Proceedings of the
9th International Congress of World Equine Veterinary Association

Jan. 22 - 26, 2006 - Marrakech, Morocco

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Neonatal emergencies in the immediate post-partum period

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Introduction
Illness in foals often results in a series of non-specific clinical signs. As such the clinician should be familiar with the normal behaviour of foals in order to optimise the chances of recognising problems early. Dramatic changes in a foal's condition can occur rapidly potentially making a short delay in the institution of therapy can have a significant impact on prognosis.

Normal clinical variables for a newborn foal
- Gestation period: 341 days (range 315 - 365 days)
- Time to sucking reflex: 20 min
- Time to standing: Ave. 60 min (range 15 - 165 min)
- Time to drinking: 110 min (range 35 - 420 min)
- Body temperature: Days 1-4: 37.0 - 38.5°C
- Heart rate: 0-5 min: 70 bpm; 6 - 60 minutes: 130 bpm; 6 - 48 hours: 96 bpm
- Respiratory rate: 0-15 min: 60 - 80 bpm; then 20 - 40 bpm
- Time to first micturition: 8 hrs (colts sooner than fillies)
- Meconium passage: By 24 hrs
- Menace response: Absent until 2 weeks

Following birth a number of adaptive responses may be used to assess the viability of the newborn foal. If a foal has responses outside these time frames maladaptation to the extra-uterine environment may be assumed. These may be listed as follows:
- Establishment of normal respiratory and cardiac rhythms: 1 minute
- Righting reflex: 5 min
- Sucking reflex: 30 min
- Attempting to stand: 60 min
- Stand unassisted: 180 min
- Drinking from mare: 180 min

Abnormalities that may reflect mal-adaptation to the extrauterine environment include:
- Increased passive range of motion of joints; tendon contracture; flexor tendon laxity
- Angular limb deformities; scoliosis, kyphosis, or lordosis of the vertebral column
- Entropion; tipped ears; velvety hair coat
- Heat, swelling, or pain at joints/physes
- Fractured ribs associated with foaling (rapid, shallow breathing)
- Umbilical or inguinal/scrotal hernias
- Cleft palate
- Injected or icteric sclera
- Dysuria, tenesmus
- Red line around the coronary band
- Swollen, moist, leaking umbilical cord
- Foal wanders away from the mare or is unaware of surroundings
- Poor/absent suckle reflex
- Placenta is thickened, discoloured; uterine discharge/odour from mare
- Udder of the mare is distended

There are a group or groups of conditions that result in a newborn foal being at increased risk of disease. These may be listed as follows:

Maternal conditions
- Purulent vaginal discharge
- Fever
- Hydrops allantois
- General anaesthesia; abdominal surgery; endotoxemia; prolonged transport prior to foaling
- History of previous abnormal/dead foal
- Premature lactation; poor colostrum production
- Poor nutritional status

**Conditions of labor - stages 1 - 3**
- Premature parturition
- Abnormally long gestation
- Prolonged labor; induction of labor; dystocia
- Early umbilical cord rupture
- Delivery via Caesarian-section

**Neonatal conditions**
- Meconium staining/aspiration
- Placental abnormalities; placentitis
- Twins; orphaning
- Inadequate/inappropriate colostral intake
- Immaturity/prematurity
- Exposure to infectious disease
- Trauma

**Specific diseases of newborn foals**

**Abdominal pain**

**Introduction**

Keypoint The most common cause of abdominal discomfort or pain in the first few days of life is retained meconium. However, a variety of other problems may give rise to abdominal pain. It is important to carefully examine foals with abdominal pain and to note whether there is any abdominal distension.

