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Postpartum mare and foal: management and considerations

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Abstract

Veterinarians are often responsible for ensuring that the general health and wellbeing of the mare and foal while simultaneously overseeing the mare's breeding. Management of mare and foal is often tailored to suit the individual needs of the breeder. Expectations and experience level for a commercial breeding operation may differ substantially from the first-time boutique hobby breeder. Although differences among clients may exist, the clinical approach should be supported by scientific data and an accepted standard of practice. This paper reviews considerations for breeding the postpartum mare and discusses management of common conditions affecting the mare and foal.

Keywords: Mare, foal, postpartum, breeding management, pregnancy

Initial assessment of the postpartum mare and foal

In clinical practice, the first examination of a normal mare and foal is typically performed from 8 - 24 hours postpartum. This allows adequate time for normal postfoaling events to proceed uninterrupted, including neonatal adaptation to ex utero life, mare-foal bonding, and passive immune transfer. Mare owners should be advised to adhere to the 1-2-3 rule: by 1 hour the foal should be standing, by 2 hours the foal should be nursing and by 3 hours the mare should have passed fetal membranes. If there is a deviation from the 1-2-3 rule or other complications arise, earlier intervention is often warranted.

During initial examination, the focus is on the general health and wellness of the mare and the foal and the assessment of the pair's readiness for turnout. A complete physical examination is performed for both mare and foal.

In addition, to routine parameters assessed during the physical examination, the mare's mammary gland should be assessed to ensure that mammary development and milk production are adequate. The perineum is assessed for any evidence of foaling trauma. Fetal membranes should be routinely examined for completeness of chorioallantois and for evidence of pathology. Healthy fetal membranes weigh ~ 10 - 11% of the foal's bodyweight. If fetal membranes are not completely presented, the mare's reproductive tract should be examined for retention. Identifying signs of placental pathology may aid in management of the mare and foal.

A through physical examination of the neonate foal is necessary to identify any signs of illness or congenital disorders. Careful observation of the unrestrained foal ensures that the foal appears physically mature and mentally appropriate. Immature foals may exhibit a silky coat, lack mane and tail hair, have a domed forehead, display significant tendon and ligament laxity, and are often small.[1] Foals are assessed while walking and standing on a firm surface to identify any lameness or the presence of angular or flexural limb deformities. Umbilicus is examined for signs of herniation, infection or evidence of a patent urachus. Scrotum of male foal is palpated to determine if both testes are descended and for evidence of an inguinal or scrotal hernia. Additional common neonatal abnormalities include cleft palate, entropion, scleral hemorrhage, petechiation, and rib fracture. At this time, routine screening blood samples taken for hematology, proteins, IgG, plasma fibrinogen, and serum amyloid A may provide information on efficacy of passive transfer and early signs of disease such as neonatal isoerythrolysis or sepsis.[1]

If physical examinations do not reveal any medical or orthopedic abnormalities, the pair may be turned out into a small paddock. Regular turnout is beneficial for both, as exercise improves uterine clearance in the mare and aids in skeletal, muscular and orthopedic development of the foal.

Management and considerations

Colostrum

Quality of a mare's colostrum can be evaluated immediately postfoaling prior to foal nursing, using quantitative and qualitative methods. Quantitative measurement of IgG concentrations in colostrum can be obtained by a radial immunodiffusion assay

at a diagnostic laboratory.[2] Brix refractometers offer a mare-side qualitative measurement that correlates optical density of the sample with IgG antibody content. Measuring colostrum quality is not only a useful method to predict the likelihood of successful passive transfer but also to determine whether the colostrum is suitable for harvest and storage.

The practice of banking colostrum is especially useful in the treatment of failure of passive transfer before gut closure and prevention of neonatal isoerythrolysis in at risk foals. Colostrum donors should be screened to ensure that they do carry antibodies against equine red blood cells.[3] Even though immunoglobulin activity of frozen colostrum decreases over time, the nutrient value of older colostrum can be useful for neonates.

