 h and bottle-fed approximately 12 oz of compatible colostrum or milk replacer hourly. The mare is milked, and the colostrum is discarded. In my practice, 15 h has been an adequate period of time for muzzling. Within 15 h, the removal of colostrum from the mare is completed. Additionally, the amount of immunoglobulins absorbed by the foal decreases after 15 h of age. However, some veterinarians elect to muzzle foals for 24 h.

Diarrhea - The diagnosis of the etiologic agent(s) of diarrhea in the foal is difficult and frustrating. Diarrhea in the foal during the first 30 days of life can be a serious problem with many adverse consequences, but it is also very common in non-life-threatening situations. A common non-infectious diarrhea is milk overload diarrhea characterized by the yellowish color. This is thought to be secondary to the osmotic effect of the milk or caused by gastrointestinal floral changes. The clinical severity varies. Occasionally, using 10 cc of gentamycin sulfate orally for 2 days may help in less severe floral diarrheas but should not be used routinely in diarrheas. Foal heat diarrheas coinciding with the mare's estrus are usually not treated in any way. The cause of this diarrhea is unknown.
The most common known viral cause is Rotavirus. This can cause diarrhea at any age, but it is particularly frustrating in foals less than 2 days of age. These foals require intensive supportive care. It is a highly contagious disease, and when it has started on a farm, it is very difficult to control. Bleach seems to be the disinfectant of choice.
The vaccine given to pre-partum mares may decrease the severity in the older foals, but it has not been a great help in the young foals. In my practice, in the face of an outbreak, mares are allowed to foal in a paddock to minimize the exposure to the virus. In addition, if Rotavirus is confirmed in a foal, especially early in the foaling season, they are immediately removed from the foaling barn and either sent to isolation in the hospital or to a different barn for treatment.
In my practice, the most common bacterial diarrheas are *Clostridium* and *Salmonella*, both of which are serious infections. Symptoms can vary from profuse watery diarrhea alone to diarrhea with severe depression and toxemia.
Fecal cultures, virus isolation, and Rotazyme tests [d]. are used as diagnostic tools. Initial therapy for diarrhea is supportive care that includes fluid therapy. Treating foals early can improve recovery time. Thus, in my practice, foals less than 2 days of age and not nursing are routinely catheterized and given IV fluids. Foals with diarrhea are given 1 l of a balanced poly-ionic fluid every 4 h. Each day, as long as the foal requires fluid therapy, blood is drawn for CBC and electrolyte determination. IV sodium bicarbonate is supplemented in acidotic foals. I usually wait for electrolyte determination before I administer electrolytes; however; many foals are given 3 mEq/kg of sodium bicarbonate divided in 2 l of a balanced polyionic fluid while awaiting laboratory results. In addition, KCl (light salt) is used orally when serum potassium is less than 3. One teaspoon of light salt is mixed with 60 ml of yogurt and given orally every 4 - 6 h. Many foals can be treated on the farm if the personnel are qualified. A major complicating factor is abdominal pain. Most painful foals are referred to the hospital.

Premature Foals - Foals are considered premature if born before 320 days of gestation. Normal gestational length is 322 - 345

days [5]. Most of my farms will use 11 mo plus 5 days when determining the expected foaling date. Many mares will foal considerably earlier than 335 days (310 - 325 days) and have completely normal foals. This is because *in utero* maturation varies between individuals. Foals at 305 - 310 days are gestationally premature, but many are physically mature. Gestational lengths tend to be familial in nature. For example, I have had as many as three generations of a family of mares repeatedly having normal gestational lengths approaching 12 mo.
Ascending placentitis, either bacterial or Nocardia, may cause premature delivery. Foals that are premature gestationally but clinically normal with normal CBC and IgG concentrations are not referred to the hospital. Foals born <305 - 310 days may require intensive therapy to save. One must consider the advisability of these attempts, because many have developmental skeletal issues as they grow on their relatively immature skeletal structure. The cost of salvaging these very immature foals is considerable as well.

