Rebreeding the Post-Partum Mare

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The mare is unique amongst domestic animals in having a short interval from parturition to first ovulation.[1] The 'foal heat' is defined as the estrus that occurs within the first 20 days after foaling.[2] Behavioral estrus usually begins 5 to 12 days after foaling, while the average day of ovulation is 10 to 13 days post-partum, with a range of 7 to 20 days.[3] It is estimated that 85 to 95 % of mares ovulate within the first 20 days after foaling.

The gestation length in the horse is approximately 340 days and the interval from foaling to pregnancy for mares initially bred on their foal heat is approximately 25 days.[4] Consequently, to maintain a 12-month foaling interval and produce on average a foal per year, mare owners need to consider foal heat breeding options. The seasonal pregnancy rate for mares bred on the foal heat has been reported to be comparable to that of mares bred on later heat cycles, indicating that there is no disadvantage in considering a foal heat breeding.[2] Breeding mares on the foal heat was noted to increase the odds of foaling mares conceiving by the end of the season by a factor of 2.04 compared to mares not bred at the foal heat.[5]

Routinely waiting until the second (30-day) heat to begin breeding will inevitably result in a longer foaling-to-conception interval and an annual gradual drift toward a foaling date later in the season. A retrospective study in Thoroughbreds revealed that 69 % of mares foaling on consecutive years drifted an average of 13 ± 23 days later in the subsequent year.[6] Owners that choose not to breed mares on the foal heat must accept the fact that mares will have to be left open for a season every 3 to 6 years when the potential foaling date becomes too late in the season to be acceptable.

Pregnancy and Pregnancy Loss Rates

Pregnancy rates for mares bred at the foal heat have been noted to be lower and pregnancy loss rates higher than for mares bred on a subsequent heat in a majority of reports (Tables 1 and 2).[2] Pregnancy rates have been reported to be higher for mares bred on the foal heat if ovulation occurred after day 10 than mares that ovulated on or before day 10 in some studies,[2] but not in others. Blanchard and coworkers noted an increased odds ratio for pregnancy loss in mares bred before day 13 postpartum.[7] Meyers and colleagues reported that mares bred on the foal heat were 1.9 times more likely to experience pregnancy loss than mares bred on a later heat.[8]

Table 1. Reports of Pregnancy Rates for Mares Bred on the First Post-Partum Estrus (Foal Heat) Versus the Subsequent Estrous Cycle.

Study	Foal Heat		Subsequent Heat	
	(n)	Pregnancy Rate (%)	(n)	Pregnancy Rate (%)
Loy[2]	252	50.0	219	58.9
Lieux[9]	304	39	490	55
Saltiel et al[10]	24	50.0	12	50.0
Lowis and Hyland[11]	96	47.9	58	55.2
Camillo et al[12]	253	71.9	26	84.6
Morris and Allen[13]	210	57.6	560	65.9
Blanchard et al[14]	399	72.2	158	75.9

Table 2. Reports of Pregnancy Loss Rates for Mares Bred on the First Post-Partum Estrus (Foal Heat) Versus the Subsequent Estrous Cycle.

Study	Foal Heat		Subsequent Heat	
	(n)	Pregnancy Loss Rate (%)	(n)	Pregnancy Loss Rate (%)
Loy[2]	126	12.7	280	11.4
Lieux[9]	103	16.5	232	13.8
Chavalier-Clément[15]	670	7.5	629	4.4
Lowis and Hyland[16]	80	10.0	52	3.9
Morris and Allen[13]	210	9.5	560	7.1
Miyakoshi et al[17]	389	11.1	531	3.8

A current recommendation in clinical practice is to not breed foal heat mares before the tenth day post foaling; if a mare does ovulate prior to day 10, it recommended to administer prostaglandins 6 days post ovulation to short cycle and breed on the subsequent heat.[18]

Mare age also has a significant effect on fertility in post-partum mares, with mares greater than 14 to 16 years of age having a lower foal heat pregnancy rate than younger mares.[5,14]

In most breeding programs, foaling mares constitute more than 50 % of the population.[1] Management plans for rebreeding the post-partum mare are based on owner goals, presence or absence of foaling or post-partum complications, ovarian function in the post-partum period, stallion availability and other factors. The goal of this review is to

discuss physiologic events and management options for re-breeding the post-partum mare.

Considerations for Foal Heat Breeding

Dystocia. Dystocia occurs in approximately 4 to 11 % of equine births.[4,19] The average duration of Stage II of labor is approximately 17 minutes with most foals delivered within 20 to 30 minutes after rupture of the chorioallantoic membrane. Prolonged labor, severe bruising, lacerations, or hematomas of the reproductive tract during spontaneous delivery, trauma secondary to dystocia or obstetrical manipulation, and hemorrhagic episodes can all adversely affect uterine involution, fertility or breeding decisions in the early post-partum period. It is important to perform a thorough reproductive examination on all foaling mares by 7 to 8 days post-partum, including examination of the external genitalia, vaginal speculum examination, manual digital examination of the vagina and cervix, as well as transrectal palpation and ultrasound.