Postpartum complications and fertility

Postpartum complications may arise following a dystocia or the normal delivery of a foal. In these cases, accurate diagnosis is based on a comprehensive workup and rapid initiation of an appropriate therapeutic plan improves outcomes. The scope of these proceedings does not allow the necessary attention to the management of these conditions; therefore, the author directs the reader to an in-depth review of common postpartum problems.4 These conditions may not only be life-threatening but they can also be detrimental to future fertility.[4,5]

Delay in uterine involution is appreciable in cases of dystocia, trauma to the reproductive tract and retained fetal membranes.[6] Alternations in the normal involution process include an increased influx of neutrophils into the endometrium and a delay in the glandular redifferentiation to the pregravid state.[7] Consequently, these compromised mares have lower pregnancy rates when compared to normal foaling mares.[7] Regardless of the inciting cause, mares should be given adequate time to allow for uterine involution to proceed prior to rebreeding.

Uterine involution

Understanding the process of uterine involution is of clinical importance in the management of postpartum mare. Involution is a multifaceted process involving tissue remodeling, clearance of debris, contraction of endometrial glands, and transformation of the endometrium.[8] Mares are unique in that uterine involution occurs rapidly after parturition. In the normal mare, histological remodeling is complete by day 15 postpartum. Size of rapidly decreases during the first week postpartum and may reach the pregravid state within 23 days postpartum[9,10] In normal mares, transrectal ultrasonography reveals an echogenic fluid that begins to decrease at ~ day 5 and should be undetectable by day 15.[10] Uterine contractions aid in the expulsion of these luminal contents consisting of cellular debris and bacterial contaminates. Normal lochia is nonfetid and may vary from red-tinge to a yellowish mucopurulent. In mares with complications during pregnancy or parturition, uterine involution may be delayed.[7]

Although involution is functionally complete by day 7 and histologically complete by day 14, this process coincides with the first postpartum estrous cycle (foal heat) occurring between days 5 - 20.[8,11,12] Authors have reported up to a 20% decrease in pregnancy rates and an increased rate of early embryonic loss for foal heat breeding.[12,13] Day of ovulation, and the presence of intrauterine fluid have been implicated as factors negatively affecting reproductive outcomes associated with foal heat breeding. Mares ovulating at or beyond 10 days postpartum had higher pregnancy rates than those ovulating prior to day 10 postpartum even though uterine involution was not complete.[13] If ovulation and fertilization occur on day 10 postpartum, the embryo is sequestered in the oviduct for 5.5 days until uterine involution is complete.[14] By contrast, the uterine environment may not be able to support embryonic development when mares conceive prior to day 10 postpartum.[14] Presence of intrauterine fluid at the time of foal heat breeding was predictive of lower pregnancy rates.[10,15] Researchers have also demonstrated that advancing age had a significant effect on pregnancy rates and embryo loss for mare bred on foal heat.[12,15] Researchers in Brazil concluded that a mare older than 10 years of age should not be bred on foal heat if embryo loss is to be reduced and reproductive performance optimized.[15]

Reproductive examination

Reproductive examination of the mare is typically scheduled within first 10 days postfoaling. A visual and functional evaluation of perineal conformation and the vestibulo-vaginal sphincter may reveal evidence of urine pooling, pneumovagina, or foaling trauma affecting the caudal reproductive tract.[14] Routine vaginoscopy is an essential part of the examination as it aids in identification of cranial lesions and small rectovaginal fistulas. Manual palpation of the cervix may identify gross lesions, and if there is concern of cervical compromise, a follow-up examination should be performed during diestrus. Mares with poor perineal conformation or a prepartum episiotomy should have Caslick's surgery performed. A breeding stitch is warranted to protect integrity of the surgical site during breeding or while reproductive procedures are ongoing.