Patent Urachus - The urachus is the *in utero* connection between the fetus' urinary bladder and allantoic cavity. In normal foals, this structure closes soon after delivery, and it eventually completely regresses to a group of ligaments. If the urachus does not close, urine will exit the umbilical area. The degree of patency is variable, and in some cases, only a urine soaked umbilicus is observed. This condition is common in foals that are weak, foals that struggle to rise, and foals that strain to defecate because of meconium retention. A patent urachus can result in bacterial entry into the foal's abdomen and circulatory system. In my practice, when a patent urachus is present, broad-spectrum antibiotics are given. A common choice is sulfamethoxazole/trimethoprim at 5 mg/kg of the trimethoprim. After 2 - 3 days of antibiotic therapy, silver nitrate sticks are used to cauterize the urachus to stimulate closure. Urine is allowed to pass from the urachus for 2 - 3 days before cautery. I believe that this results in remnant debris being flushed from the urachus, which decreases the likelihood of a subsequent umbilical or urachal abscess. A once daily treatment with silver nitrate sticks for 3 - 4 days is all that is required. One must be careful in application of the silver nitrate sticks, because penetrating the urachus can cause uroperitoneum, omental hernia, or peritonitis. Usually, the silver nitrate stick is passed no more than 1 cm into the urachus. In refractory cases that are non-responsive to silver nitrate cautery and sulfamethoxazole/trimethoprim (SMZ-TMP) therapy, surgery could be required.

Omphalophlebitis - With the intensive management employed by our clientele, umbilical remnant infections have become relatively infrequent and are rarely a cause for veterinary consultation. Omphalophlebitis is predisposed by inappropriate handling of the umbilicus at delivery or an unsanitary environment. Umbilical hematomas are relatively uncommon, occurring in less than 1% of foals born, but they tend to pre-dispose a foal to this condition. In addition, weak or recumbent foals are more likely to have umbilical infections because of increased exposure to bedding, dust, and/or fecal material. Most farms routinely dip the umbilicus twice daily for 3 days using 0.5% chlorhexidine or povidone solution as recommended [2]. Umbilical infections are usually found around the time that the dried umbilical remnant falls off at 3 - 4 wk of age. Some foals are febrile and have leukocytosis at presentation; however, most foals have a normal physical examination except for purulent drainage or abscess formation surrounding the umbilicus. Inapparent urachal or umbilical vein abscesses do occur, and these foals usually present with fever of unknown origin, elevated WBC count, and fibrinogen or septic arthritis. Most foals with umbilical infections are examined with an ultrasound to determine the severity of the infection, the structures involved, and the extent of the infection. This will determine the length and type of treatment. In our practice, foals with umbilical remnant infections that also have fevers usually have an umbilical vein abscess, anaerobic infection, or *Staphylococcus* abscess. Most abscesses are external, but many involve the internal structures and will run the entire length of the arteries, abdominal urachus veins, or abdominal umbilical veins. If the abscess is draining, it is cultured for bacterial identification and sensitivity. The most common bacteria isolated are *beta hemolytic Streptococcus sp.* and *E. coli*. Occasionally, an abscess around the umbilical area will be lanced and cultured. In our practice, very few are treated surgically. Our decision to perform fewer surgeries is based on numerous cases where a simultaneous septic condition has been present with an umbilical or urachal abscess; these cases have required long-term antibiotic therapy. As these cases were followed, most umbilical infections responded to the antibiotic therapy, making the surgical option less necessary. The most commonly used antibiotics are oral chloramphenicol or penicillin with Gentocin or amikacin. Follow-up ultrasound examinations and CBCs are performed to decide the appropriate time to stop the treatment.