Retained Fetal Membranes. Expulsion of the fetal membranes (chorioallantois, amnion and umbilical cord) usually occurs within 30 minutes to 2 hours after foaling. In the mare, a 'placenta' is considered to be abnormally retained beyond 3 hours post-foaling.[20] Retention of the fetal membranes is more common after dystocia, abortion, prolonged gestation, induction of labor and obstetrical procedures, and the overall incidence rate is 2 to 10 % in the general horse population. Retained placenta may predispose mares to systemic diseases such as metritis and laminitis, as well as adversely affect fertility in the early post-partum period. Retention of the fetal membranes longer than 3 hours may result in decreased pregnancy rates in mares bred at the foal heat. Ishii and colleagues[21] reported foal heat pregnancy rates of 50% and < 20 % for Thoroughbred mares that passed their placentas in less than 3 hours and greater than 3 hours, respectively. Consequently, it is recommended that early prompt treatment be initiated to remove retained fetal membranes both for the health of the mare and to optimize her reproductive potential.

Excessive Lochia. The term lochia refers to placental fluid, inflammatory cells and debris remaining in the uterus after foaling. Mares normally pass a small amount of turbid red-brown non-malodorous lochia fluid for several days after foaling. A small amount of fluid may be observed in the uterine lumen during ultrasound examination for the first 3 to 6 days after foaling, after which the fluid volume should reduce significantly.

There is no clinical need to treat a mare for the presence of a normal amount of lochia discharge early in the post-partum period. However, a prolonged duration of lochial discharge, an abnormal odor or character to the discharge, or an increased volume or echogenicity of lochia within the uterus visible on ultrasound examination beyond 5 to 7 days after foaling are all abnormal and may decrease fertility or increased embryonic loss in the early post-partum period.[22] In these circumstances, a therapeutic uterine lavage along with administration of oxytocin should be considered. Exercise may also be helpful for uterine involution and evacuation of uterine fluid in post-partum mares.

Uterine Involution. The term involution has been used to describe the restoration of the uterus to a pre-gravid state, and includes expulsion of uterine fluid and debris, a reduction in uterine size, and regeneration of the endometrial lining of the uterus.[23] In a study evaluating uterine involution, biopsy of the uterus the day after foaling revealed distinct microcaruncles, distended endometrial glands and marked edema. Re-evaluation seven days after foaling showed that microcaruncles were no longer present, the luminal epithelium was intact and the endometrial glands were no longer distended, indicating that uterine involution was complete.

The previously gravid horn remains larger than the contralateral horn for approximately 3 weeks after foaling. Histologically, the endometrium returns to normal by 14 days post foaling.[24] The endometrium of the mare sustains only limited damage as a consequence of pregnancy, foaling and passage of the placenta. This has been attributed to the non-invasive diffuse epitheliochorial placentation of the horse.

Culture and Cytology. Culture of the uterus of post-partum mares commonly results in growth of *Streptococcus equi* subsp. *zooepidemicus* and/or *Escherichia coli*.[25,26] In some reports, a decrease in foal heat pregnancy rate was noted in mares with a positive uterine culture, whereas other studies did not note a difference in pregnancy rates based on the presence or absence of bacterial growth. Mares with a positive culture on their foal heat typically have a negative culture on the subsequent heat. Ultimately, there is no clear relationship between results of culture and pregnancy rates in mares bred on the foal heat.

Post-partum mares also exhibit considerable variability in the amount of inflammation present in the uterus as determined by the number of inflammatory cells in cytologic samples.[25,27] There is not a clear relationship between the presence or absence of inflammatory cells in a sample collected during the foal heat and the potential for generating a pregnancy at a foal heat breeding.

The post-partum period is the only period in the life of a mare in which the presence of bacteria (i.e. *Streptococcus* sp. and *E. coli*) on culture and white blood cells on cytology may have limited clinical relevance. If a stallion owner requires a ‘clean culture’ prior to a live cover, it is anticipated that many foal-heat mares will be disqualified. If present, the bacteria and inflammation will usually be eliminated during and/or after the foal heat and a subsequent culture should be negative and cytology clean on the 30-day heat. The author’s current recommendation is that decisions regarding foal heat breeding should not be based solely on endometrial cytology or culture samples collected early in the postpartum period.