Transrectal palpation of the postpartum uterus allows assessment of uterine size and tone, whereas ultrasonography allows for evaluation of uterine lumen. Ultrasonography may reveal excess uterine fluid, flocculent debris, and also the presence of fetal membranes. In the normal postpartum mare, uterine tone is increased and > 90% of the uterus is palpable by day 5.[9] In contrast, a poorly involuted uterus is often large, atonic, and lacks the presence of palpable rugae. Presence of intrauterine fluid during uterine involution is a normal phenomenon.10 Repeat examinations are performed to monitor the depth and character of uterine fluid and therapeutic treatment, including ecbolic agents and uterine lavage may be initiated to aid in uterine clearance, based on clinician preference.[14] Exercise and access to turnout should also be encouraged to promote uterine clearance. In a normal mare, presence of intrauterine

fluid should resolve by day 15 postpartum and urine pooling should cease once uterine involution is complete.[10,16]

Follicular activity is assessed whether the mares is destined to be bred during foal heat or the second postpartum estrous cycle.

Endometrial cultures obtained during the first postpartum estrus will often be positive as the uterus is readily contaminated during parturition. Mixed bacterial growth is common with *Streptococcus equi zooepidemicus* being the most commonly identified organism.[17] Accompanying endometrial cytology is useful to differentiate between infectious endometritis and postpartum bacterial contamination and can help confirm normally progressing uterine involution.[11] Recently, the endometrial cytological changes of mares with normal and abnormal parturitions were evaluated.[18] Uterine neutrophil counts increased until day 4 postpartum, followed by a constant decline, and can thus be readily used to evaluate progress in uterine involution.

Postpartum uterine treatments

Higher pregnancy rates are reported in mares that are bred after day 10.[13] Therefore, strategies to improve fertility for the first postpartum estrous cycle focus on methods to delay first ovulation or hasten uterine involution. Regardless of the strategy, mares should have access to turnout as exercise will aid in uterine evacuation and improve gross involution.[19]

Multiple exogenous steroid regimens have been investigated, with varying results. Estradiol-17β alone did not delay the first postpartum ovulation.[20] However, a combination of estradiol-17β and progesterone was an effective means to delay and synchronize first postpartum ovulation.[21,22] Progestin supplementation effectively delayed ovulation and pregnancy rates were higher in mares that ovulated after day 15.[10,23] Although progestin supplementation may be an effective method to delay ovulation, there was no ultrasonographic evidence that it hastens uterine involution.[10] In mares with delayed uterine clearance, progestin treatment may be contraindicated.[14]

Myriad treatment protocols aimed at hastening uterine involution and improving pregnancy rates have been tested, including postfoaling uterine lavage and various ecbolic agents. In the normal mare, postfoaling uterine lavage substantially decreased endometrial polymononuclear cells but did not improve pregnancy rates or hasten uterine involution.[24-26] Repeated ecbolic treatment failed to reduce uterine size or improve reproductive outcomes.[27,28] Recently, researchers at the University of Gluck assessed effects of mycobacterium cell wall fraction (MCWF) on uterine involution; it decreased the interval to bacterial clearance and increased expression of proinflammatory cytokines.[29] These effects may reduce tissue inflammation, ultimately hastening tissue repair. Therefore, MCWF may be of value in the management of the foaling mare although effects on fertility are yet to be investigated.

Alternatively, the simplest approach to improve fertility after foaling is to forego foal heat. Prostaglandin treatment on day 5 postovulation will hasten the return to estrus. Researchers demonstrated favorable outcomes when comparing mares bred on the first postpartum cycle (foal heat) to mares bred on a prostaglandin-induced second postpartum estrus cycle, including a decreased rate of early embryonic loss and increased first cycle, seasonal, and per cycle pregnancy rates for mares bred on the prostaglandin-induced cycle.[30]

Considerations for breeding on foal heat

Breeding on foal heat is often a controversial topic amongst veterinarians and breeders. The decision is often based on anecdotal experiences and validated by citing selected literature supporting or condemning the practice. Increasing mare age, day of ovulation, and disturbances during the postpartum period delaying uterine involution are all associated with decreased reproductive outcomes.[6,10,13,15] To improve outcomes, breeding on foal heat should be avoided for mares with any of the aforementioned factors or any other conditions that may delay uterine involution. Nevertheless, foal heat breeding can be successfully implemented into breeding programs by abiding data-driven guidelines and strict selection criteria.