**Clinical findings and diagnosis**

- A good general examination is critical for determining the cause of the pain.
- As with adult horses, determination of the vital signs (heart rate, respiratory rate, temperature, capillary refill time) and gut sounds are essential in making an assessment of the extent of the problem.
- Keypoint If the foal is straining, it should be determined whether it is straining to urinate (legs spread) or straining to defaecate (arching of the back).
- Careful digital rectal examination should be performed to determine if there is retention of meconium.
- Passage of a nasogastric tube should be done to determine whether there is gastric reflux, which may indicate an upper intestinal obstruction.
- Abdominocentesis will assist in determining whether there is a problem that is likely to require surgery. This is most easily done in newborn foals with the foal in lateral recumbency but may also be carried out with the foal standing. An 19 gauge 3.75 cm (1.5") needle is inserted through the midline of the abdominal wall.
- The haemogram and serum or plasma electrolytes may be useful in assessing the requirements for fluids and electrolyte (see fluid and electrolyte section earlier in this section).
- In more specialised practices, techniques such as endoscopic examination of the stomach, abdominal radiography and ultrasound are now becoming more widely used. These techniques do require considerable experience before accurate interpretation can be made. Gastric endoscopy is performed to determine the presence of ulcers. Abdominal ultrasound investigating for fluid in the abdomen, rupture of the urinary tract, distended loops of bowel etc is useful. Radiography is useful also as foals are small and imaging of the abdomen and thorax is relatively easy to perform.
- Keypoint Cases that undoubtedly require surgery are those with persistent abdominal pain where there is increasing abdominal distension. The degree of abdominal distension can be assessed by sequential recordings of abdominal circumference.
Treatment

- Because of the wide range of possible conditions that can give rise to abdominal pain, it is essential to narrow the diagnostic possibilities.
- Keypoint Retained meconium can be treated by the use of enemas and most cases resolve without complicated treatment. Soapy water is quite satisfactory as an enema solution but there are commercial products available. This can be supplemented by the use of mineral oil given by nasogastric tube. With severe impactions acetylcysteine enemas have been recommended. In severe cases a laparotomy may be required. Radiographs and/or ultrasound prior to surgery are very useful aids.
- Exploratory laparotomy is not often necessary in newborn foals but should be considered if there is severe unremitting pain together with increasing abdominal distension. Remember that foals have a high likelihood of developing adhesions post surgery.
- Pain relief should be used judiciously. Keypoint The non-steroidal anti-inflammatory drugs may cause gastrointestinal ulceration. They should be used at low dose rates and for short periods. Flunixin is the anti-inflammatory drug of choice and the dose rate should be in the range 0.2-0.5 mg/kg. Although some adverse effects have been reported with xylazine (particularly hypotension), we have had good results from dose rates in the range 0.1-0.2 mg/kg, given IV.
- Many clinicians prescribe medication for gastric ulcers as foals under stress appear prone to these. The DOC at present is omeprazole (1 mg/kg PO or IV q24h).

Failure of passive transfer of immunoglobulins

Introduction

While the foal has some immunological function as a foetus, immunity is essentially a passive transfer of colostral immunoglobulins during the first 6-12 hours after birth. Failure of passive transfer of immunoglobulins is quite common in newborn foals and therefore assessment of IgG concentrations in plasma is important in management. Keypoint The volume of colostrum normally consumed by newborn foals in the first 8-12 hours has been estimated at between 1 and 2 litres. Keypoint The optimal concentrations of IgG in foal plasma 24 hours after birth are greater than 8 g/l. Values less than 4 g/l are considered to reflect failure of passive transfer and those between 4 and 8 g/l are suboptimal concentrations. Foals with low IgG concentrations are more likely to be predisposed to a variety of bacterial infections. Many stud farms measure IgG concentrations at 12 hours and if they are low additional colostrum is administered before the foal is 24 hours old.