Septic Arthritis (Joint Ill or Navel Ill) - The name (Joint Ill or Navel Ill) arises from an association with umbilical infections. In my practice, other routes of infection are probably a more common cause of septic arthritis. It is common to have a septic joint subsequent to septicemia. It is very common to have a foal survive *Salmonella* septicemia and later become ill with a septic joint. It is more likely that bacteria from the intestinal or respiratory tract are the more common sources. Circulating bacteria, whether from the umbilicus or other areas, are shed into the blood. They then lodge and grow in the epiphyseal or metaphyseal growth complex, extending into the joint cavity. Primary synovial colonization, although possible, is less common.
Many foals that develop septic arthritis have no history or clinical signs of umbilical disease, and most have adequate IgG

levels as newborns. Any time a foal presents with a lameness and fever, septic arthritis is the first problem to rule out. Waiting for just 1 day can many times make a serious difference in the eventual outcome. These foals are immediately sent to the hospital, where a diagnostic evaluation is performed. The confirmed septic joints are lavaged, and systemic antibiotics are used. The antibiotics selected depend on culture results and sensitivity. Broad spectrum antibiotics are used initially, but culture and sensitivity are imperative, because non-responsive infections are frequently found to be resistant to the broad-spectrum selection.

It cannot be stressed enough that a lame foal with or without a fever should be looked at very closely for the presence of septic arthritis. Any edema or effusion in or around a growing area of the bone should be investigated. I have had numerous foals that have had normal blood work and normal temperatures, but have had over 100 000 WBC/µl counts in a joint. The longer one waits to lavage the joint, the more the cartilage is damaged. Additionally, the infection seems to become more deeply seated in the bone, making the treatment more extensive and costly with a poorer prognosis. Infections established in the bone quickly become hypovascular because of the exudates pressure, and, therefore, they are more difficult to penetrate with systemic antibiotics [e].

Foals with a clinically identifiable septic joint that is not obvious along with lameness and fever are started on systemic antibiotics and monitored very closely. Many have a bacterial osteomyelitis that has not penetrated into the joint or abscess in some other area. These foals often have marked leukocytosis and a fibrinogen concentration of 1000 mg/dl. Generally, they are referred to the hospital. Radiographs will often identify metaphyseal osteomyelitis with resultant pain and lameness.

"Windswept" Foals - "Windswept" foals have a conformational abnormality in which the limbs are slanted in one direction with a valgus deformity in one limb and a varus deformity in the other. This conformation is thought to occur secondary to fetal positioning during the last few weeks of gestation. Affected foals require stall rest until their conformation improves enough to walk to a small pen or paddock. They should be examined for severe abnormalities such as curvature of their long bones and spinal deformities. Although surgical intervention such as a periosteal transection (PT) or transphyseal bridging may be required in some cases, many foals will correct without specific therapy during the first month of life. The site normally requiring the most careful monitoring is the cannon bone of the varus limb. Although the valgus limb is often more dramatic, it is usually centered higher in the limb where there is more time for correction to occur.

Angular Limb Deformities - Angular limb deformities are very common in the newborn and developing foal. The fetlocks, carpus, and tarsus can have valgus or varus deformities. In my practice, the amount of valgus or varus deformity is given a subjective score. Foals are graded from 0 to 3 with 0 being straight. For foals with a slight deformity, a score of 1 is used. In addition to angular limb deformities, many foals will have sickle hock conformation or rotational deformities that need to be monitored. Most foals will improve without treatment within the first 30 days of life. Therefore, one should let the foal improve on its own and initiate specific therapy only when the foal has stopped improving, the rate of improvement has slowed, or a drastic change in the conformation has occurred. If you do not record a grade, it is impossible to remember if the foal is improving or worsening. Most foals with carpal valgus will improve dramatically within the first few weeks of life. These foals are monitored for improvement for up to 60 days. If the angulation has not corrected by that time, a periosteal transection is performed. When a foal is found to have grade 2 - 3 valgus deformities, the affected limb(s) are radiographed to evaluate the cuboidal bones. The grade 2 - 3 valgus foals without bony abnormalities will have very limited turn out to allow for the soft tissues to strengthen, because unlimited turn out may result in ligamentous stretch, damage to the physis, or damage to the cuboidal bones. Improvement usually occurs with a week of stall rest, and a gradual increase in exercise can be initiated in a round pen turnout or temporary small pen. These foals are candidates for periosteal transection at 2 wk of age if they are not improving. Occasionally, a second PT is required at a later date, or if severe enough, transphyseal bridging may be performed. Improvement with time is the key parameter to monitor.

