Preparation of the Mare for Normal Parturition (21-Nov-2003)

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1. Introduction
The preparation of the mare for parturition has been discussed numerous times in the literature [1]. This paper will be limited to the standard practices employed during the third trimester in my Thoroughbred breeding farm practice in central Kentucky. I have attempted to choose topics that hopefully will be of interest to all veterinarians in reproductive practice, regardless of breed or region.

2. Management in the Final Trimester
In my 25 yrs as a veterinarian, I have seen the management of all horses move to decreased stall confinement and increased pasture turn out. This trend is certainly evident in the management of pregnant mares. Until the last month before foaling, most mares in my practice are either left out 24 h/day and fed outside or left out except for feeding in the stall twice a day. Broodmares, like all horses, thrive on routine; therefore, this schedule would be altered only in cases of extreme weather such as freezing rain or heavy ice. A few farms do put their pregnant mares under lights beginning December 1, which requires either stabling or using lighted paddocks. Two potential benefits of lighting pregnant mares are:

1. A decrease in the length of gestation by 7 - 10 days, which permits more time to breed the mare in the breeding season.
2. A decrease in the likelihood of postpartum anestrus [2].

Most mares will enter the foaling barn approximately 30 days before their expected foaling date. Exceptions to this practice include mares that are undergoing premature udder development or mares that have a history of premature foaling. After entering the foaling barn, the mare is generally turned out 6 - 8 h each day. During the day, the mares are observed in their paddocks approximately one time each hour. The majority of mares have undergone the Caslick's procedure either before breeding or shortly afterwards; therefore, the mares must be opened before foaling. Some farms will routinely open all mares at a standard time such as 2 wk before their due date. Other farms will open the mare when she begins to show signs of imminent foaling, e.g., waxing or running milk. After the mare has been opened, petroleum jelly will be applied to the vulva daily to prevent adhesions at the episiotomy site.

3. Monitoring Pregnancy
Veterinary care of the normal mare in the last trimester is very limited. All pregnant mares are examined for pregnancy by rectal palpation in late November or early December. Any mares found not pregnant are then added to the barren mares and put under lights. Unless abnormal clinical signs develop, no further examinations for pregnancy are performed. Throughout gestation, each mare is typically examined by a manager or groom twice a day for vulvar discharge and udder development. Abnormalities are noted and then brought to the attention of the veterinarian. After discussing the clinical signs and the mare's history, the veterinarian and the manager will decide if a veterinary examination is needed. This examination will first involve observation of the abnormalities noted. If udder development is deemed inappropriate for the stage of gestation or the vulvar discharge is significant, further examination will include rectal palpation and transrectal ultrasonography. In addition to confirmation of pregnancy, the rectal palpation will allow evaluation of cervical tightness, fetal position and movement, and amount of uterine distension. Transrectal ultrasonography will permit:
1. Measurement of the combined thickness of the uterus and the placenta (CTUP) at the cervix.
2. Evaluation of placental edema or separation.
3. Evaluation of allantoic and amniotic fluids.
4. Observation of the amnion and the measurement of its thickness.

Because the fetal heart cannot be imaged by transrectal ultrasonography during the last trimester, determination of fetal viability may require transabdominal ultrasonography, unless movement was evident on rectal palpation. Fetal heart rate has been used to monitor fetal stress in late gestation. A mean heart rate of 75± 7 beats/min has been reported with the rate decreasing as a function of gestational age [3]. Although the heart rate should be appropriate for the level of activity in the resting fetus, rates <50 beats/min and >100 beats/min have been associated with compromised pregnancies [4]. Abdominal ultrasound will also allow further evaluation of the placenta and the amnion as well as the umbilical cord.

Additional workup of mares with premature udder development or vulvar discharge may include assays for measuring total estrogens and progesterone. In my practice, the measurement of total estrogens has been a reliable indicator of fetal viability from 150 to 300 days of gestation. Total estrogens reflect the rise and fall in estrogen production by the fetal gonads and placental unit during mid-gestation. If the feto-placental unit is not functioning properly, total estrogen production will be affected adversely. It is important to measure both estradiol and its metabolites. From 150 to approximately 310 days of gestation, total estrogens should be >1000 ng/ml [a]. Levels <1000 ng/ml are an indication of fetal stress. Before 300 days gestation, total estrogens <500 ng/ml are commonly associated with a severely compromised or dead fetus. In these mares, I advise the client that treatment is unlikely to alter the outcome and abortion should be expected. Levels between 500 and 800 ng/ml indicate a compromised fetus that will successfully go to term in approximately 50% of cases. In these cases, I recommend therapy, which may include altrenogest at a double dose (0.088 mg/kg), pentoxifylline, and systemic antibiotics. I prefer not to pass a vaginal speculum in a mare with a potentially compromised pregnancy; therefore, if a vulvar discharge is present, I will culture the vaginal vestibule and choose the appropriate antibiotic based on this culture. In my experience, total estrogens between 500 and 1000 seem to be associated with mild stress, with the fetus going to term in approximately 75% of the cases. In these cases, I will start the mare on the previously mentioned therapy. When the total estrogens are <1000 ng/ml, I recommend repeating the total estrogens in 2 - 3 days. If the estrogens remain <500 ng/ml, I will recommend weekly total estrogens. A decline in the estrogens below 500 ng/ml is an indication of impending abortion in most cases.