History and presenting signs

- Foal slow to stand and suck
- Mare has 'let down' colostrum prior to foal being born
- Mare and foal separated after birth
- Mare with a very distended udder indicating foal has not sucked
- Foal with suspected septicaemia
- Foal presented with "joint ill"

Clinical findings and diagnosis

- The availability of quick, reliable measurements of IgG concentrations in foal plasma has enabled early diagnosis of failure of passive transfer, before a foal is presented with an infection.
- Keypoint A range of techniques are available for measuring immunoglobulin concentrations.
- Measurement of the colostral specific gravity in mares provides a good guide to the likely IgG concentrations in their foals. Colostral specific gravities greater than 1.06 generally indicate adequate antibody concentrations.

Treatment

- Maintenance of colostral banks are vital on larger stud farms so that foals with failure of passive transfer or which are likely to have inadequate IgG concentrations can be given supplementation of colostrum. In most cases, a round 1 litre of colostrum should be given within the first 8-12 hours after birth.
- If colostrum is not available or if the foal is older than 24 hours, plasma transfusions are required to increase the IgG concentrations. Normally 20-40 ml/kg are required to increase the IgG levels to around 8 g/l. Further details are provided in the section on fluid therapy in foals.

**Septicaemia**

**Introduction**

Bacterial infection is probably the most important clinical disorder in foals. Infection may be localised but in the majority of cases is generalised with subsequent localisation to areas such as the lung, joints and physes. Infections may be acquired in utero but in most cases are acquired after birth. The most important predisposing cause of infection is failure of passive transfer of immunity. Keypoint It is an important part of management on stud farms to screen the colostrum IgG concentrations and/or IgG level in the foal in the first 6-12 hours after foaling.

**History and presenting signs**

- Previous history of abortion or death of foals
- Overcrowding/poor management
- Chronic long-standing infectious disease eg. Salmonella
- FPT
- Dystocia
- Premature foal
- Depressed, sick foal presented

**Clinical findings and diagnosis**

- Keypoint The most important signs of septicaemia are behavioural. Affected foals will appear depressed and stop sucking. The first thing noticed by the stud farm manager or owner may be that the mare has a distended udder. Because foals infected in utero may show signs similar to those with neonatal maladjustment syndrome, it is important to investigate sepsis as a possible cause of any foal with maladaptation.
- Body temperature provides no accurate guide to the presence/absence of infection with normal, increased or decreased temperatures being reported. In fact most foals with septicaemia are presented with normal or low body temperatures.
- There may be an increase in respiratory rate but even in cases of pneumonia, abnormal lung sounds may not be heard, unlike the situation in adult horses.
- Diarrhoea is a common finding in foals with septicaemia.
- Sudden onset of lameness is an important sign, which may suggest localisation of infection in a joint or physis.
- Keypoint Haematology is useful but total white cell count does not appear to be a good indicator of infection. The most consistent findings are increased band forms of neutrophils (normally no present or in very low numbers in normal foals) and toxic changes within the neutrophils.
- Fibrinogen may be increased in foals with septicaemia with values usually greater than 4 g/l.
- Hypoglycaemia is a common finding in septicemia with values less than 5 mmol/l (90 mg/dl).
- Because many foals with septicemia have pneumonia, hypoxaemia is common and should be anticipated.
- Keypoint Blood cultures are ideal and blood samples should be collected using impeccable sterile technique. Blood samples should be injected into blood culture bottles. It is imperative to take blood for blood culture prior to commencement of antibiotic therapy. It should also be noted that because some bacteria take up to 5-6 days to grow, a negative blood culture result should not be given too quickly.
- Tracheal aspirates for bacteriology and cytology may also be indicated because a high percentage of cases will have pneumonia. Remember that this is a stressful procedure and therefore care must be taken when doing it.
Treatment

- Keypoint The combination of penicillin (sodium or potassium) given IV at a dose rate of 20,000 IU/kg and IV q6h or ceftiofur (5-10 mg/kg) combined and gentamicin (6 - 8 mg/kg) or amikacin (7-10 mg/kg) are often to drugs of choice.
- Keypoint If septicaemia is suspected it is important to begin broad spectrum antimicrobial therapy ASAP.
- The duration of antibiotic treatment should be based on clinical response and subsequent haemograms. In some cases 5-7 days is adequate while others may require 2 weeks or more of treatment.
- The most common sequelae of septicaemia are: septic arthritis or septic physitis, enteritis and in foals that are recumbent for some time, corneal ulceration.

