Agalactia, Dysgalactia, and Nutrition of the Postpartum Mare

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Successful initiation and continuation of lactation in the postpartum mare depends on normal hormonal activity and a lack of any inhibitory influences on the mare. Impediments to adequate lactation include underlying systemic disease of the mare, pathology of the mammary gland, malnutrition, and diminished neonatal vigor reducing normal suckling activity. Author’s address: Rood and Riddle Equine Hospital, PO Box 12070, Lexington, KY 40580; e-mail: pmorresey@roodandriddle.com. © 2012 AAEP.

1. Introduction
Lactation places considerable nutritional and physiological demands on the mare. The nursing mare must provide sufficient milk to allow the foal to achieve approximately 45% of its mature weight at weaning. At the same time, to maintain a yearly foaling interval, the mare must be sufficiently recovered from the demands of gestation to allow rebreeding within the first month of lactation if so desired. Numerous management decisions and medical conditions can lead to either complete failure of lactation or insufficient milk production to meet the needs of the growing foal.

2. Anatomy, Physiology, and Endocrinology of Lactation
The equine mammary gland is composed of four separate functional gland units, two on either side of the inguinal midline. Each pair (collateral) is served by a single teat; however, each of these has two teat canals and cisterns, with separate duct and alveolar systems for each gland unit. Secretory epithelial cells line the alveoli, with myoepithelial cells encasing the alveoli. The alveoli empty milk into progressively larger ducts that converge into cisterns above the teats. Groups of alveoli cluster together to form lobules. In turn, these cluster together to form lobes, which is collectively known as a lobuloalveolar construct.

The mammary gland undergoes a cycle of growth and differentiation of tissue after every mating that results in a pregnancy. Growth of the mammary gland tissue continues to some degree into the lactation phase, with this being followed by a period of involution. In most species, growth of the lobuloalveolar tissue is stimulated by high levels of both estrogen and progesterone during pregnancy, with the latter inhibiting milk production. The mare differs from other species in that circulating progesterone levels are relatively low during the third trimester of gestation. Progesterone entering the maternal circulation from the fetoplacental unit is metabolized to the 5α-pregnanes. The most bioactive metabolite is thought to be 5α-pregnan-3,20-dione, which is found in high concentration and has demonstrable affinity for the progesterone receptor. Estrogens are represented by the inactive equilin and equilenin during late...
pregnancy, with estradiol 17-β rising before parturition. The trigger for initiation of lactation is thought to be the progestagen decrease and prolactin increase at the end of lactation. Prolactin has a major role in the initiation of lactation in the mare. Levels suddenly increase in the last days of gestation and peak at parturition, remaining elevated for up to 3 months postpartum. Prolactin is not required for the continuation of lactation once established, even though suckling raises maternal prolactin concentrations. Prolactin receptors are present in mammary tissue and increase in number during gestation and after parturition.

Lactation in the mare peaks 30 to 60 days postpartum. During this time, average daily production of 15 L per day in Thoroughbred mares and 12 to 13 L per day in Quarter Horse mares is achieved. Therefore, daily consumption by the foal is in the range of 21% to 25% of body weight on average over this period.

As the demand for milk by the foal decreases, the mammary gland undergoes a progressive involution. Weaning occurs at relatively high milk production, causing increased intramammary pressure due to accumulation of milk. This increased pressure along with suspected inhibitors in the milk further decreases production. Secretory tissue is subsequently replaced with connective and adipose tissue.

3. Composition of Milk

Synthesis of milk within the mammary gland of the mare is similar to that in ruminants. Components are sourced from body reserves, feed materials, and de novo synthesis within the mammary gland epithelium. Throughout lactation, a slow decline occurs in energy, total solids, protein, ash, and minerals; however, lactose concentrations increase.

Lactose is derived from glucose absorbed from the small intestine. Fatty acids are produced from acetate and 3-hydroxybutyrate sourced from carbohydrate digestion in the large intestine. Unsaturated C18 fatty acid is supplied either directly from the diet or from body reserves. Protein in milk is derived from the highly synthetic cells of the mammary gland epithelium. Most research has centered on the effects on the foal after variations in mare protein intake; however, research in mares has found that an increase in dietary crude protein up to 14% of the diet increased milk production.

Compared with human and bovine milk, mare milk is of lower fat and hence energy content. Mare milk and human milk have a similar sugar content, whole protein, and electrolyte content, in contrast to the increased electrolyte content of cow’s milk, making that a less suitable replacement for mare milk.

