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Review Article

Diagnosis and treatment of mastitis in mares

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Summary

Infection and inflammation of the udder (mastitis) is a common condition affecting all domestic mammals, but it appears to be less prevalent in mares than in dairy cows and dairy goats. The seemingly reduced incidence of mastitis in mares can be partially explained by the smaller size and relatively concealed location of the mare's udder, coupled with a smaller storage capacity than cows and goats. Mastitis can affect lactating, peripartum, dry mares, mares at dry-off or prepubertal foals. Common clinical signs include swollen mammary tissue, abnormal mammary gland secretion, fever and anorexia; less common signs are hindlimb lameness and a swollen mammary vein. On rare occasions, mastitis pathogens can severely affect the nursing foal and mares may develop fibrotic tissue and consequent agalactia in the side(s) or quarter(s) affected. Based on the clinical presentation, mastitis can be classified as acute or chronic, and clinical or subclinical. Diagnosis is based on the clinical signs aided with aerobic culture and cytological evaluation of the gland secretion. In addition, these ancillary tests can also be used to assess prognosis and duration of treatment. Mares suffering from mastitis may present neutrophilia and hyperfibrinogenaemia. Treatment for mastitis includes antimicrobial therapy (systemic and/or locally), nonsteroidal anti-inflammatory drugs, frequent milking and cold hosing with/without hot-packing applied on the gland. While the frequent monitoring of mares after weaning and reducing food intake should be part of common practices at weaning, cleaning of the udder, control of insect populations and frequent milking of mares with a foal unable to nurse can also aid in preventing mastitis.

Introduction

Mastitis, or infection and inflammation of the udder, is a common condition affecting all domestic mammals, but it appears to be less prevalent in mares than in dairy cows and dairy goats (Jackson 1986; McCue and Wilson 1989). The seemingly reduced incidence of mastitis in mares can be partially explained by the smaller size and relatively concealed location of the mare's udder, coupled with a smaller storage capacity than cows and goats (Jackson 1986). These factors render the equine udder and teats less subjected to trauma and infection than species where the udder is larger and closer to the ground (Jackson 1986). While one report from Germany estimated that as much as 5% of breeding mares are affected by mastitis (Böhm *et al.* 2009) the incidence does not appear to be that high in North America (McCue and Wilson 1989; Perkins and Threlfall 2002; Brendemuehl 2008). However, the true incidence across breeds and countries remains to be determined.

While mastitis is less prevalent in mares, severe consequences associated with mastitis can occur in horses as well as ruminants. Transmission of the infectious agent to the nursing foal may cause septicaemia, polyarthritis and pneumonia in the foal (Perkins and Threlfall 2002; Knottenbelt 2003). Additionally, agalactia can lead to subsequent foal malnutrition (Kocabiyik *et al.* 2008). Mastitis can also induce abortion if the mare is pregnant and systemically compromised, or less commonly, severe infection can cause permanent loss of function in the affected quarter(s) of the mammary gland due glandular fibrosis or obstruction (Perkins and Threlfall 2002; Knottenbelt 2003). Verminous mastitis (e.g. *Cephalus* sp and *Halicephalobus deletrix*) may potentially disseminate to the mare's systemic circulation and result in lesions to the mare incompatible with life (Wilkins *et al.* 2001; McCue and Sitters 2011).

Mastitis can affect lactating, peripartum, dry mares, mares at dry-off or prepubertal foals (McCue and Wilson 1989; McCue and Sitters 2011). Lactating mares are usually either affected by mastitis within the 2–3 days immediately post-partum or late in lactation (Bostedth *et al.* 1988; McCue and Wilson 1989; Perkins and Threlfall 2002). Peripartum mares affected with mastitis may have a history of galactorrhoea before parturition (Perkins and Threlfall 2002) (**Fig 1**). A retrospective study from California showed that 42% of mares were affected by mastitis during lactation, another 28% displayed signs within the first 8 weeks post-weaning, and the remaining 30% of mares had not lactated (McCue and Wilson 1989). In the same study, the mean age of affected mares was 13.2 ± 6.2 years, with a range from 3 to 24 years (McCue and Wilson 1989). It is also worth noting that another retrospective study from Ohio involving mostly Standardbred horses had a broader range of age in affected mares, including a 2-month-old foal and three young fillies 2–3 years of age (Perkins and Threlfall 2002).