Cervical Function. Speculum examination of the vagina early in the post-partum period may reveal a reddened or hyperemic cervix,and a cloudy discharge. The cervix of a post-partum mare remains relaxed and open until after the first ovulation, whether that is on the foal heat or a subsequent heat. Closure of the cervix is due to an elevation in serum progesterone levels that occurs after the first post-partum ovulation. Lacerations

or bruising of the vulva, vestibule, vagina and/or cervix are relatively common in the post-partum mare and may be a reason to pass on a foal heat breeding.

Ovarian Function. Ovarian follicular development is usually present in mares during late pregnancy and mares may have small (10 to 15 mm) to medium sized (20 to 25 mm) follicles the day of foaling. Reproductive function in the post-partum mare follows one of three general scenarios:

- Development of a large follicle, with associated behavioral estrus and uterine edema, and ovulation in the foal heat period followed by ovulations at normal 21-day intervals;
- A foal heat ovulation followed by a regression into anestrus before eventual resumption of follicular activity;
- Limited to no follicular development in the post-partum period, with eventual initiation of follicular activity and ovulation;

Post-partum anestrus is a term used to describe mares in the latter two scenarios. Affected mares may remain anestrus for weeks or months before cyclic ovarian activity is initiated. A majority of mares that experience post-partum anestrus will resume cycling in the late spring (i.e., April or May in the Northern Hemisphere). It has been reported that up to 27 % of foaling mares exhibit a delay in reproductive function in the post-partum period, dependent on the time of year. Fortunately, a majority of mares have a true foal heat ovulation and continue to cycle if they are not bred or do not become pregnant at a foal heat breeding. One advantage of breeding mares on their foal heat is that mares that do become pregnant are not at risk of post-partum anestrus.

Potential causes for post-partum anestrus include ambient photoperiod/season, lactation, and nutrition/body condition. Ambient photoperiod is the primary culprit responsible for postpartum anestrus in mares.[1] A majority of mares that exhibit post-partum anestrus are mares that foal out early in the year, prior to the vernal equinox.[28] Post-partum anestrus is much less common for mares that foal out after the vernal equinox. Maintaining pregnant mares due to foal in the winter under a stimulatory artificial photoperiod for at least the last 2 months of gestation will decrease the probability of post-partum anestrus. The duration of artificial photoperiod exposure prior to foaling was noted to be inversely proportional to the percentage of mares that experienced post-partum anestrus. Additional consequences of housing pregnant mares under lights include a decreased duration of pregnancy, a shorter foaling-to-ovulation interval, and a lower average duration of open days post foaling.

Lactation and nursing have a suppressive effect on reproductive function in some domestic animal species, most notably cats, pigs and beef cows. Once the offspring are weaned in those species, ovarian function resumes. Lactation is considered to have a less dramatic effect on reproductive function in mares. However, anecdotal reports have suggested that some mares which failed to develop follicles in the postpartum period or become anestrus following a foal heat ovulation exhibit rapid follicular development and come into estrus as soon as the foal is weaned.

Inadequate nutrition and poor body condition in late gestation and the early postpartum period may also contribute to poor reproductive performance.[29] The effects of inadequate nutrition and poor body condition may be manifested in delayed return to reproductive cyclicity postpartum, reduced pregnancy rates and increased embryo loss rates.

In addition, failure to exhibit behavioral signs of estrus (i.e., 'silent heat') is more common in the foal heat period than in mares that have not recently given birth. Mares with a young foal at side are very protective and may not show behavioral estrus to a stallion. A combination of ultrasound examinations and 'adjusted' teasing techniques may be needed to monitor reproductive function in breeding programs that utilize or require live cover mating. A safe and effective teasing technique for a mare with a young foal may need to include manual restraint of both the foal and mare.

Maximizing Foal Heat Breeding Success

Qualifications. In the author's opinion, post-partum mares 'qualify' for consideration of a foal-heat breeding under the following conditions:

- Normal foaling (i.e., no dystocia)
- No trauma to the reproductive tract
- No prolonged retained placenta
- No prolonged discharge of uterine fluid (lochia)
- No increased volume or echogenicity of fluid visible within the uterine lumen on transrectal ultrasound by day 7 to 10
- Ovulation does not occur prior to day 10 post-foaling
- Mare is not of an advanced age (i.e., not ≥ 15 years old)
- Mare is not confined to a box stall

Potential Therapeutic Options. Several therapeutic strategies have been used to enhance fertility of mares in the early postpartum period. Administration of 150 to 300 mg of progesterone with or without addition of 10 to 20 mg of estradiol-17β to post-partum mares have been used in an attempt to delay the first ovulation, enhance uterine involution, synchronize estrus, and/or enhance pregnancy rates. In one study, administration of progesterone plus estradiol therapy initiated within 12 hours after foaling and continued for 6 days delayed the first ovulation of the year (day 15.6 ± 2.6 days vs. 10.3 ± 2.4 days) and increase pregnancy rates (58.5 % vs. 53.0 %) over that of untreated mares.[30] The combination of progesterone and estradiol initiated immediately after foaling results in suppression of the normal periparturient surge of follicle stimulating hormone (FSH) and luteinizing hormone (LH), and subsequently delays the development of the first follicular wave post-partum. Administration of altrenogest (0.044 mg/kg) orally once per day for 8 days beginning the day after foaling was reported to delay the first post-partum ovulation to 18.2 days and increased pregnancy rates over that of untreated mares.[31]