Measurement of serial samples of plasma progestins may be used to identify impending abortion, premature delivery, or fetal stress between 250 and 305 days of gestation [5]. There are no specific radioimmunooassays or enzyme-linked immunosorbent assays (ELISAs) for measuring progestins. However, the progesterone assays cross-react with the progestins produced by the equine feto-placental unit. In the third trimester, normal progesterone levels range from 2 to 8 ng/ml in our laboratory, which uses an enzyme immunoassay test [b]. Progesterin values obtained from endocrine laboratories should be viewed as qualitative and not quantitative, because the results indicate cross reactivity with the assay. Therefore, results between laboratories will differ.

The feto-placental unit produces progestins from 90 days of gestation until delivery of the foal. Plasma progestins are stable and do not fluctuate until the last 3 wk of gestation; at that time, they will rise dramatically, falling only in the 48 h that precede delivery. The rise in progestins is a result of increasing production of pregnenolone (the precursor of progesterone) by the fetal adrenals. Because the fetal adrenals lack the enzyme needed to convert progesterone to cortisol, progesterone is reduced to progestins within the placenta and the fetal liver. A premature rise in progestins (before the last 3 wk of gestation) indicates fetal stress or premature fetal maturation. A premature fall in progestins is associated with an acute fetal crisis, which commonly results in abortion.

Progesterone assays should be performed every 2 - 3 days until a total of three have been performed. Comparing the relative change in values is helpful in advising the client in the prognosis of a normal foal. Levels that rise to >50% of your laboratory’s high normal and maintain or increase are an indication of ongoing fetal stress such as is seen in placentitis. These mares should be followed closely and considered as candidates for therapy. Levels that decline to 50% of low normal and maintain or decrease are an indication of severe fetal compromise or death. This has been seen in acute placentitis and after a medical crisis or surgical intervention. Measurement of progestins after day 305 of gestation must be interpreted with caution, because levels normally rise during this time.

4. Vaccination of the Pregnant Mare

Vaccinations of the pregnant mare are needed for two reasons: protection of the mare and future protection of the foal through passive transfer. The neonate relies on antibodies passed in the colostrum to provide the protection necessary to prevent disease until the foal can respond appropriately and be vaccinated; therefore, a proper vaccination program for the mare is essential for the health of the foal. Equally important is checking each foal to make sure that it has received adequate passive transfer from the dam. If failure of passive transfer is identified, the foal must receive colostrum or plasma from a vaccinated donor.
Mares are routinely vaccinated against the following diseases in our practice: influenza, rhinopneumonitis, tetanus, rabies, eastern and western encephalomyelitis, West Nile virus, botulism, and rotavirus. *Streptococcus equi* vaccination is used by a few farms with histories of strangles outbreaks. With all vaccines, it is essential to pay close attention to primary and booster vaccinations. With most mares in our practice, these initial vaccinations have been given before the mare’s entrance into the broodmare band. If vaccination history is in question, the mare should ideally receive primary and initial boosters before the third trimester. Vaccination of the mare 4 - 6 wk before foaling is recommended to ensure maximum concentrations of immunoglobulins in the colostrum for passive transfer to the foal. With our recommended vaccinations, this would require a total of 8 - 9 vaccinations. Because I prefer to vaccinate with no more than 4 vaccines at a time, I have moved vaccination with tetanus, rabies, and eastern and western encephalomyelitis vaccinations to the fall of the year or at least 60 days before foaling. This decision was made for rabies and tetanus, because it is known that vaccination against these diseases produces a strong, long-lasting antibody response [6,7]. This decision is supported by the report of no cases of either disease in foals in my practice. Encephalomyelitis has not been reported in central Kentucky since records have been kept at the Livestock Disease Diagnostic Center and therefore, is not considered a serious threat to our horse population. For this reason, I feel that it is reasonable to vaccinate for encephalomyelitis outside of the 4 - 6 wk pre-foaling window.