In the Northern Hemisphere, May to September is the time of the year when most mares in reproduction are lactating or have been weaned. In a report from California, 71% of the mares had signs of mastitis during this time point (McCue and Wilson 1989). Since milk production is dramatically reduced by 4–5 months of lactation (Bostedth *et al.* 1988), while the foal's nutrient requirements are only increasing, it is possible that certain foals become more aggressive while nursing, particularly under food-restricted conditions, thus potentially inflicting trauma to the gland or teat orifice making the mare prone to mastitis. This appears to be especially true for mares raising mule foals (I.F. Canisso, unpublished observations).

Fig 1: Streptococcus mastitis in a pony mare on the day of foaling. The mare displayed galactorrhoea prepartum. Note that only the left cranial quarter is affected (*), while the left caudal quarter (≠) and both right quarters (┼) are not affected.

However, this increase in foal energy requirements cannot be separated from the seasonal effects, as mares are more commonly affected by mastitis during the summer months when insect populations increase (McCue and Wilson 1989), coincidentally also the time when many foals are 4–5 months old. Interestingly, mastitis has also been reported in prepubertal foals due to trauma in the inguinal region (Pugh *et al.* 1985; Perkins and Threlfall 2002; Gilday *et al.* 2015).

Drying-off mares are more likely to suffer from mastitis up to 8 weeks postweaning, which under typical horse industry conditions in the Northern Hemisphere coincides with summer and early fall (May–September), when insect populations are still peaking (McCue and Wilson 1989). In addition, after weaning, mammary gland secretions will accumulate and potentially drip, facilitating the entrance of infectious agents to the teat ('streak') canal (Jackson 1986). Similarly, mares presenting mastitis right after delivery have a history of dripping milk prefoaling, or may have lost a foal at, or immediately after, delivery (Perkins and Threlfall 2002). Other dry mares may present improper idiopathic lactation, particularly in the fall, and inappropriate lactation is also seen in mares with Cushing's disease, probably due to a secondary increase in plasma prolactin (Pugh *et al.* 1985; McCue and Sitters 2011).

The following manuscript describes the diagnosis and treatment of mastitis in mares. Clinical conditions with a somewhat similar presentation will be discussed as part of the differential diagnoses. The presented information herein will be useful for veterinarians facing cases with a similar clinical presentation.

Clinical signs, classification and aetiopathogenesis

Mastitis can occur uni- or bilaterally; 78.6% of cases were unilateral in one report from California (McCue and Wilson 1989), and 59% were unilateral in another report from Ohio (Perkins and Threlfall 2002). Interestingly, in unilateral mastitis, it is possible for only one lobule or quarter (4/28 clinical cases) to be affected (McCue and Wilson 1989) (**Fig 1**). Typically, each udder half is composed by two lobules and rarely three lobules (Jackson 1986; McCue and Wilson 1989; Knottenbelt 2003); this is particularly relevant if intramammary gland infusions are to be performed as part of the treatment. If the mare has three lobules, three orifices can be seen draining

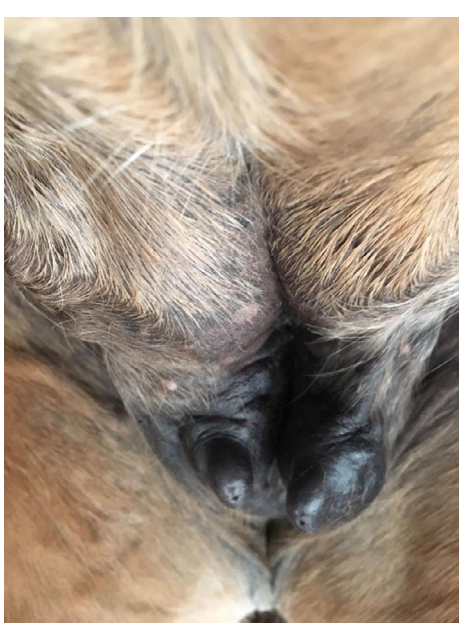

Fig 2: Ventral view of the mammary gland from a 21-year-old multiparous Quarter Horse mare depicting two orifices in each gland. Scar tissue was present on the right gland (left side of the picture) as a consequence of a mastitis post-weaning. This mare had delivered and weaned 10 foals, and while gland asymmetry is not unexpected, in this case, it was due to fibrosis.

from each teat, rather than two orifices as seen in most mares (Jackson 1986; Knottenbelt 2003) (**Fig 2**).

