

How We Induce the Normal Mare to Foal

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The induction of foaling enables practitioners to attend the foaling and provide assistance. Induction also reduces nightly foal watches by the owner. Methods to ensure fetal viability are needed to aid the practitioner when deciding to induce the mare. This paper discusses our experience with this technique over the past decade. Authors' address: Dept. of Animal and Poultry Sciences, College of Agriculture and Life Sciences (Jack) and Dept. of Large Animal Clinical Sciences, Virginia-Maryland Regional College of Veterinary Medicine (all other authors), Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. © 1998 AAEP.

1. Introduction

Normal gestational length can vary widely in the mare. Most mares foal during nonbusiness hours for horseowners and practitioners. Thus many sleepless nights can be spent waiting for the mare to foal. Physical signs of the mare's approaching readiness for birth include udder enlargement with the presence of colostrum (milk) in the teats, waxing of the teat ends, and relaxation around the tail head, buttocks, and lips of the vulva.¹ While helpful, none of these signs are accurate as a means of predicting when the mare will foal. The monitoring of prefoaling milk (mammary secretion) electrolyte changes increases the ability to predict the mare's approaching readiness to foal.¹⁻⁴ These electrolyte changes, especially with regard to calcium level, have also been shown to be related to the development of maturity of the foal *in utero*, and its subsequent survivability (viability) following a normal delivery.⁵

The FoalWatch test kit^a has been used extensively by us for 10 years and has proven useful in the

routine management of foaling mares. Its intended use is to assist the practitioner in determining when the mare is approaching readiness to foal, based on changes in the prefoaling mammary secretion (milk) calcium carbonate (CaCO₃) level.⁶ It is a clinical tool that aids in the determination of when the practitioner should attend the mare's foaling, without an excessive number of sleepless nights. Alternatively, it can be used as a tool for the accurate prediction of when the elective induction of parturition may safely be initiated. The advantages of this kit include its accuracy and repeatability compared with other test kits (or test strips) available on the market,^{b,c} its ease of use, its quantitative determination of the CaCO₃ level in each sample of prefoaling milk tested, and its economy.² When the kit is combined with a known breeding date, a gestation length greater than 330 days, physical examination findings consistent with the mare's readiness for birth, and an appropriately elevated mammary secretion of CaCO₃, few untoward complications have been encountered. This article is a general descrip-

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tion of how we use the prefoaling mammary secretion CaCO_3 testing procedure with client mares.

There are several protocols for the induction of parturition in the mare that vary in action and time of onset to delivery. The three main methods reported for the induction of foaling are the use of oxytocin, prostaglandin $\text{F}_{2\alpha}$, and dexamethasone.^{1,7-9} Oxytocin is generally considered the drug of choice for inducing parturition in the mare. It is associated with a rapid effect. Foaling usually occurs within 15–90 min of its administration. Various doses and routes of administration of oxytocin have been used to induce foaling. A dose of 2.5–5 IU will cause a slower progression toward delivery, whereas a dose of 100 IU will initiate a more rapid delivery response. Oxytocin can be given by subcutaneous, intramuscular, and intravenous routes. One disadvantage of oxytocin is that it can override the physiologic events responsible for normal parturition without consideration for fetal maturity. High doses of oxytocin can increase the incidence of perineal tears, uterine rupture, fetal cerebral vascular accident, fetal hypoxia, and premature placental separation.

2. Methods

It is best to begin sampling the mare for mammary secretions approximately 10–14 days in advance of the mare's predicted foaling date (calculated as 335–340 days from the last known breeding date). In mares with an unknown breeding date, testing should begin as soon as some udder enlargement is noted and a small amount of secretion can be obtained from the teats without undue effort. It is best to keep a close check on udder development on a daily basis and practice massage of the mare's udder and teats to allow her to get used to your presence in this area. Once a day sampling is sufficient until values of CaCO_3 exceed 100 ppm (parts in 10^6). Thereafter, twice daily sampling is recommended. A more accurate assessment of the mare's readiness to foal will be from daily, late afternoon to early evening sampling. Since a few mares will foal in the daytime, a morning sampling should not be neglected and is highly advisable when CaCO_3 values first exceed 100 ppm.

The testing procedure involves wiping the udder and teats with a clean, dry, soft paper towel prior to attempting to collect a sample. This reduces the amount of skin debris and dirt that might contaminate the sample. This step is strongly recommended if the mare has been out in the weather and is wet. The hands of the person doing the sampling also should be clean and dry. If possible, 2–5 ml of prefoaling mammary secretion should be obtained per mare. It should be collected in a clean manner by gently stripping a small amount from each teat, using thumb and index or middle finger, into a clean plastic test tube or other sampling cup. The cup or test tube can be reused if it is thoroughly cleaned,

rinsed with distilled water, and then air dried between uses.