In my practice, I use a modified live virus vaccine for the prevention of rhinopneumonitis in the mare. Thus far, in 25 yr of practice, I have had only 3 positive herpes abortions, each being an isolated incident. Although the modified live vaccine is not labeled as an aid in the prevention of abortion, the experience in my practice supports its continued use in pregnant mares. Mares in our practice are vaccinated for rhinopneumonitis every 2 mo throughout the year, which means that each mare will be vaccinated within 2 mo of foaling.

Equine herpes virus type 1 (EHV-1) and equine herpes virus type 4 (EHV-4) cause respiratory tract disease, and EHV-1 also causes abortion. The modified live vaccine is an EHV-1 vaccine that is known to provide a good cross protection for EHV-4; therefore, it seems that foals from vaccinated mares are adequately protected from respiratory disease caused by EHV-1 and EHV-4 [8]. It is important to note that maternal protection from herpes virus respiratory disease declines by 4 - 5 mo [9]. We, therefore, recommend that vaccination for herpes virus in foals should begin at 6 mo in a closed herd (no contact with outside horses) and 4 mo in an open herd.

When vaccinating for influenza, it is important to use a vaccine that includes a viral strain isolated in the 1990s. We recommend that the influenza vaccine be given 30 days before expected foaling. Although intranasal vaccines have proven effective in preventing infection, an intramuscular form must be used before foaling to stimulate production of systemic immunoglobulin G (IgG) for passive transfer to the foal.

West Nile virus has now become a significant concern in many parts of the United States including central Kentucky. Our current recommendation is vaccination of the mare 30 days before foaling. Because type B botulism is endemic in central Kentucky, we recommend vaccination with the type B toxoid for all horses. Although botulism is a problem in all ages, it is most commonly seen in foals 2 - 6 wk of age and has been termed "shaker foal syndrome". Before the development of the botulism toxoid, a small but significant percentage of foals were lost to botulism each year. We now recommend vaccinating pregnant mares in the eighth, ninth, and tenth month of gestation. In years subsequent to this series, a single booster given 30 days before foaling stimulates adequate production of colostral IgG for passive transfer to the foal. Loss of foals from properly vaccinated mares has been virtually eliminated.

A vaccine for rotavirus group A (inactivated H2 strain) was approved in 1996 and has been used by the majority of farms in our practice since becoming available. Clinical trials have shown a decreased incidence and a decrease in the severity of clinical signs in foals from vaccinated mares [10]. My clinical impression supports these studies. Vaccinations are recommended in the eighth, ninth, and tenth months of gestation each year before foaling. The need for a series of three vaccinations each year versus a single booster 30 days before foaling has been questioned by some practitioners. I recommend to my clients that three vaccinations be used for optimal protection of the foal. In a closed herd (no entry of new horses), a single yearly booster may be adequate.

### 5. Antibody Screens for Neonatal Isoerythrolysis

Neonatal isoerythrolysis (NI) is a disease seen in approximately 1 - 2% of the equine population. Cases occur when foals ingest colostrum containing antibodies, and it reacts with red blood cell types that the foal inherited from the sire. The mare produces antibodies in response to transplacental hemorrhage in late gestation or placental hemorrhage during foaling; in rare cases, sensitization may occur after administration of homologous tissue vaccines or after blood or plasma transfusion [11]. In our practice, all mares are screened for antibodies to red blood cells before foaling. This screening test has been effective in preventing NI. Although mares carrying their first foal are unlikely to test positive, a small percentage have been found to react; therefore, primiparous mares are also tested.

It has been shown that the earliest detectable antibodies to red blood cells are found during the eighth month and the latest detectable antibodies to red blood cells are found during the tenth month of gestation [12]. In 1975, researchers found that the best time to check for erythrocyte antibodies is during the last 2 wk of gestation [13]. In our practice, we have found that
testing >4 wk before parturition can lead to false negatives. We recommend testing 2 wk before expected foaling, and if a mare has not foaled within 4 wk, we retest. When a strong positive is found, we immediately notify the client and recommend that the foal not receive colostrum from the mare. Donor colostrum that is negative for antibodies should be given to the foal, and replacement milk should be fed for the first 24 - 36 h until the mare's milk does not cross react with the foal's blood. During this time period, the mare should be milked every 2 h, and all milk should be discarded. When a mare's blood tests as a weak positive, we recommend rechecking the mare in approximately 1 wk. If the titer is found to be rising, we advise that the mare's colostrum be withheld from the foal. If the test remains weak, weekly rechecks should be done; the positive antibodies are probably from a previous pregnancy and are unlikely to cause erythrolysis, but crossmatching at the time of foaling is recommended as a safeguard.