Clinical signs associated with mastitis include pain, local swelling or heat in the affected gland, gland asymmetry, gland firmness, ventral oedema with or without concomitant lower limb oedema, a congested mammary vein, rejection of the foal (e.g. kicking, biting, walking away and picking up the hindlegs) and grossly abnormal purulent and/or serosanguineous secretions (McCue and Wilson 1989; Perkins and Threlfall 2002; McCue and Sitters 2011) (**Table 1**, **Figs 1** and **3**). Some mares may become reluctant to move, grumpy or aggressive in response to pain (Roberts 1986; McCue and Wilson 1989). Mares can also show systemic signs such as pyrexia (up to 41°C), anorexia/hyporexia, depression and hindlimb lameness (McCue and Wilson 1989; Perkins and Threlfall 2002). The most common clinical signs are a firm and swollen udder with purulent discharge (Perkins and Threlfall 2002) (**Fig 1**). Bloodwork is often unremarkable in horses without systemic signs but may also show neutrophilia and hyperfibrinogenaemia (McCue and Wilson 1989; Perkins and Threlfall 2002).

Mammary gland abscessation is a potential sequela of mastitis, with *Corynebacterium* spp, *Streptococcus* spp. and *Staphylococcus* spp. appearing to be the predominant agents causing udder abscesses in mares (McCue and Wilson 1989; Knottenbelt 2003; Brendemuehl 2008). True incidence and prevalence of mastitis and subsequent mammary abscesses is unknown. In the authors' experience, cases of mastitis coupled with mammary abscess are more common in horses coming from areas endemic for Pigeon fever (*Corynebacterium pseudotuberculosis)*.

Based on the clinical presentation, mastitis can be classified as acute or chronic, and clinical or subclinical. Although specific cut-offs have not been determined for these classifications, in practical terms, mares with acute mastitis present overt clinical signs of less than a week's duration, and clinical signs resolve within 7 days once treatment is initiated. Mares with chronic mastitis fall outside this arbitrary classification. Subclinical mastitis are those cases without overt clinical signs or mares without a fever or painful udder (**Table 1**).

Mastitis is most commonly caused by bacteria, and less commonly by fungi, nematodes or noninfectious agents such as avocado tree poisoning (Greiner *et al.* 1991; McKenzie 1991; McCue and Wilson 1989; Perkins and Threlfall 2002). More than 20 aerobic bacteria have been associated with mastitis in mares. Overall, *Streptococcus* species were the most common isolates reported by various authors (Bostedth *et al.* 1988; McCue and Wilson 1989; Perkins and Threlfall 2002; Böhm *et al.* 2009), although in one report from California, 42% mares suffering from clinical mastitis had

TABLE 1: Common clinical signs of mastitis

- Swollen udder
- Agalactia
- Purulent/serosanguineous secretions
- Pyrexia
- Anorexia
- Depression
- Lameness
- Reluctance to move
- Kicking at, or rejection of, the foal

Fig 3: Mammary gland development and unilateral mastitis in a dry 13-year-old Quarter Horse mare. The left udder felt warm and tender on palpation and the mare developed systemic signs. While milk could be expressed from both glands, only the left udder half was affected. The arrow points to a congested 'mammary vein'.

Gram-negative bacterial agents isolated (McCue and Wilson 1989). Most bacteria isolated from mares with mastitis are also found on the skin of the udder and have also been isolated in the milk of healthy post-partum mares (Bostedth *et al.* 1988; Böhm *et al.* 2009), suggesting that occurrence of mastitis may be associated with the breakdown in the innate immune response or disturbance between the host and microbe.

Fungi isolated from mastitis cases include *Rhadotorula mucilaginosa*, *Coccidiodis immitis* and *Blastomyces dermatidis* (Hajsig and Jacovac 1960; Walker *et al.* 1993; Wilson *et al.* 2006), whereas nematodes diagnosed in mares suffering from verminous mastitis include *Cephalus* sp. and *Halicephalobus deletrix*. In one interesting case, there was evidence of transmission from the dam to the newborn of a soil worm (*H. deletrix*), which resulted in severe neurological signs in both the dam and foal culminating in their euthanasia (Greiner *et al.* 1991; Wilkins *et al.* 2001).