Ecbolic agents have been administered to post-foaling mares to promote uterine contractions, eliminate fluid and debris, and/or decrease the size of the uterus in an attempt to enhance foal heat conception rates.[32]

Lavage of the uterus of the post-partum mare has also been used in an attempt to enhance the rate of uterine involution, remove placental debris, reduce the degree of inflammation, reduce bacterial numbers and/or improve foal heat pregnancy rate.[25] However, controlled clinical trials determined that there is no advantage in performing a routine uterine lavage on postpartum mares that had a normal foaling, no retained placenta or no prolonged or abnormal lochial discharge. A therapeutic uterine lavage may be beneficial in mares that experience a retained placenta, prolonged lochial discharge or presence of an abnormal volume or adverse character of uterine fluid in the post-partum period.

Adherence to the principles of antibiotic stewardship dictate that use of antimicrobial agents should be justified. The routine use of antibiotics in the post-partum mare is controversial and most often not indicated. As noted previously, many post-partum mares have a positive growth on microbial culture and white blood cells are present on uterine cytology, are not treated with antibiotics, and have normal fertility. Systemic antibiotics may be indicated in mares with retained placenta, metritis-septicemia, and/or severe trauma to the reproductive tract. Intrauterine infusion of antibiotics, if used at all, should follow a uterine lavage to eliminate inflammatory debris which may otherwise bind and inactivate the antibiotics. However, there have been clinical studies that report an increase in post-partum pregnancy rate following intrauterine infusion of antibiotics along with either infusion of autologous plasma[33] or systemic administration of oxytocin.[34]

Management Strategy. One management plan to optimize post-partum conception rates in mares with an uncomplicated foaling is to perform an initial reproductive examination on the mare 6 to 8 days after foaling. The goal of this examination is to evaluate the reproductive tract for trauma associated with foaling, determine the degree of follicular development, note the amount of uterine edema and identify the presence or absence of fluid in the uterine lumen. A subsequent ultrasound examination is performed on day 9 or 10. Mares that ovulate before day 10 are not bred, but are administered a dose of prostaglandins 5 to 6 days after ovulation to lyse the corpus luteum and bring them back into heat early. Mares that still have a large follicle 10 days post-foaling are bred using standard techniques (live cover or artificial insemination). The use of an ovulation-inducing agent such as human chorionic gonadotropin (hCG) or a gonadotropin releasing hormone (GnRH) agonist is discouraged until at least day 9 or 10, since ovulations early in the postpartum period are associated with a lower pregnancy rate and higher embryonic loss rate.

Alternative Breeding Options. If an owner does not want to breed a mare on the foal heat, but also does not want to wait until the 30-day heat, an alternative strategy is to administer a dose of prostaglandins 5 to 6 days after the foal heat ovulation to short cycle the mare. This strategy results in higher per cycle and per season conception

rates, a lower pregnancy loss rate and ultimately a higher foaling rate than mares first bred on the foal heat. However, it does result in a slightly longer foaling-to conception interval (34.9 days vs. 25.6 days).[16]

In lieu of multiple ultrasound examinations to determine the day of the foal heat ovulation, an alternative plan would be to administer a dose of prostaglandins 17 to 20 days after foaling in an attempt to short cycle the mare, assuming that most mares will have ovulated by 12 days post-foaling. The obvious risk is not knowing if or when a mare actually ovulated in the early post-partum period.

Summary

Factors that lead to consideration of foal heat breeding include the long equine gestation length, photoperiod-dependent physiologic breeding season, limited-duration imposed breeding season, designation of January 1 as the official birth date of foals (North America), and the possibility of a prolonged post-partum anestrus period. However, not every mare is a suitable candidate for foal heat breeding and each foaling mare should be considered as an individual. Evaluation of foaling ease and passage of the placenta, a thorough physical and reproductive examination performed approximately 6 to 8 days post-partum and monitoring the development of the dominant follicle prior to and after day 10 will provide critical information for a foal heat breeding decision. Adherence to sound reproductive management guidelines can yield an acceptable pregnancy rate while minimizing pregnancy loss. Mares that do not qualify for a foal heat breeding may be short cycled by administration of prostaglandins approximately 6 days after the foal heat ovulation.

References

Available upon request.