Pregnancy rates can be > 70% for mares bred on foal heat;[12,31] free range management of these mares may be an important factor contributing to the success of foal heat breeding.[12] As such, conditions affecting either the mare or foal that require stall confinement should preclude the mare from breeding on foal heat. As mare age has a substantial effect on reproductive outcomes, it is a key factor to be considered prior to breeding on foal heat.[12,32] Authors have suggested that mares > 10 years of age are not suitable for foal heat breeding.[15] Presence of intrauterine fluid is associated with lower pregnancy rates, regardless of reproductive status.[33] Although reports of early initiation of postbreeding uterine lavage may decrease early embryo loss for mares bred on foal heat, conflicting reports have demonstrated that the presence of intrauterine fluid, even with appropriate treatment at foal heat breeding, is associated with decreased reproductive outcomes.[12,34] Intrauterine fluid is a normal finding up to day 15 postpartum.[10] However, if intrauterine fluid is present at foal heat breeding, the author suggests that the mare should not be bred, as reproductive outcomes will be decreased. Ovulations occurring > 10 days postpartum are associated with improved foal heat breeding outcomes; thus, breeding on foal heat is not recommended for mares expected to ovulate prior to day 10 postpartum as histological involution will likely be insufficient to support pregnancy. Initiation of protocols designed to delay the first postpartum ovulation may be warranted for mares foaling late in the breeding season.[10]

Positive endometrial cultures are common amongst normal postparturient mares.[17] They are often associated with contamination during parturition and exhibit minimal effect with foal heat fertility.[35] An increased concentration of neutrophils

in endometrial biopsy was more indicative of poor foal heat breeding outcomes; however, logistical constraints preclude their use in clinical practice.[35] Serial endometrial cytology in combination with clinical findings may be a valuable method for determining suitability for foal heat breeding.[18]

Suitable candidates for breeding on foal heat include mares < 10 years of age, with free access to turnout, no periparturient disturbances and an absence of intrauterine fluid at the time of breeding with ovulation coinciding at ≥ day 10 postpartum. Breeding mares that do not satisfy these criteria should be delayed until at least the second postpartum estrous cycle to improve reproductive outcomes.

Management of postpartum anestrus

Postpartum anestrus occurs in mares foaling early in the season that are not exposed to supplemental light during late pregnancy. This phenomenon is most commonly observed in mares foaling in the northern hemisphere before April 1st or in the southern hemisphere before October 1st.[36] Often a normal foal heat and ovulation are observed, but ovaries subsequently become hard and inactive with a typical follicle measuring < 15 - 20 mm in diameter.[12,36]

Several hormonal regimes including GnRH agonists, progestins, the combination of progestins with estradiol, and dopamine antagonists have been utilized to restore cyclicity in the postpartum mare.[37,38] The author's preferred approach is based on firsthand experience using GnRH agonists or dopamine antagonists to successfully treat postpartum anestrus. Buserelin (GnRH agonist) treatment resulted in adequate ovulatory, pregnancy, and return to estrus responses.[38] Buserelin (12.5 µg, intramuscular twice daily) is recommended. Ovulation is induced with hCG once a dominant follicle ≥ 35 mm is identified. Buserelin is discontinued once ovulation is detected. Treatment protocols using dopamine antagonists, sulpiride (1 mg/kg, intramuscular twice daily) and domperidone (1.1 mg/kg, oral once daily) may also stimulate follicular development, ovulation, and luteinization of follicles in anestrus mares.[36,39] Ovulation can be induced with hCG or a GnRH agonist. A lack of follicular response within 21 days of treatment represents a failure of the mare to respond and treatment should be discontinued.