The pathogenesis of mastitis in mares is not completely known. It has been suggested that infectious agents penetrate the gland via the teat canal or that bacteria spread via haematogenous infections, breakdown of the skin or potentially by active penetration of the intact skin by parasites (Jackson 1986; McGladdery 1998). Since the mare's udder is in a relatively protected area compared to ruminants, trauma to the gland is not as common as it is in dairy cows or goats (Jackson 1986; McCue and Sitters 2011). In addition, due to the relatively small udder size and reduced storage capacity (gland cistern), the foal nurses frequently, which is thought to play a role in preventing infection of the gland (Jackson 1986; Knottenbelt 2003). Conversely, after weaning the mare continues to produce milk, the gland becomes engorged, milk drips and insects may feed off the dripping secretions of the mare. This situation can make mares susceptible to developing mastitis, again particularly during the summer (Jackson 1986; Perkins and Threlfall 2002; Knottenbelt 2003).

Diagnosis

Diagnosis of mastitis can be achieved based on inspection of the udder (**Table 2**), which will reveal typical clinical signs. In addition, it is recommended to confirm bacterial presence by

TABLE 2: Workflow mastitis diagnosis

- Mare general physical examination
- Udder inspection and palpation
- Expression and inspection of mammary gland secretions
- Ancillary tests
  - Culture
  - Cytology
  - Complete blood cell count
  - Fibrinogen
  - Ultrasound

performing an aerobic culture coupled with cytology of the mammary gland secretions (Freeman *et al.* 1988; Knottenbelt 2003). Mares suffering from bacterial mastitis have a remarkably high number of neutrophils with degenerate changes (Freeman *et al.* 1988; McCue and Wilson 1989). Cytology of the mammary gland secretions can be easily performed; a drop can be placed on a glass slide, smeared with a coverslip or another slide, allowed to dry and then stained with a Romanowsky stain (e.g. Diff-Quick) readily available in most equine practices (**Fig 4**). The slide can be gently washed with tap water, allowed to dry at room temperature and placed in an incubator at 37°C or a heated stage warmer for 15–20 min and then read in an optical microscope. The slides can be read at 10–40× magnification; however, utilising 100× will increase the chance of detecting bacteria. While only 30% of the samples had bacteria detected on cytological evaluations in one report (McCue and Wilson 1989), the presence and morphology of bacteria can be helpful as a presumptive diagnosis of mastitis. Cytological specimens collected from lactating mares show a proteinaceous material with an occasional squamous cell (**Fig 5**), whereas drying-off mares present occasional macrophages with a foamy appearance (Freeman *et al.* 1988). The authors use cytology both as a diagnostic aid and to monitor the mare's response to treatment and to determine when to discontinue treatment.

On many occasions, any udder development and enlargement is deemed mastitis by veterinarians, owners and grooms; however, a brief manual examination of the udder and evaluation of the appearance of the mammary secretions is often enough to rule out mastitis (McCue and Sitters 2011) (**Figs 1**, **6** and **7**). It is worth noting that some mares display classic signs of mastitis and secretions may look grossly normal; in this case, a cytological evaluation will reveal mammary gland secretions full of degenerated neutrophils as was seen in the mare's cytology in **Fig 4**. Other conditions causing mammary gland development and enlargement include idiopathic lactation in dry mares, mammary gland neoplasia, inappropriate lactation in young fillies, galactorrhoea in pregnant mares days before expected due date and conditions affecting the fetoplacental unit (e.g. placentitis, twin pregnancy, imminent abortion and late-term fetal death) (Knottenbelt 2003; Brendemuehl 2008; McCue and Sitters 2011).

