Eve's Mammary Mayhem

Kathryn E. Hoppensteadt

Mississippi State University College of Veterinary Medicine

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Advisor: Michael Pesato, DVM, DABVP (Food Animal Practice)

Introduction:

Mastitis is an important health issue in dairy goats that leads to major economic losses due to decreased productivity.[1] Mastitis, the inflammation of the mammary gland, is caused by various pathogens including bacteria, fungi, and viruses. Environmental stressors such as extreme temperatures or changes in diet can lead to immunocompromise which predisposes to or further exacerbates infection. Mastitis can have a clinical or subclinical presentation and results in physical and chemical changes in milk and pathological changes in the mammary glandular tissue.[1] In an average herd, there is a very high prevalence of subclinical mastitis especially during late lactation, as chronic infections are at their highest prevalence.[2] Mastitis can persist through lactation and the dry period, and re-infection is very common. With clinical mastitis, fever is often present, the mammary glands may appear swollen and hard, the supramammary lymph nodes enlarge, and the milk from affected glands has an abnormal color and consistency. Most cases of clinical mastitis in the goat are sporadic, but there has been reports of herd outbreaks. Cure rates of clinical mastitis vary according to the severity of the infection and the causative infectious agent.

History and Presentation:

An approximately 3-year-old Saanen doe presented to the Mississippi State University College of Veterinary Medicine Food Animal Service on August 25, 2020, for suspected mastitis and evaluation for a mastectomy to remove the affected portion of the udder. The owner noticed a lump in the doe's right mammary gland in December of 2019 immediately after freshening. The lump doubled in size over the next few months, and a second lump was appreciated in the left mammary gland on August 22, 2020. Milk from both glands was tested at the beginning of August, and the somatic cells count was elevated at 3 million cells/mL (with normal counts

ranging between 600,000 to 800,000 cells/mL). Based on these results, the owner started treatment with tulathromycin (Draxxin) and pirlimycin (Piruse) for two days but saw no improvement. The doe was then taken to Auburn University College of Veterinary Medicine on August 23, 2020, with a fever of 107 degrees Fahrenheit. At this time, intravenous oxytetracycline and dexamethasone were given in addition to vitamin B complex. The next day, the doe received enrofloxacin (Baytril), thiamine, bovine probiotic gel (Probios), oral electrolytes, a digestive paste supplement (Immediate Response), and flunixin meglumine (Banamine). Three milk cultures were performed while she was treated at Auburn CVM, and *Staphylococcus aureus* from the left gland and *Klebsiella pneumoniae* from the right gland were isolated. The owner elected to bring the doe to Mississippi State for further assessment and treatment.

On initial presentation, the doe was quiet, alert, and responsive, had a body condition score of 3/5 (with 3 being ideal), and weighed 67 kilograms. She had a rectal temperature of 103.5 degrees Fahrenheit, an increased respiratory rate of 36 breaths per minute, and an increased pulse of 132 beats per minute. No arrhythmias, murmurs, crackles, or wheezes were noted on cardiopulmonary auscultation. Ruminal contractions were weak, and one rumination per minute was auscultated (normal: one to three ruminations per minute). Bilateral mucoid green discharge in both nostrils was noted. The sclera was mildly ejected, the mucus membranes were pink, and the capillary refill time was less than 2 seconds. Upon palpation, the doe's supramammary lymph nodes were enlarged on both sides. The left mammary gland was warm upon palpation and moderately swollen. The right mammary gland appeared normal with no redness, heat, or obvious swelling. On further inspection, the right mammary gland had very little milk and a 3–4-centimeter lump was palpated, and a 1–2-centimeter lump was also palpated

in the left mammary gland. A milk sample collected from the left side of the udder revealed brown liquid with fibrin. Similarly, a milk sample was obtained from the right mammary gland. This sample yielded a small amount of white to yellow, thick fluid with large amounts of fibrin.

Pathophysiology:

Intramammary infection begins with exposure to an infectious agent, which then enters and colonizes the mammary gland. These infectious agents can also invade the mammary tissue when damage to the teats occur from fly bites, nursing, wounds, or during milking. Inflammation in the mammary gland is then initiated by the host's immune response. The intensity of the inflammatory response determines if the mastitis is clinical or subclinical.[6] Mastitis is transient and mild if the host's immune system effectively clears the infection. However, if the host becomes immunocompromised due to increased stress or the pathogen can successfully evade the host's immune system, a more severe or chronic case of mastitis occurs. Subclinical mastitis results in normal appearance of the animal and the mammary glands. Leukocytosis and other soluble changes do occur in the milk, but it also has a normal appearance. In cases of clinical mastitis, initially there is a decrease in milk production accompanied by abnormalities in the milk produced by the affected portion of the udder. Milk from the affected side appears abnormal with large clots or flakes, fibrin, and a change in color and consistency (thin and watery). As the intramammary infection becomes more severe, changes to the udder also occur. Asymmetry of the udder is appreciated in addition to erythema, edema, and pain on palpation of the affected half. In the most severe clinical mastitis cases, changes in the milk and udder are accompanied by signs of systemic illness such as lethargy, fever, or inappetence.