"Joint Ill" (Polyarticular septic arthritis/osteomyelitis)

Introduction

"Joint ill" is a common term used for polyarticular septic arthritis in foals, usually following a systemic bacterial infection/septicaemia. Most commonly infection involves multiple larger joints and/or the physes but in some cases may involve the metaphysis adjacent to the physis. "Joint ill" is a serious condition that carries a poor prognosis for future athletic function.

History and Presenting Signs

- Prematurity
- Failure of passive transfer
- Mare with uterine infection
- Poor hygiene at foaling

Clinical findings and diagnosis

- Foals with "joint ill" are often clinically ill and will show signs of systemic infection, with signs of depression, inappetence and fever. Keypoint However, it should not be assumed that a foal does not have joint ill just because it has no signs of systemic disease.
- Foals are often reluctant to move and will show variable signs of lameness.
- Careful examination will usually reveal joint effusion, with one or more joints being warm to touch, distended with fluid and showing thickening of the dorsal joint capsule.
- Radiographs may not show changes in the early stage of disease but are useful to help in assessing the prognosis. One of the difficulties in radiographic interpretation of bone infection is that the bone around the physes often has a similar appearance to infected bone.
- Keypoint Synovial fluid collection is essential for diagnosis and should be performed prior to any antibiotic therapy (if possible). It is critical that the aspiration of synovial fluid be done in a sterile manner, with thorough preparation of the area, gloves being worn by the operator and sterile drapes used around the site. We find it easy to collect samples with the foal given a brief period of gaseous anaesthesia. Samples should be collected into tubes containing EDTA for a total and differential white cell count. Synovial fluid white cell counts greater than 1 x 109/l with a predominance of neutrophils and an elevated total protein (normal range 15-25 g/l) suggest that there is infection. For bacteriology, it is best if samples are collected and injected immediately into blood culture medium which has enrichment properties to enhance the chance of growth of the organisms.
- It may be worthwhile to take blood for blood culture if early in the course of the disease.

Treatment

- It is important to obtain samples for bacteriology prior to commencing any therapy (if possible).
- If a Gram or Diff Quick stain of the synovial fluid deposit reveals bacteria, antibiotic therapy can be based on the result of the Gram stain.
- If there are no Gram stain results, the use of a bactericidal combination of drugs such as IM penicillin (20,000 IU/kg q12h) or ceftiofur (5-10 mg/kg IV or IM q12h) combined with IV gentamicin (6-8 mg/kg q24h) are good choices.
- Irrigation of infected joints by joint lavage is usually necessary using polyionic fluids. This should be done with the foal under general anaesthesia. This may need to be repeated and on occasion arthroscopy and/or arthroscopic investigation of affected joints is indicated.

**Neonatal isoerythrolysis**

**Introduction**

Neonatal isoerythrolysis is a condition that is most commonly found in Thoroughbreds, Quarterhorses and mules when during pregnancy the mare manufactures antibodies against the foal's red cells. After birth, ingestion of colostrum by the foal results in absorption of the anti red cell antibodies which destroy the foal's red cells. **Keypoint** The condition is mainly found in multiparous mares and is associated with specific alloantibodies, usually Aa and Qa.

It is believed that mare's who do not have the Aa or Qa red cell antigens (~1% of Thoroughbreds) have foals one of these antigens (inherited from the sire) and there is transplacental passage of blood from foal to mare. This in effect vaccinates the mare against the foal's blood type and the mare produces alloantibodies to either Aa or Qa.