Mammary gland secretions should be collected aseptically if intended for aerobic culture (Knottenbelt 2003). The udder should be scrubbed and washed with povidone-iodine scrub, and the teat should be cleaned with 70% rubbing alcohol and allowed to dry for 3–5 min. Then the

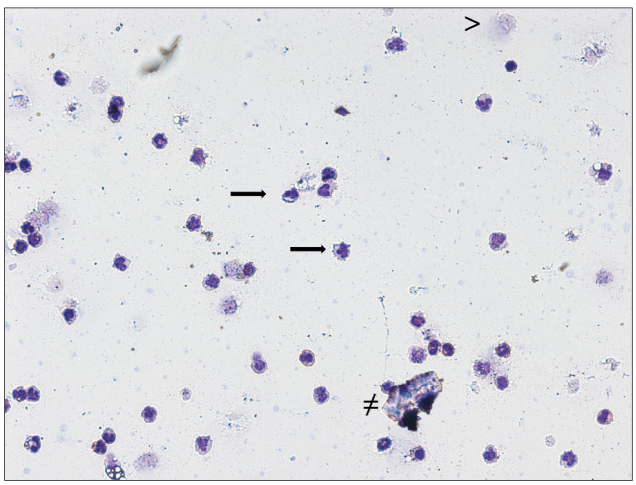

Fig 4: Cytology of mammary gland secretions from a 13-year-old Standardbred mare with clinical mastitis. The mammary gland secretions were grossly normal. Inflammatory change in clinical mastitis on a cytologic smear of the mammary gland secretion showing the presence of polymorphonuclear leukocytes (arrow). Squamous epithelial cells and rare histocytes (arrows) are present (Romanowsky stain, 20×).

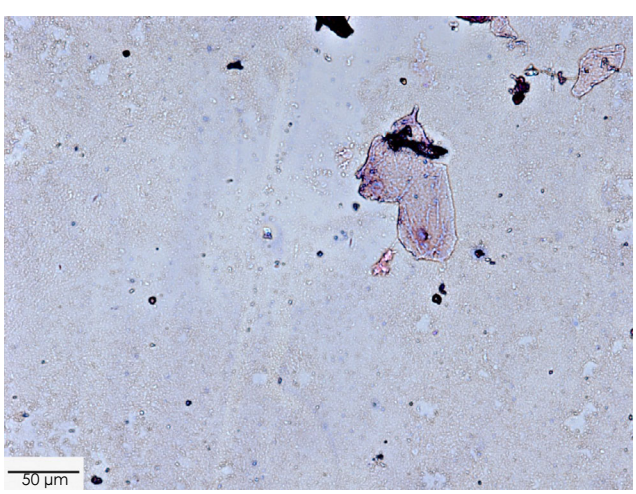

Fig 5: Mammary gland secretion cytology from a mare with normal lactation (Romanowsky stain, 20×).

udder should be milked while wearing sterile gloves, and the first three milk jets discarded to avoid contamination with micro-organisms known to colonise the teat canal. An assistant can then open a plain sterile tube (e.g. a 15-mL falcon tube or vacutainer tube), taking care not to contaminate or touch the top of the tube.

Ultrasonography of the mammary gland can be useful particularly in chronic mastitis, mammary gland neoplasia and unusual mastitis cases (Motta *et al.* 2011). Acute mastitis does not result in remarkable ultrasonographic changes (Waldridge 2011). Obstructive lesions are uncommon and may be better observed with an infusion of saline into the lactiferous sinus or ducts (Motta *et al.* 2011). Mares presented for breeding with obvious signs of bilateral udder fibrosis can have their udder gently distended with saline and assessed