Foals with delayed ossification of cuboidal bones are stall confined, and radiographs are taken weekly. They are stall confined until the bones totally mature. Occasionally, these foals will require splinting. In cases with severe tarsal valgus or sickle hock conformation with abnormal tarsal bones, a splint cast is applied to the front of the limb for support.

Fetlock (metacarpal/metatarsal) valgus usually improves dramatically as the foal grows. This type of deformity must be severe to require any special attention. This is in contrast to fetlock varus, which is frequently familial and requires more aggressive treatment. The blacksmith, at 3 - 4 days of age, trims the foal's hoofs, applying only slight correction for a toe-in and removing the points on the toes. This foal is usually trimmed on a 2-wk schedule. With foals that wear their foot excessively despite trimming, equilox can be used. Most improve dramatically by 30 days of age, but for full correction, many will require a PT on the inside of the fetlock for fetlock varus. In severe cases, transphyseal bridging of the fetlock has been successful. If done early (before 60 days) and bandaged appropriately, the cosmetic effects are very good. However, this procedure is reserved for severe fetlock varus that has not responded to trimming or PT. One will observe that, after thirty days of therapy (trimming or PT), no change in the varus deformity has occurred, with the foal's fetlock and knees moving laterally when the foal walks. Also, these foals often have offset knees that give the foal a "bow-legged" appearance. In the

most severe cases, crushing of the medial aspect of the metacarpal physis may occur, resulting in an extreme toe-in conformation and ultimately, affecting future soundness. Therefore, all means available are employed to correct a varus fetlock in the presence of offset knees.

Carpal and tarsal varus is not common in the newborn and is usually associated with a "windswept" conformation. Unless severe, carpal varus rarely requires surgical intervention. Non-responsive varus always requires a closer examination. Foals with cow hocks or tarsal valgus and sickle hocks usually do not require a great deal of attention unless the deformities are severe or asymmetrical when radiographs are taken. These deformities improve a great deal as the foal strengthens with exercise. If severe, the tarsus should be radiographed for delayed ossification of the cuboidal bones, which requires stall confinement pending radiographic improvement. Hock conformation generally continues to improve for many months, and only a few will require a PT. Tarsal varus is usually associated with a "windswept" conformation, most of which will improve satisfactorily by 30 days of age.

Flexor and Extensor Abnormalities - The most common flexural weaknesses are "back at the knees" and weak pasterns. Both of these conditions improve in the first few weeks of life. When the supporting soft tissues strengthen, many moderately affected foals with carpal overextension will gradually improve to normal. Thus, a "back at the knee" conformation in the neonate does not provide an indication of the adult conformation. In severe cases, the amount of turn out is restricted until the conformation improves.

Weak pasterns (fetlocks) are a very common finding. Most foals improve in a few days and require very little special attention. In mild cases, simply trimming the heels slightly will rid the foot of the rocking motion and keep the foot on the ground. In cases where the foal rocks back on its pasterns to the fetlock and the hoof is seen to extend dorsally, special shoes, glued or taped on, with a heel extension can be used for support for up to 2 wk. Occasionally, these shoes will need to be reset for an additional 1 - 2 wk. I prefer to make aluminum shoes, which are applied to the foot with equilox; however, commercially available glue-on shoes are also adequate. A small bandage with extra padding behind the heel bulbs can serve as adequate protection until the foal strengthens or until shoes can be applied. Without protection, heel bulb and pastern lacerations are common in these foals, which can lead to a severe ascending cellulitis. Foals should be confined to the stall until the shoes are applied. Usually, a round pen or small temporary pen works well for initial turn out.