Antimicrobial defense in mare's milk seems to be due mainly to the presence of lysozyme (as in human milk) and, to a lesser degree, to lactoferrin, which is preponderant in human milk. A dynamic state of immunity exists during the prepartum and the immediate postpartum periods. Prepartum, colostral immunoglobulin accumulates in preparation for transfer of immunity to the neonatal foal. The mammary gland does not produce immunoglobulin G but instead concentrates it from the vascular supply. Lysozyme remains elevated in milk well after parturition, remaining active in the foal intestine and providing protection after cessation of macromolecule absorption. This elevated level of lysozyme may also protect the mammary gland against infection.

4. Disturbances of Lactation and Differential Diagnoses

The failure to produce colostrum or milk is known as agalactia. This is a separate condition from lack of milk letdown by some inexperienced primiparous mares or that caused by painful mammary glands. Dysgalactia is defined as poor or inadequate milk production, this being essentially a partial failure in lactation initiation or its continuation. Devitalization of the mare due to a systemic medical condition or during a period of postsurgical convalescence may be responsible for diminution or cessation of lactation.

5. Fescue Toxicosis

The most common cause in the United States is ingestion of fescue pasture contaminated with the endophyte Neotyphodium coenophialum. This compound is a dopamine agonist which antagonizes the action of prolactin during initiation of lactation. Placental edema and prolonged gestation also result.

6. Concurrent Disease Process

Whereas milk production is a potent driver of metabolic requirements, it is subservient to survival of the mare. In the absence of other precipitating factors, systemic disease of the mare should be ruled out in cases of agalactia or decreased milk production. Also, diminished suckling activity by the foal, failure to fully let down by the mare, or incomplete manual milking (where the foal is unable to suckle the mare, such as with hospitalization) can lead to rapid diminution of milk production due to incomplete clearance of the mammary secretions, thereby raising pressure within the mammary gland, which is deleterious to further production.

7. Malnutrition

The energy requirements for lactation are high. Lactose is sourced from glucose provided in the diet, with fatty acids produced from acetate and butyrate of large intestinal origin. Adipose tissue will be mobilized during times of limited intake with the potential to decrease mare body condition. Protein is similarly harvested from tissue stores.
8. Mastitis
Infection and inflammation of the mammary gland of the mare is uncommon. Most common at weaning, this condition may occur during lactation if the foal does not regularly and sufficiently suckle the mare during periods of high production. Tail swishing, ground stomping, regional swelling, and pain, as well as curdled milk, are common signs of mastitis. In addition, the mare may be reluctant to move, and fever may be present. Causative organisms have been reported to include Streptococcus equi subspecies zooepidemicus, which was the most common isolate, and a wide range of both Gram-positive and Gram-negative aerobic organisms. Both systemic and local antimicrobial therapy, antiinflammatories, and regular milking have been recommended and are common treatments. Fibrosis of untreated tissue decreases secretory mammary mass and therefore decreases future milk production.

9. Mammary Pathology
Reported neoplasia of the mammary gland is rare. Invasion of mammary tissue with carcinoma, adenoma, ductal adenocarcinoma, fibrous histiocytoma, and lymphoma have been reported. The most common presenting clinical sign in one review was enlargement of the affected gland; other findings reported were increased firmness of the gland, heat, pain, purulent or hemorrhagic mammary secretion, ventral abdominal edema, ipsilateral hind limb lameness, and a serous mammary gland discharge.

10. Endocrinopathy
Diminished circulating T4 and T3 concentrations have been obtained during investigation of a variety of conditions in horses. Because of this, hypothyroidism is deduced as the cause of poor performance, weight loss, infertility, laminitis, anhydrosis, and lactation failure. In the absence of thyroid stimulation testing demonstrating abnormal responses or overt pathology of the gland, there is no confirmation possible for this diagnosis. The euthyroid sick syndrome is well recognized in human medicine, whereby clinical signs attributable to another disease process are ascribed to the thyroid gland as suppression of circulating T4 levels, not thyroid function itself, is occurring.

11. Management
Key to the successful management of lactation failure is to diagnose and manage any underlying medical cause of physiological stress to the mare. In the absence of systemic disease, causes specific to the neurohormonal lactation axis must be sought and addressed.

In situations in which access to the endophyte Neotyphodium coenophialum is suspected to have occurred, avoidance of further grazing of those areas may lead to resolution of the diminished mammary development and resultant agalactia.

Domperidone is the most commonly used lactogenic agent due to its ability to stimulate prolactin secretion in situations of dopaminergic inhibition such as with fescue toxicosis. This medication will also be administered in situations in which systemic health of the mare or lack of appropriate suckling by the foal is thought responsible. Reserpine is also in common usage, with the added benefit of behavioral modification. Reports of metoclopramide and sulpiride usage also exist.

The use of pergolide (a dopamine agonist and therefore a prolactin antagonist) is not without risk of causing lactation failure in treated mares. Although many mares initiate lactation without difficulty while on this treatment, it is the author’s preference to remove this treatment in the last 30 days of gestation if the health of the mare is not endangered. Once lactation has been established postpartum, pergolide treatment can resume.