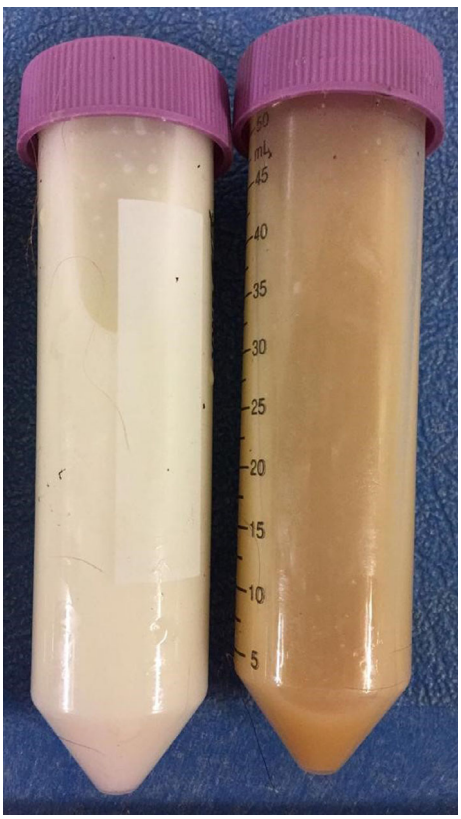

Fig 6: Mammary gland secretions from a mare with unilateral acute mastitis caused by Streptococcus zooepidemicus. The mare had moderate mammary gland development. The left udder had normal consistency and yielded secretions with normal appearance (left tube), whereas the right udder was hot, painful and firmer than normal and secretions were grossly abnormal (right tube) with purulent appearance.

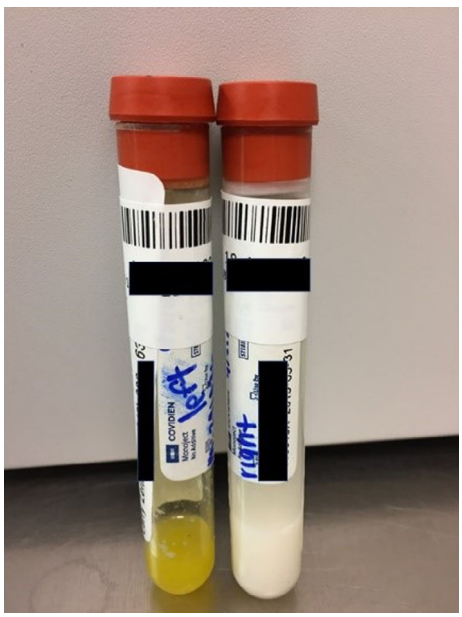

Fig 7: Mammary gland secretions from acute Streptococcus mastitis. Left tube shows a remarkably yellow secretion, while the right udder had normal milk secretions. Cytological examination revealed large numbers of degenerate neutrophils and bacteria. The udder was hot, firm and painful on palpation.

this way as a proxy for potential milk production. Before infusion, the udder needs to be aseptically prepared and then completely drained after the procedure is finished to avoid iatrogenic infection. As this procedure may carry a risk of infection and inflammation, prophylactic antimicrobial therapy with sulfamethoxazole and trimethoprim (30 mg/kg bwt per os for 3 days) can be carried out at the clinician's discretion. Clients may elect to not breed mares with extensive udder fibrosis, or alternatively assisted reproductive techniques or nurse mare can help circumvent this problem.

Some diagnostic tools widely used in the dairy cattle industry have conflicting results when used in horses. The detection of gross abnormalities in milk is routinely performed with the first jets collected in a cup with a filter and a dark contrast to diagnose clinical mastitis. While this seems to be useful, the tool used in cattle is not commonly available in the equine practitioners' clinic or truck, thus making this technique less useful. The California mastitis test (CMT) is based on somatic cells reacting to a detergent solution and producing an agglutination that can be graded according to the degree of gel-like formation (0, +, ++ and +++). Studies assessing this technique concluded that there was no association between the CMT results and the presence of clinical or subclinical mastitis and aerobic culture in mares (Waldridge 2011). Similar findings were obtained with mares assessed via total somatic cell counts (Böhm *et al.* 2009). Typically, CMT is not commonly available in the equine practitioners' clinic or truck. In cows, a somatic cell count of fewer than 100,000 cells/mL is considered ideal and counts greater than 200–250,000 are considered to indicate infection. In contrast, in a study assessing CMT, somatic cell count and aerobic culture in horses, there was no association between somatic cell count and clinical disease (Böhm *et al.* 2009; Motta *et al.* 2011). Collectively, the authors concluded that these tests are not currently optimised for horses, therefore not useful screening or diagnostic tools.