The most common flexural deformities involve the carpus, fetlock, or pedal joints. In my experience, the biggest mistake made when treating flexural deformities of the neonate is a lack of aggressiveness with non-responsive cases. Many times, foals are merely bandaged, given tetracycline, and turned out, although they are not responding. Aggressive splinting is required. By the time appropriate splinting is used, many foals will have severe pressure sores that may become life threatening. In general, a flexural deformity of the fetlock or pedal bone should be corrected in 3 days of routine splinting. No more than 5% of these foals will take longer than 3 days of steady splint pressure on the short flexor tendons to obtain normal limb position. Oxytetracycline, given at 3 g diluted in saline IV as needed for 3 consecutive days, will relax most flexor tendon contractions in neonates [6].

If a foal with fetlock flexural deformity cannot walk without the fetlock-flexing forward, a splint is applied. I use an aluminum splint manufactured by a blacksmith, that is easily applied, shaped as necessary, and lightweight. PVC pipe is also very useful and can be cut or shaped into the correct size. Selective pressure should be applied to the back of the foot by applying extra padding to the bottom of the splint. The splint is applied, and the foal is given 2 g tetracycline IV and 1 mg/kg flunixin meglumine. The foal is not turned out until the splinting is no longer needed. Most fetlock contractions take 2 - 3 days to correct.

Flexoral deformity of the pedal bone is less common and is a challenge. Again, one cannot stress the importance of aggressive treatment in these cases. I have had the most success by applying the splint on the anterior surface of the leg, drilling two holes in the anterior hoof wall, and connecting it to the bottom of the splint. A fulcrum is placed on the front of the bandage, and the splint is applied to the bandage. Because of the force placed on the deep flexor tendon, foals can become pained. Therefore, this splint will need to be removed at 12-h intervals. In addition, 1 mg/kg flunixin meglumine and 2 g tetracycline are used for up to 3 days. Flexural deformity of the carpus (over at the knees) is very common but has a large variation in severity. Most improve with normal exercise. In cases where the foal has difficulty standing, the legs are bandaged from the elbow to the foot or a splint cast is used. I have not had much success with surgery, casting, or tetracycline in severe carpal flexural deformity. Even some of the more severe cases will improve in a couple months with paddock exercise. In most cases, an intermittent turn out schedule is used. The foal is allowed to exercise in a small paddock with it smother, and when the foal becomes fatigued, characterized by a trembling of the legs, the mare and foal are returned to their stall. Usually, this is no more than 30 min/turn out and can be repeated four times daily. If these foals do not become painful, improvement is usually seen within a few days. A 0.5 mg/kg dose of flunixin meglumine is used to eliminate pain. Patience is the most successful, non stressful method of treating flexural deformity of the carpus in the foal.

4. Conclusion

As the end of the first month is reached, most neonatal diseases become less frequent. In our practice, the "30 day" conformational examination has become a popular procedure. This is an important time in the developing foal's life, especially with regards to fetlock conformation, because the distal metacarpal and metatarsal physes lose 50% of their growth every 30 days. An initial conformation evaluation is recorded to compare with future examinations. Thus conformational trends can be followed; when conformation changes drastically for the worse, more aggressive therapy such as trimming, equilox application to the foot, or surgery may be initiated. I have found the 30 day examination most important in cases of fetlock varus when more aggressive treatments need to be considered. Surgical correction of fetlock varus is less effective after 60 days of age. Periosteal transection is a controversial procedure in the developing foal; however, when used properly and with discrimination, we have found it to be a useful adjunct to corrective trimming. Ultimately, by improving the conformation of these individuals, especially the "offset kneed," toed-in individuals, we hope we are improving their future soundness.

Footnotes

[a] Lane Manufacturing, Denver, CO, 80202.
[b] Roche Diagnostic Corp., Indianapolis, IN, 46201.
[c] Butler Company, Lexington, KY, 40511.
[d] Meridian Bioscience Inc., Cincinnati, OH, 45201.
[e] Bramlage LR. Personal communication. 2003.

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