To reduce the incidence of postpartum anestrus, mares destined to foal early in the season or mares that have a history of postpartum anestrus should be under supplemental lighting during late pregnancy.[40] Lighting regimes should be initiated by December 15th for the northern hemisphere or June 15th for the southern hemisphere.[36] Positive effects of supplemental light are not limited to decreasing the incidence of postpartum anestrus; use of artificial blue light delivered via a mask worn by mares in late pregnancy improved the average birth weight of foals and decreased pregnancy length compared to controls.[41]

Common foal issues

Substantial time and effort are dedicated to the breeding process and the production of a foal, whether it is a destined to be an elite athlete or beloved companion. Unfortunately, numerous congenital and pathological conditions may affect the foal. Therefore, it is extremely important to provide proper veterinary care and attention during foal's growth and development. The following are commonly recognized conditions that may affect the foal.

Failure of passive transfer

An IgG concentration < 400 mg/dl is indicative of failure of passive transfer. IgG concentrations can be increased through the ingestion of good quality colostrum (> 23% BRIX) prior to gut closure, which occurs between 18 - 24 hours of age, or treatment of hyperimmune intravenous plasma transfer. Plasma may increase IgG concentrations by at least 200 mg/dl per liter. However, many insurance companies will require an IgG concentration > 800 ng/dl. Plasma transfusion reactions may occur that are evident by clinical signs including tachypnea, tachycardia, dyspnea, sweating, muscle fasciculations, fever, and sudden death.[42] Therefore, transfusions should be started slowly while patients are monitored. If clinical signs develop, transfusion should be stopped immediately.[43] Corticosteroid administration is helpful in decreasing inflammation.

Neonatal isoerythrolysis

Neonatal isoerythrolysis (NI) is an immunogenetic disease in which the maternal antibodies are directed against the foal's red cell antigens.[44] Although more common in multiparous mares, NI can occur with first pregnancy.[44] Ingestion and absorption of these antibodies causes hemolysis. Clinical signs appear between 24 - 36 hours postnursing and vary based on the severity and degree of anemia. Pale to icteric mucus membranes, lethargy, rapid to labored breathing, tachycardia, and seizure like activity may occur. In severe cases, death may ensue.

The condition is preventable. Mares at risk of producing an NI foal may identified by screening the pregnant mare's serum for anti-red cell antibodies or red cell typing based on the absence of factors Aa, Qa and Ua. Jaundiced foal agglutination (JFA) test may be utilized to detect the presence of maternal antibodies in the colostrum directed against red cell antigens.[45]

If the mare is at risk or JFA test is positive, the mare's colostrum should be stripped and discarded. During this time the foal should muzzled to prevent suckling from that mare. The foal should be given colostrum from a suitable donor. Feeding of the foal is supplemented for 24 - 48 hours or until a JFA test has determined that it is safe for the foal to begin nursing.

Rib fractures

During parturition it is not uncommon for rib fractures to occur. Rib fracture may involve a single or multiple ribs, unilateral or bilateral. Fractures most commonly occur at or near the costochondral junction involving ribs 2 - 7. If rib fractures are suspected based on auscultation or palpation, ultrasonography should be performed to confirm diagnosis and to determine the number and degree of rib displacement, and any evidence of hemorrhage.[46] Initiation of medical or surgical management is based on the number of ribs involved, degree of displacement and presence of pneumothorax or hemothorax. Conservative approach involving stall rest for up to 2 - 4 weeks and supportive care are often successful. One advantage of surgery is rapid stabilization of the fracture mitigating the risk further displacement and trauma to the lungs, heart, and diaphragm.