Infectious agents that cause mastitis are categorized as either contagious or environmental based on reservoirs on the farm and the most likely source of initial exposure.[6]

Transmission of environmental pathogens occurs when the teat is exposed to these pathogens through environmental sources such as soil, bedding, contaminated water, or fecal material. Infection can also occur by use of contaminated intramammary infusion cannulas or improperly disinfecting the teat end before intramammary infusions. Environmental pathogens include Gram-negative streptococci or coliforms such as *Klebsiella pneumoniae* and *Escherichia coli*.[7] Other Gram-negative bacteria include *Pseudomonas aeruginosa*. While coliforms and streptococci are commonly isolated, there are numerous other organisms found in the environment that can cause mastitis.[6] Contagious pathogens are spread from animal to animal. Exposure most often occurs during milking, and these pathogens can be spread by hands of milking technicians, towels used to dry the teats, or on the milking equipment. Contagious pathogens include *Mycoplasma* spp., *Streptococcus agalactiae*, and *Staphylococcus aureus*. Intramammary infections with *Staphylococcus aureus* can sometimes progress to gangrenous mastitis, which is characterized by ischemic necrosis of the udder. While many organisms have been classified as contagious or environmental, there have been multiple cases of contagious transmission of a supposedly environmental pathogen such as *Klebsiella* spp.[8]

Diagnostic Approach:

To identify cases of subclinical mastitis and to support a diagnosis of clinical mastitis, there are various diagnostic tests that can be performed. Measuring an individual's somatic cell count is one method of identifying cases of subclinical mastitis that can potentially progress to clinical mastitis. Compared to cows and sheep, the somatic cell count of goats is not as specific to infection. Increases in somatic cell count in goats is associated with days in milk, stressors, the onset of estrus, and increased parity in addition to infection.[5] Many automated somatic cell count methods are inaccurate when used for goat milk. Goats produce milk by apocrine secretion, and

there is a large quantity of non-nucleated cellular debris released, known as cytoplasmic particles. The cytoplasmic particles are similar in size to milk somatic cells, which falsely elevates the total somatic cell count. For this reason, a milk somatic cell count in goats is more accurate when direct microscopic counts are performed using pyronin Y methyl green staining. DNA-specific counting mechanisms are also used to accurately enumerate somatic cells in goat milk. While several noninfectious causes can increase somatic cell count, intramammary infection is the most common cause.[5]

Another option is a California Mastitis Test (CMT). Used in conjunctional with clinical signs, a CMT is low-cost and supportive of a diagnosis of subclinical mastitis. For more severe cases, a strip cup test is the most effective test that supports a clinical mastitis diagnosis. A CMT can also determine if one gland has more somatic cells than the other or if both are showing high somatic cell numbers. This test is often used as a screening test to identify a goat with a high somatic cell count in their milk. A third option is performing a culture and sensitivity on the milk obtained from each half of the udder. Performing a milk culture is a cost-effective method that allows confirmation of what bacteria are present in the milk and directs antibiotic therapy for that particular pathogen. Performing a culture also aids in determining sources of infection, as some infectious agents are contagious and spread from animal to animal while others only spread through environmental contamination.

Ultrasound is a non-invasive method used to visualize teat structures and the glandular parenchyma. It allows for localizing and examining the extent of pathologic changes in the udder including inflammation, tissue proliferation, mucosal lesions, milk stones, hematoma formations, or abscessations.[3] In cases of mastitis, the udder parenchyma can have areas of increased or decreased echogenicity depending on the infectious causative agent. For example, small areas of

hyperechogenicity are indicative of gas formation within the udder parenchyma, indicating infection with specific bacteria such as *Clostridium* spp. and *Staphylococcus aureus*.[4]

In cases where other diagnostics are insufficient in providing a cause of mastitis, a mammary gland biopsy can be performed. The biopsied tissue can be used for histopathologic analysis, viral isolation, or bacterial culture. Biopsy is not performed in routine cases but instead reserved for complicated cases in which a definitive diagnosis is warranted and necessary for directing treatment options.[5] Ultrasound-guided biopsy is especially helpful in sampling a specific area where localized lesions are present.

Treatment and Management Options:

Treatment of mastitis is dependent on the causative agent, but cure rates may vary depending on the animal and severity of the case. Even with treatment, some cases of clinical mastitis can become subclinical instead of resolving completely. Because mastitis treatment in goats involves extra-label drug usage, an appropriate veterinarian-client-patient relationship is crucial for proper treatment. Systemically ill animals are treated with a combination of supportive care and appropriate antibiotic therapy based off milk culture and sensitivity. Supportive care includes intravenous fluids and administration of anti-inflammatory agents such as non-steroidal anti-inflammatory drugs. Glucocorticoid therapy such as dexamethasone can be administered early in the disease course, as it can reduce swelling in the mammary gland. Intramammary infusion therapy is usually reserved for animals with local signs of clinical mastitis. Treatment of subclinical mastitis may be pursued by dairy farms with use of dry-off intramammary antibiotic therapy. Culling an individual with clinical, chronic, and recurrent intramammary infections may be warranted.[2] Animals with chronic subclinical mastitis should be milked last to decrease potential spread of the organism to other herd members or culled from

the milking herd. Surgical intervention can be an effective treatment that maintains a good quality of life for pet goats or genetically valuable animals. Mastectomies are often performed for gangrenous mastitis that is unresponsive to medical treatment or localized mammary disease.