Blood groups Ca, Aa, and Ua are the most common reactors in our laboratory. In 2002, we performed 2710 antibody screens at Rood and Riddle Equine Hospital. Of these, 206 were positive for Ca, 59 were positive for Aa, 22 were positive for Ua, 7 were positive for Qa, 2 were positive for Da, 2 were positive for Ka, 1 was positive for Pa, and 1 was positive for Ca and Ua. It is important to note that antibodies to the Ca blood group are not associated with NI (investigators are not certain why Ca antibodies do not cause erythrolysis) [c]. These Ca antibodies can cause a problem in crossmatching tests by producing false positives [14]. In cases when the colostrum is crossmatched with the foal's red blood cells, the technician should be aware that the mare is producing anti-Ca antibodies that could cause a weak background reaction.

6. Nutrition

I will discuss only general guidelines for nutrition in the last trimester. Although nutritional requirements have been established for pregnant mares, [15]. I feel that there is much that we do not know. Feed requirements for the late gestation mare are met by a combination of concentrates, hay, and pasture. Each component of the diet should be carefully analyzed when formulating the nutritional program of the pregnant mare.

In central Kentucky, excessive nutrition is far more common than inadequate feeding. Excessive nutrition during pregnancy in combination with stress has been suggested as a cause of reproductive problems including placental disease and placental edema [16]. Recently, excessive protein in the diet of pregnant mares was offered as a possible cause of Mare Reproductive Loss Syndrome [17]. Although these proposed theories have not gained broad support, it is apparent that research to substantiate or refute these theories is greatly needed.

The mare should receive 2.25 - 2.5% of her total body weight in feed. During gestation, the average 1200 lb Thoroughbred mare gains between 175 and 225 lb. [18]. Because the majority of this gain occurs in the last 3 mo of gestation, proper nutrition at this time is critical. Evaluation of the mare's body condition is probably the best guide to the quality of the nutritional program [21]. Although obese mares are not desirable, there is now less concern about excess weight gain in late pregnancy [18]. Mares in moderately fleshy to fleshy condition have been shown to have higher live-foal rates and to produce more milk than thinner mares [19].

The total diet should contain 12 - 14% crude protein. [18]. The percent of crude protein in the hay, concentrates, and pasture must be evaluated to achieve the desired percentage of protein in the diet. Because the alfalfa hay that is commonly fed in central Kentucky may contain as much as 20% protein and the spring pasture may exceed 20% protein, the total protein in the diet of pregnant mares in central Kentucky may be far greater than the recommended 12 - 14%. Research should be done to determine the effect of this excess protein on the pregnant mare.

Analysis of the hay, concentrate, and pasture should be available to calculate the amounts of each needed to provide an adequate calcium and phosphorous balance. The desired Ca to P ratio during the last trimester is 1.2 - 1.5:1. Alfalfa hay has high levels of calcium with possible Ca to P ratios of 5:1. If alfalfa was the only hay being fed, it would be necessary to feed a concentrate with a high phosphorus content to achieve the correct Ca to P balance. Nutritionists have advised me that Ca to P ratios up to 3:1 are thought to be safe, with the understanding that the diet contained 0.35 - 0.4% phosphorus. It has been theorized that diets high in calcium could cause an increase in calcitonin production, which could lead to the development of osteochondritis in the foal [20]. A controlled study on the effects of excess calcium in the diet of pregnant mares is needed to confirm the safety of high calcium diets.

The greatest amount of mineral retention takes place in the fetus during the tenth month [21]. Trace minerals, such as copper and zinc, are essential for normal bone development; therefore, it is critical that the mare ingest adequate quantities of minerals in late gestation for normal fetal growth. Because mare's milk contains minimal trace minerals, the fetus must also store minerals to draw on after birth [22]. No advantage to foals was shown when mares were fed minerals in amounts greater than normal requirements [21]. However, some researchers have suggested that feeding higher levels of copper and zinc may help prevent the development of osteochondritis [23]. Again, it is apparent that more research in the nutritional requirements of the pregnant mare is needed.

7. Conclusion

The intent of this paper has not been to cover all aspects of preparation for normal foaling, but rather to discuss selected areas
of the author's practice that might be of interest to practitioners in other geographic regions. When reading this material, it is important to keep in mind the regional differences that may dictate changes in practice. Management policies must be made based on economics, available resources, and capabilities of personnel. Advances in the monitoring of pregnancy are ongoing, and the veterinarian must stay abreast of new technology. Vaccination programs must be appropriate for the individual farm and for the region. Because proper nutrition is critical to the success of any breeding operation, regularly scheduled consultation with a qualified nutritionist is highly recommended. In closing, it should be stressed that a strong partnership between the veterinarian and the farm manager is necessary to maximize the likelihood of producing a healthy foal.

Footnotes
[b] Progesterone test, Tosoh Medics, Inc., South San Francisco, CA 94080.

References

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