Flexural limb deformity

A musculoskeletal condition as a result of excessive tendon or ligament laxity or contracture affecting the normal position of the joint. Laxity and contracture may occur simultaneously affecting multiple limbs. Diagnosis is by observing the foal's walk and stand on a firm surface. Treatment is based on the severity of the condition. Analgesics, splinting the affected limb, toe extensions and oxytetracycline treatment have been utilized for tendon contracture. However, oxytetracycline may be nephrotoxic and is contradicted in a compromised foal.[47]

Tendon laxity will often improve with controlled periods of exercise as the foal gains muscle tone. Moderate to severe cases are recognized by the toe being elevated off the ground or the fetlocks being dropped. In these cases, heel extensions will support the fetlock joint.[48] Tendon laxity may be exacerbated by excessive turnout leading to muscle fatigue and administration of oxytetracycline.

Umbilical lesions

Umbilical infections, patent urachus, and umbilical hernia are common amongst foals. Ultrasonographic examination of the umbilical remnants is useful in diagnosis and management of suspected omphalitis.[49] The majority of cases will resolve within 3 weeks with medical management.

A patent urachus can be congenital or occur secondary to omphalitis. In uncomplicated cases a patent urachus will often spontaneously resolve. Topical application of silver nitrate may chemically cauterize and hasten the closure of the umbilical remnant. Surgery is indicated when umbilical infections and patent urachus do not respond to medical management.

Small umbilical hernias will often resolve; however, if the hernia has not resolved by 4 to 6 months, surgery or banding is often warranted.[50]

Septic joints

Joint infections should be the primary differential for a foal with an acute onset of lameness. Careful palpation of the affected limb may identify synovial distension. Foals with suspected septic joint require immediate veterinary attention and referral for intensive management that may improve outcome. Antimicrobial selection should be based on culture and sensitivity results of the synovial fluid. Broad spectrum antimicrobials should be initiated pending culture results. Hematology, serum amyloid A, fibrinogen and total nucleated cell count of the synovial fluid should be monitored to assess response to treatment. Intraarticular injection, reginal limb perfusion, and therapeutic lavage of the joint space may improve outcomes.

Management of the foal

Parasite control

Foal may invariably become infected with a number of helminths but *Parascaris* spp., commonly-known as ascarids or roundworms, are the most common and of clinical importance.[51,52] In addition to environmental exposure, the mare is another potential source of infestation for the foal. Ingestion of parasites may occur while suckling as the larvae may be present in the dam's milk, or due to coprophagy. Deworming the pregnant mare with an ivermectin-containing product 4 - 6 weeks prefoaling and 48 hours postfoaling is recommended to decrease the potential worm burden. Heavy ascarid burdens may cause weight loss, poor body condition, lethargy, colic, and the risk of life-threatening small intestinal impactions.[52] Migration of larvae is associated with signs of upper airway disease, including cough, and nasal discharge.[53] Heavy worm burdens of *Strongyloides westeri* (> 2000 eggs per gram) have been associated with severe foal diarrhea.[54]

Deworming programs should include anthelminthic treatments that are effective against adult, migrating, and encysted larvae with the intent of decreasing the potential overall worm burden. The following information is based on recommendations from the American Association of Equine Practitioner's parasite control guidelines. A minimum of 4 treatments during the first year of life, ~ every 3 - 4 months. Targeted therapy based on fecal egg counts is not recommended in foals. The first treatment given between 2 - 3 months of age should be efficacious against ascarids. Dewormers should subsequently be given every 3 - 4 months. At weaning, fecal egg counts may be utilized to differentiate between primarily strongyles or ascarids worm burdens. At ~ 9 months, use a product that is efficacious against tapeworms and ascarids.

Vaccination

Goal of prefoaling mare vaccination is to increase antibody concentrations in the mare's colostrum aiding in development of the foal's passive immunity. Absorption of immunoglobulins

offers protection against infections. As maternal antibodies may interfere with a foal's response to vaccination, the foal's vaccine schedule is based on whether or not a mare was vaccinated prepartum. The American Association of Equine Practitioner's vaccination guideline is available online and offers additional information and a comprehensive schedule for core and risk-based foal vaccinations.[55]

Conflict of interest

There are no conflicts of interest to declare.

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