Treatment

Treatment of mastitis involves systemic antibiotics, intramammary antibiotic infusion or antiseptics solution (e.g. povidone-iodine solution), nonsteroid anti-inflammatories, frequent milking, cold water hosing or hot packs (McCue and Wilson 1989; Motta *et al.* 2011) (**Table 3**). Frequent milking is utilised to remove bacteria, debris and inflammatory cells from the gland, and intravenous or intramuscular administration of oxytocin (10–20 units) can aid with milk let-down and clearance. During the first 5–7 days of treatment, the mare should be milked two to three times a day. At the onset of treatment, some mares may become difficult and violent while having their udder touched and milked. Physical restraining methods such as lip-chain, nose-twitch and/or skin-twitch can be used in combination with sedatives such as alpha-two agonists. Tranquilisers such as acepromazine are also effective to chemically restrain the mare but can stimulate prolactin production and potentially aggravate clinical mastitis in dry or drying-off mares.

Hot packs have also been recommended as an ancillary method to treat mastitis in mares; however, the authors' preference is to cold hose with water for 15 min right after the mare has been milked out. After the mare's udder is cold-hosed, the udder is dried, and petroleum jelly applied to the udder and teat to prevent skin cracks caused by mastitis and the frequent milking.

Nonsteroidal anti-inflammatory drugs (e.g. flunixin meglumine 1.1 mg/kg q. 12–24 h or phenylbutazone 2.2 mg/kg q. 12 h) can be used to treat pyrexia, to reduce inflammation and promote analgesia. Febrile mares will go off-feed, stop drinking water and become depressed and dehydrated if not treated adequately. We recommend treating the mare initially twice a day with nonsteroidal anti-inflammatory drugs. Normally, the mare will restore appetite and become afebrile within 12–24 h. Mares left untreated for a long period of time may need fluid therapy to restore normal hydration.

Antimicrobial therapy should be performed according to culture and sensitivity. Interestingly, micro-organisms cultured from affected glands were resistant to many of the commonly used antimicrobials in horses (McCue and Wilson 1989). Given that approximately 75% of bacterial agents cultured from mastitis mares in a study from California were susceptible to sulfamethoxazole and trimethoprim (McCue and Wilson 1989), it seems reasonable to collect milk samples from affected mares, submit for culture and sensitivity, and while waiting for the results to come back, start treating the mare with sulfamethoxazole and trimethoprim (30 mg/kg bwt per os q. 12 h). Alternatively, some clinicians have advocated administering systemic long-acting cephalosporin (i.e. Excede Zoetis, ceftiofur crystalline free acid) at recommended manufacturer's doses to empirically treat mastitis in mares, although its effectiveness has not been critically tested. This antimicrobial is the dairy cattle producer's favourite to treat uterine and respiratory infections, and since it does not diffuse to milk, it requires no discard of milk when administered systemically. It remains to be determined whether this antimicrobial diffuses to mammary gland secretions in mares; if it does not, its usage to treat mastitis should be questionable. In addition, in view of the critical importance of this antimicrobial drug in human medicine, its use in the horse should be restricted to cases where culture results indicate an absolute need.

Other authors proposed to use intramammary antimicrobial infusion of the affected gland(s) with bovine intramammary products, particularly in cases not responding to initial treatment (Jackson 1986; McCue and Wilson 1989; Perkins and Threlfall 2002). It is worth noting that quarter(s) unaffected by mastitis should not be infused. This route can be used alone or in combination with systemic antibiotics (McCue and Wilson 1989; Perkins and Threlfall 2002). If the clinician elects to use such products, short-life (lactating cow) formulations should be used to allow for frequent milking, and each affected lobule (i.e. teat orifice) should be infused. Cow mastitis long-life (dry off cow) products are less soluble and have a slower release of drugs and are more expensive. In addition, since the teat canal is shorter, and the cistern of the gland is smaller in mares than cows, the clinician should be careful to not cause further trauma to the gland while performing intramammary gland infusions (McCue and Wilson 1989).

TABLE 3: Treatment of mastitis

- Milk the mare frequently (2–3×/day)
- Nonsteroidal anti-inflammatory drugs (e.g. flunixin meglumine, phenylbutazone)
- Oxytocin for milk-let-down premilking (optional and not recommended in mid to late pregnant mares due to risk of premature labour)
- Antimicrobials (start with sulfamethoxazole and trimethroprim and switch if needed based on sensitivity)
- Cold hose with water
- Hot pack compress
- Feed restriction

The authors use the gross appearance and cytological findings (e.g. scant or absent presence of neutrophils and lack of hypersegmented neutrophils) of the milk to decide whether to discontinue or reduce milking frequency. Once the mammary gland secretions are grossly and cytologically normal, the authors reduce the milking frequency to once a day and continue to observe the mare. A complete blood count and measurement of plasma fibrinogen can be useful for determining when to discontinue treatment. Fortunately, most mares respond in 2–3 days to treatment for bacterial mastitis and most are normal within a week after diagnosis. Some mares may fail to respond to treatment, particularly mares with fungal or verminous mastitis. Unfortunately, the treatment for fungal or verminous mastitis in horses is poorly defined.