Product insert directions for use should be followed as described. Briefly, a syringe is used to measure 1.5 ml of the sample. All of the measured sample is placed into a test cup and diluted with 9.0 ml of distilled water. This ratio of 1 part mammary secretion to 6 parts distilled water is important since it brings the potential calcium level to within range for testing. This must be carefully and accurately performed at all times. After the dilution is completed, one or two drops of an indicator dye solution (supplied in the test kit) is added to the test sample. With the tip of the Titret^d pipe immersed in the sample solution, press the device control bar firmly, but briefly, to pull in a small amount of sample fluid. The fluid in the glass Titret chamber will turn orange to pink. Press the control bar again briefly to allow another small amount of sample to be drawn into the tube. After each sample addition into the glass Titret chamber, rock or invert the entire Titret apparatus to mix the fluid contents. Watch for the color to change from orangish pink to blue. At the transition stage, you may first note a slight grayish discoloration, or the solution in the chamber might appear to be colorless. Repeat aspiration of small aliquots until the desired color change (i.e., sky or azure blue) is detected and remains without reverting back to pink. Invert the glass Titret and read the scale directly at the fluid meniscus. If bubbles are present in the solution, stand the vial upright for a few minutes and read the scale again. There may be a slight alteration in the actual value once the bubbles have disappeared. Base your estimate of the actual value on the bubble-free reading, estimated to the nearest premarked line on the scale (ppm of CaCO_3). Do not recalculate the concentration back to the raw sample, as all interpretations are based upon the CaCO_3 in the diluted (1:6) sample.

When the prefoaling mammary secretion CaCO_3 first equals or exceeds 200 ppm, there is a 51% probability that foaling will spontaneously occur within the next 24 h, an 84% probability that foaling will occur within 48 h, and a 97% probability that foaling will occur within 72 h.⁶ The majority of mares spontaneously foal within a short period of time when a value of 300–500 ppm of CaCO_3 is obtained. However, not all mares can be expected to reach these higher values. For mares that have not yet reached 200 ppm, there is a 99% probability that foaling will not occur within the next 24-h period.⁶

All mares that were induced to foal under our supervision had met the minimum criteria defined above. Their tails were wrapped, their perineum was washed with soap and water, and they were placed in stalls bedded with clean straw. In most mares, a prefoaling evaluation was performed by using transabdominal ultrasonography to observe fetal activity, allantoic and amniotic fluid echo-

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genicity and volume, and to obtain a fetal cardiac rate. Some mares additionally received prefoaling manual vaginal examination to determine relaxation of the cervix, but not all mares received this prior to the initiation of induction. We have used the following method for 6 years for the induction of foaling: Fenprostalene^e (0.5 mg SQ) followed in 2 h with low-dose oxytocin (2.5 IU IV, at 15- to 20-min intervals until initiation of stage 2 labor). Our total dose of oxytocin did not exceed 20 IU. The withdrawal of Fenprostalene from the veterinary market necessitated its elimination from our induction protocol. Currently, we use only oxytocin at 2.5 IU per dose at 20-min intervals to effect stage 2.

3. Results

Some mares are resentful of being milked, especially if they are maidens. Make this a pleasurable experience for the mare; offer her some grain while collecting the sample. The more comfortable the mare is with her udder being touched and massaged, the greater the likelihood will be that she will accept her foal attempting to do the same. It is not unusual for maiden mares to fail to develop much of an udder prior to foaling, in which case one's ability to obtain a sample for testing will be greatly diminished. Colostrum is typically a very thick, honey colored, sticky secretion. This is an appropriate sample to recover, as calcium levels will be detectable just as with more normal-appearing milk.

Obtaining the small sample volume that was required for testing, on a once to twice daily basis, for the 10–14 days before foaling did not deprive the foal of any significant amount of colostrum or its antibody content. All foals have been monitored during the past 10 years of use of this test, and in no case has a failure of passive transfer been attributed to the sampling protocol. In like manner, the quality of the mares' colostrum was not affected. Mares that were prone to running milk prior to foaling did so whether they had been sampled for testing or not. Such mares were still at risk of losing too much colostrum prior to foaling and were managed accordingly.

The procedure of prefoaling mammary secretion sampling slightly increased the risk of mastitis development (one mare in 100 total). This is true for any animal when milking is performed by hand, especially if precautions are not taken to wipe the skin and teat surfaces clean and to dry them prior to obtaining the sample. When clumps of cellular debris, or pink to red discoloration in the milk sample obtained from the mare is noted, then a proper diagnostic work-up and treatment is warranted.