**History and presenting signs**

- Multiparous mare
- Foal shows weakness within first few days of birth

**Clinical Findings and Diagnosis**

- Foals are normal at birth and for the first 1-3 days after birth.
- The onset of clinical signs is variable and depends on the amount of antibody ingested and absorbed.
- Foals usually show signs of listlessness and decreased appetite.
- **Keypoint** Clinical examination may reveal severe pallor (and jaundice) of the mucous membranes and elevated heart and respiratory rates. The temperature is often normal.
- Blood for haematology shows very low red cell values, with the haematocrit usually in the range 0.10-0.20 l/l (10-20%) and icteric plasma. An increase in the white cell count is also common and may be a 'stress' related response. In most foals that show clinical signs, the haematocrit is usually below 0.12 l/l (12%).
- Urine samples will demonstrate haemoglobinuria.

**Treatment**

- Prevention is the most important aspect of management and mares that have lost foals within a few days of birth should be suspected. Blood samples can be taken for determining the presence of Qa and Aa red cell antigens and/or alloantibodies. If the mare does not have these antigens the risk of producing alloantibodies likely to cause neonatal isoerythrolysis is increased as more than 90% of stallions will have them.
- If there is a likelihood of neonatal isoerythrolysis, colostrum from the mare should be discarded and colostrum from a colostrum bank administered. The foal can be muzzled for at least 48 hours to prevent access to antibodies which are ingested.
- **Keypoint** Ideally treatment of an affected foal involves a blood transfusion with administration of the mare's blood which has had the red cells washed three times to remove alloantibodies. We have had good co-operation from local blood banks. Alternatively, cross matching may be carried out and a suitable donor found. If facilities are not available to do this, a transfusion from a gelding (preferably Standardbred) is unlikely to cause a transfusion reaction. Usually 20-30 ml/kg of packed red cells is adequate to produce a haematocrit in the range 0.15-0.20 l/l (15-20%) and this is often satisfactory for the foal to survive until further red cells are manufactured. Some foals require further transfusions. If the mare's red cells have been washed, packed red cells are returned after centrifugation. If gelding's plasma is to be used, the majority of the plasma can be removed prior to the transfusion, although this is not an imperative.
- It is important to perform an IgG evaluation to determine whether there has been failure of passive transfer of immunity. Some foals with neonatal isoerythrolysis survive only because they absorb
inadequate IgG. Therefore plasma transfusion may be necessary and the foal should be covered for 3-5 days with a bacteriocidal broad spectrum antibiotic combination.

Neonatal Maladjustment Syndrome (Hypoxic-ischaemic injury)

**Introduction**

Keypoint Neonatal maladjustment syndrome is really a descriptive term which may encompass a number of conditions resulting in maladaptation in the newborn foal. The condition appears to be related to central nervous system dysfunction and may be induced by birth asphyxia (hypoxia) and/or intracranial haemorrhage. It is important to distinguish maladjusted from septicaemic foals.

**History and presenting signs**

- Dystocia in some cases
- Most foals affected are not premature
- Signs usually noticed within 24 hours of birth

**Clinical Findings and Diagnosis**

- Foals will stop sucking and show a progression of disease from signs of depression and weakness through to wandering behaviour, loss of recognition of the mother and finally recumbency.
- Foals may have a grunting respiration and make an abnormal sound. For this reason they have been termed "barker foals" by some clinicians.
- Neurological signs can include rigidity of fore and hindlegs, apparent blindness and in some cases convulsions.
- Most foals will demonstrate some degree of dyspnoea and it is important to eliminate a primary respiratory complaint.
- Blood cultures may be necessary to eliminate the possibility of septicaemia.

**Differential diagnosis**

- Septicaemia
- Blood loss (via umbilical rupture during birth)
- Rupture of the urinary tract
- Trauma
- Metabolic disorders

**Treatment**

- Nursing care is the key to management, ensuring that metabolic and hydration status is normal. Foals often need to be fed to ensure they receive sufficient calories during recovery.
- Some clinicians use drugs hoping to decrease cerebral oedema. DMSO, mannitol etc have been prescribed.
- Some foals will be hypoxaemic and may require intranasal oxygen administration.
- No specific treatment is useful although it is essential to ensure that foals are not septicaemic. As these foals are under stress antimicrobial cover may be indicated.
- Foals that have reversible disease, usually show improvement within the first 2-5 days.