Surgical removal of the udder has been advised for mares suffering from recurrent chronic mastitis, mammary gland neoplasia, extensive laceration and for convenience of the owner in mares from owner's disturbed by the occurrence of idiopathic lactation. The surgery is not trivial; post-surgical complications include haemorrhage, improper healing, surgical infection and dehiscence. It has fewer complications if performed when the mare is not lactating, as there is an increase in blood flow to the udder during lactation (Knottenbelt 2003). For the procedure, the mare needs to be under general anaesthesia, and placed in dorsal recumbency, and then the major vessels irrigating the mammary gland ligated (Knottenbelt 2003). Except for select cases, surgical removal of the mammary gland should be discouraged due to inherent surgical and general anaesthesia risks and welfare concerns.

Prevention

Most mares developing mastitis after weaning were up to 8 weeks after weaning (McCue and Wilson 1989). Milk production is highly linked with feed intake, and reduction or complete removal of grains from the mare's diet at drying-off can be helpful in preventing mastitis. For mares losing foals at, or immediately after, parturition, the authors' preference is to collect all colostrum for storage in a colostrum bank and then start drying off the mare by reducing grain and hay. Such mares are also at high risk of metritis and are often maintained on frequent doses of oxytocin (e.g. 10 units, 2–3×/day for 7 days) to help with uterine involution. Mares with down foals (e.g. critically ill) or mares with a history of neonatal isoerythrolysis should be milked regularly every 2–6 h until the foal is recovered or able to suckle on its dam, respectively.

It is also helpful to suggest to clients to wash the udder and hindlegs of mares to clean off dripping milk. This ensures

TABLE 4: Prevention of mastitis

• Monitor and keep the udder clean for 8 weeks post-weaning
• Control insect population on farm
• Reduce dry matter intake, particularly grains
• Provide creep feed for foals
• Keep stable groups of mares to avoid fights and accidents

that clients are paying attention to mares accumulating and dripping milk (e.g. weaned-off or mares with dead foals). Mares dripping milk will present 'oily' hindlegs and will attract more flies that could potentially increase the odds for mastitis. Since gland distension is important for discontinuation of milk production, the practitioner should instruct clients not to milk the mare after weaning, but also to watch for signs of mastitis in the 4–8 weeks post-weaning. Providing good nutrition support for the nursing foals will allow them to be less dependent on maternal milk, which will potentially lead to a gradual decrease in milk production towards the end of lactation (**Table 4**).

Conclusion

Mastitis is a disease affecting mares of all categories (nursing, dry and drying-off) and also fillies. While mastitis is less prevalent in mares, severe consequences associated with mastitis can occur in horses as well as ruminants. Transmission of the infectious agent to the nursing foal causes septicaemia, polyarthritis and pneumonia in the foal. Additionally, agalactia can lead to subsequent foal malnutrition. Mastitis can also induce abortion if the mare is pregnant and systemically compromised, or less commonly, severe infection can cause permanent loss of function in the mammary gland due to glandular fibrosis or obstruction. Diagnosis of mastitis can be achieved based on inspection of the udder, which will reveal typical clinical signs. In addition, it is recommended to confirm bacterial presence by performing an aerobic culture coupled with cytology of the mammary gland secretions. Mares suffering from bacterial mastitis have a remarkably high number of neutrophils with degenerate changes. Treatment for mastitis involves systemic antibiotics, intramammary infusion of antibiotics or antiseptics solution, nonsteroid anti-inflammatories, frequent milking, cold hosing or hot packs. Prevention including mainly monitoring mares after weaning or loss of a foal, potential reduction of feeding post-weaning, provide appropriate nutrition for the nursing foals to be less dependent on mare's milk, control insect populations on the stud farm.

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Authorship

All authors contributed to the preparation of this manuscript.

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