A repeated sampling of well over 100 pregnant mares during their last 10–30 days of gestation has been judged by us to be an innocuous procedure. There have been no alterations in normal behavior or prefoaling activities. It is cautioned that premature or precocious lactation, inappropriate to an

individual mare's gestational length or expected foaling date, may be attributable to placentitis and the potential for premature parturition of a septic neonate.¹⁰ An analysis of sodium and potassium mammary electrolyte concentrations in addition to calcium in such high-risk pregnant mares is helpful. In pregnancies with placental pathology and a precocious elevation of mammary secretion calcium, the sodium–potassium relationship can help to assess fetal *in utero* maturity; a sodium level that is less than that of the potassium (i.e., sodium–potassium inversion) is a further indication of fetal maturity.¹¹

Mares that have been exposed during the last 60–90 days of gestation to fescue grass infested by *Acremonium coenophialum* may suffer from the toxin(s) that are produced within the grass.¹² Such mares very often suffer agalactia and fail to exhibit normal udder development prior to foaling. Without a sample for testing, this method will be of little help to predict the time of induction.

In every case, the induction of foaling was performed when the prefoaling CaCO₃ level exceeded 200 ppm on the first or second test. This usually meant that the mares were induced within 4–24 h of the first event when CaCO₃ exceeded 200 ppm. Inductions were smooth, the mares were quiet, and they were often under the observation of from two to 15 students plus one or more clinicians during the entire process of labor and delivery. All inductions were scheduled for daylight hours, usually in the late afternoon. The average time from onset or initial oxytocin administration to initiation of stage 2 labor (i.e., rupture of the allantochorionic membrane) was 45 min. This meant that an average of two doses (2.5 IU IV, 20 min apart) of oxytocin were administered per mare.

Premature placental separation was noted in 10% of the mares (10/100). This was immediately recognized and treated without undue complication to the viability of the foals during their neonatal periods. The dystocia rate was 5% (5/100), with most related to the retention of one forelimb at the carpus or shoulder or presentation of the poll (nose down). All dystocias were recognized early and corrective manipulations were performed easily and rapidly, allowing the delivery of healthy foals. No foals or mares were lost as the result of the induction procedure.

4. Discussion

This clinical test does not predict the actual foaling time of the mare and should not be expected to be 100% accurate in all mares. As with many biological systems, variations occur. Few clinical tests have the ability to be consistently accurate and reliable with regard to a prediction of future events in all situations.

It was not unusual for some mares to reach 100–175 ppm CaCO₃ and remain at that level for several days before proceeding to 200 ppm, or above. Variations occur between mares, and even within the

same mare from year to year. Patience and careful monitoring on a once to twice daily schedule are a must. A dramatic rise, or significant change in value, over a 12- to 24-h interval indicates that the mare is approaching readiness for birth. Occasionally a value would drop from the previous day's sampling; this was not a cause for alarm. Repeating the test, being certain that the dilution technique was accurate, carefully drawing up only small increments of the diluted sample, inverting the Titret several times between each aspiration, reading the scale with each repetition, and observing for the color change were steps employed to ensure consistency and accuracy. Numerous students and clients were trained in the use of the test. The majority indicated the test to be useful but did require some proficiency to make it repeatable.

In a recent study¹³ evaluating three methods of oxytocin-induced foaling in the mare, it was noted that the incidence of premature placental separation (PPS) was 38% (e.g., six mares experiencing PPS out of 16 total mares induced to foal). That study used one of three protocols for induction: (a) 75 IU of oxytocin by a single intramuscular injection; (b) 15 IU of oxytocin by an intramuscular injection at 15-min intervals for a maximum of five injections or rupture of the chorioallantois; or (c) 75 IU of oxytocin diluted in 1 L of physiologic saline administered by intravenous injection at 1 IU/min until rupture of the chorioallantois. In our experience, with the use of comparatively smaller dose (i.e., oxytocin 2.5 IU IV at 15- to 20-min intervals until rupture of the chorioallantois or a total of 20 IU of oxytocin), the PPS incidence was 10%.

We have found the technique as described here to be a useful instructional tool for veterinary students. In the hands of clients, the prefoaling mammary secretion testing gives them something more active to do than just watch, and it gets them closer to the mare in more ways than one. From a clinical standpoint we would not induce a mare without knowing her pattern of mammary secretion of CaCO₃ for at least the previous 12 h and preferably 24 h. The induction protocol itself is safe and predictable. Our immediate attendance ensures that all foaling difficulties are quickly recognized and corrected prior to any threat to the life of mare or foal. Inductions during routine working hours also ensure that support personnel are (or should be) readily available should additional more intensive measures be necessary (anesthesia, cesarean section, neonatal intensive care, etc.). We have not found these to be necessary in any but a very few circumstances

(1/100). Whether similar support measures would have been required given a spontaneous foaling (cf., induced) is a matter of conjecture. We believe in retrospect that they would have been.

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^bPredict-A-Foal, Animal Healthcare Products, Vernon, CA 90058.

^cSofchek, Environmental Test Systems, Elkhart, IN 46514.

^dTitret, CHEMetrics Inc., Calverton, VA 22016.

^eSyntex Animal Health, Division of Syntex Agribusiness, Inc., Palo Alto, CA 94304.