**Urachal problems**

**Introduction**

The urachus is the normal communication pathway between the bladder and the allantois during foetal life. After the umbilical cord ruptures, the urachus may remain open or re-open several days after birth. It may also be the site of infection and in some cases become abscessed.

**History and presenting signs**

- Foal usually less than 1 week of age
- Swelling around the umbilicus
- Urine dribbling from umbilicus
Clinical findings and diagnosis
- Infection around the urachus may be manifest as swelling around the umbilicus.
- Patent urachus is simple to diagnose as there will be obvious urine leakage from the umbilical stump.
- Ultrasound examination of the urachus and umbilicus is indicated in all cases if possible as there may be abscesses etc in the region.

Differential diagnosis
- Rupture of the urinary bladder
- Umbilical abscess

Treatment
- Many cases of patent urachus will resolve without any treatment.
- Keypoint If the urachal opening does not close within 2-3 days, a caustic agent such as phenol or strong tincture of iodine, applied carefully around the opening with a cotton bud will often result in closure or the urachus.
- If there is infection, surgical treatment is necessary to remove the infected umbilical stump.

Urinary tract disruption

Introduction
Urinary tract disruptions occur relatively frequently in newborn foals. Rupture of the urinary bladder and the abdominal urachus can occur, resulting in uroperitoneum. Mostly this occurs during delivery and the signs manifest within a few days of birth. A small percentage of cases can occur from an infected umbilical stump.

History and presenting signs
- More common in male foals - probably due to the longer urinary outflow tract thus increasing vesicle pressure during parturition
- Progressive signs of depression
- Small amounts of urine passed
- Abdominal distension
- Foal 2-3 days of age

Clinical findings and diagnosis
- Foals usually show signs of depression and and stop sucking.
- By the time signs of depression are seen, there is usually significant abdominal distension.
- Keypoint Straining to urinate may be seen together with passage of small volumes of urine and progressive distension of the abdomen.
- Serum biochemistry profiles often show lower Na and Cl values together with increased K and urea. A mild metabolic acidosis is commonly found on acid base assessment.
- Keypoint Abdominocentesis is the critical technique for the diagnosis of uroperitoneum. With the foal standing or in lateral recumbency, a 19 gauge 25 mm (1") needle is inserted through the abdominal midline just caudal to the umbilicus. Keypoint The sample may smell like urine (especially if heated) and the creatinine concentration will be elevated to more than twice the concentration in the serum or plasma. It is worthwhile measuring the leucocyte count and the total protein in case there is urinary tract infection.
- If a sterile dye is available (methylene blue is the dye of choice), a small amount (5-10 ml) can be injected into the bladder via a urinary catheter and abdominal fluid later taken to determine if the dye is present. This technique is rarely used and in most cases abdominocentesis will yield diagnostic results.
- Abdominal ultrasound is also very useful in the diagnosis of rupture of the urinary tract.
**Treatment**

- Keypoint Surgery is necessary but the foal should be stabilised prior to the surgery. Ruptured bladder is a medical emergency not a surgical emergency. Thus prior to surgery it is ideal to drain the abdomen (place a urinary catheter and drain the abdomen via a teat cannula or the like) and re-establish the foal's fluid and electrolyte balance. This will decrease the risk of anaesthesia. Glucose or bicarbonate (5 mmol/kg) may be given to assist in decreasing serum K.

- Repair usually involves gaseous anaesthetic induction. A midline laparotomy is necessary to repair the defect and the usual approach is to make an elliptical incision around the umbilicus. After the abdomen is entered it is important to determine if there are infected foci along the course of the urachus. The area of leakage in the urinary bladder is then identified and repaired.