12. Nutritional Requirements of Lactation
In addition to the endocrine and medical reasons for lactation failure, provision of inadequate nutrition should not be overlooked. Total energy and protein requirements are composed of maintenance and lactation needs. Maintenance is estimated from body weight, with lactation requirements calculated from milk production and composition at all stages of lactation, factoring in diet composition, feed intake, conversion efficiency, and current body reserves. Therefore, a primary deficiency may result when insufficient calories and nutrients are offered for mare maintenance and lactational demand, or a secondary deficiency when consumption and utilization of nutrition is diminished or uncompensated catabolism is occurring due to underlying disease. The energy cost and nutrient requirement of milk production therefore exceeds available substrate intake.

13. Requirements for the Pregnant Mare
Daily energy requirements for a 200- to 600-kg mare are calculated as follows:

\[ DE = (\text{maintenance}) + (\text{pregnancy requirements}) \]

\[ DE = (1.4 + 0.03BW) + (\text{maintenance} \times F) \]

where \( DE \) = digestible energy (MJ); \( BW \) = body weight (kg); and \( F = 1.11 \) (9 months); 1.13 (10 months); 1.2 (11 months).

Daily protein requirements for a 200- to 600-kg mare are calculated as follows:

\[ \text{gCP/d} = (\text{maintenance}) + (\text{pregnancy}) \]

\[ \text{gCP/d} = (10 \ g \ CP/MJDE) + (11 \ g \ CP/MJDE) \]

where \( CP \) = crude protein and \( MJDE = MJ \) of digestible energy.
14. How Much of Common Feed Materials Is That?

As a percentage of body weight, dry matter intake in the last trimester for the pregnant mare ranges from 1.5% to 2% of body weight. Of this, 35% to 40% is suggested to be derived from concentrate. In the final stages of gestation, voluntary intake of pregnant mares compared with nonpregnant controls decreased on average 20% due to the increase in fetal size making the quality of the forage offered important to allow mares to meet their needs.

Intake depends on forage quality. In a study of light breed mares fed ad libitum, daily intake of hay was 11% higher in the high-quality versus the low-quality group. Although energy requirements were met in both groups, protein was only sufficient in the high-quality group.

With respect to the lactating mare, little is known regarding dietary protein intake and its effect on milk protein. Protein content of milk decreases throughout lactation, also as the energy content of the ration increases milk volume increases, leading to dilutional effects on proteins. In one study, foals of mares fed the minimum recommended (National Research Council, 1989) total daily protein were significantly decreased in size at weaning compared with those of mares fed 160% of minimum.

Protein intake is not dependent solely on the amount of crude protein in the diet but the overall quality of the protein offered. Also, mares are able to use body reserves to maintain milk production and composition when fed a diet deficient in protein. Protein content of milk was found to be positively affected the growth of their foals in consistent and to predictably decline during lactation in several studies. Using this range of protein content from 1.9% to 3.9% of body weight throughout lactation can be achieved as follows:

\[
\text{CP requirement} = \text{BW} \times 1.44 \text{ g CP/kg BW/d}
\]

plus milk production (kg/d) \(\times 50 \text{ g CP/kg milk.}

This equates to, for a 500-kg mare:

\[
500 \times 1.44 = 720 \text{ g/d}
\]

and assuming 3.2% BW of milk (16 kg) in early lactation:

\[
16 \times 50 = 800 \text{ g/d.}
\]

Total daily requirement in early lactation is therefore 1520 g/d.

It is therefore a straightforward calculation to determine the amount of feed material needed daily to provide this amount. Crude protein from all sources (grass, hay, concentrate) should be considered when calculating the amount of concentrate feed required:

For example, daily amount of concentrate feed required that provides 16% CP (assume 40% of ration) \(= \frac{100/16 \times 0.4 \times 1520 \text{ g (calculated above)}}{3.8 \text{ kg.}}

15. Induction of Lactation

Lactation may be induced by hormonal methods in nonparous mares. Protocols have been reviewed in the literature. A combination of exogenous hormones and repeated mammary stimulation by milking is required. Two avenues are taken to establish lactation in conjunction with repeated mammary stimulation. As detailed by Steiner, the first involves the use of serial estrogen and progesterone supplementation, with a dopamine antagonist (prolactin agonist) added. An alternative program involves the use of a lighting program and a dopamine antagonist as relayed by Lyman.

16. Summary

Lactation is the result of a complex interplay between specialized anatomy and endocrinology driven by the reproductive necessities of the equine. The mammary gland develops in response to each pregnancy and involutes when no longer required. Milk production is tailored to the requirements of the foal but is affected by the systemic health of the mare, nutritional status, and exogenous prolactin inhibitors.

References