Case Details:

Initial diagnostics performed on the doe included a complete blood count (CBC), a serum chemistry profile, a fecal flotation (eggs per gram), a milk culture and sensitivity of milk from each gland, and an udder ultrasound. The owner of this doe also performed somatic cell counts on this doe's milk monthly and noticed that the somatic cell count was abnormally high (2 million cells/mL), decreased as intramammary antibiotic infusions were started (400,000 cells/mL), and then increased again a month prior to presentation (3 million cells/mL). On CBC, a moderate neutropenia and leukopenia were present. On serum chemistry, hyperchloremia, hypoglycemia, hypoproteinemia, hypocholesterolemia, hypophosphatemia, hypomagnesemia, hyperbilirubinemia, a decreased GGT, an increased BUN, and an increased creatinine were seen. A fecal flotation (eggs per gram count) was performed and was within normal limits. When a milk culture was performed at MSU-CVM, the clinically affected left side of the udder showed greater than 10,000 CFU/mL of a multi-drug resistant *Staphylococcus intermedius*. A milk culture of the right side showed greater than 10,000 CFU/mL of a multi-drug resistant *Pseudomonas aeruginosa* and greater than 1,500 CFU/mL of a multi-drug resistant *Klebsiella pneumoniae ssp. pneumoniae*. In this doe's case, the milk cultures indicated that initial antibiotic therapy was ineffective, as the cultured bacteria and their antibiotic susceptibility were different from what were originally cultured from Auburn University College of Veterinary Medicine. An ultrasound on the patient's udder was performed to evaluate the extent of inflammation and to examine the parenchyma for abscessation. The doe's left mammary parenchyma was diffusely

thickened. In the teat cistern and milk ducts, large amounts of fibrin were seen. These changes were indicative of heavy inflammation and infection. No other abnormalities were noted. On the right side, a mild amount of fibrin was seen in the cistern and milk ducts, but no inflammation of the parenchyma was noted. A biopsy of affected mammary tissue was submitted for bacterial culture following an emergency mastectomy on the patient, and heavy growth of *Staphylococcus intermedius* was seen. In this case, a biopsy prior to surgery would not have affected the course of treatment or the decision to perform a mastectomy.

Initial treatment of the doe in this case was aimed at correcting electrolyte abnormalities seen on bloodwork and combat the progressing infection and sepsis. She was started on intravenous Lactated Ringers with 500 milliliters of 50% dextrose to make a 2.5% dextrose solution and 10 milliliters of vitamin B complex at a rate of 300 ml/hour (twice maintenance rate). To address her intramammary infection, she was administered 20 mg/kg of oxytetracycline (100 mg/ml) intravenously, 0.25 mg/kg of flunixin meglumine (Banamine) intravenously, 1 mg/kg of pantoprazole (4 mg/ml) intravenously once daily, and intramammary infusion of 10 ml of ceftiofur hydrochloride into both sides of the udder. On the third morning of hospitalization, the patient's left udder was dark and discolored, and the teat end was cold and swollen with dark green to black discoloration. Gangrenous mastitis was suspected in the doe's left mammary gland, so an emergency radical mastectomy was performed. She was placed in dorsal recumbency under general anesthesia. Two incisions were made through the skin on both lateral margins of the udder and were extended around the entire udder. The skin was dissected down to the inguinal area, and the udder was lifted off the body wall using blunt dissection. The external pudendal arteries and veins and perineal arteries and veins were identified, double ligated, and transected. The udder was completely removed, and a Penrose drain was placed adjacent to the

incision site as the skin was closed. The patient recovered from anesthesia uneventfully. Following surgery, the patient was administered 40,000 IU/ml PPG (300,000 IU/ml) subcutaneously once daily, 20 mg/kg Nuflor (300 mg/ml) intramuscularly every 48 hours, and 1 mg/kg of pantoprazole (4 mg/ml) intravenously once daily along with intravenous Lactated Ringers at 300 ml/hour (twice maintenance) and Lactated Ringers containing ketamine, morphine, xylazine, and acepromazine at 150 ml/hr. The patient tolerated this treatment regimen well and slowly improved over the next four days in hospital.

Case Outcome:

The evening after the mastectomy surgery, the patient developed edema on her cranial ventrum that spread to her front legs. Emphysema was also present on her dorsal abdomen that spread caudally. The doe was administered a loading dose of 2 mg/kg of oral meloxicam for one day and then continued receiving 1 mg/kg of oral meloxicam for the next two days. However, on the third day after surgery, the owner elected to discharge the patient from the hospital and manage her at home instead. The owner was instructed to monitor the doe for signs of pain including teeth grinding or increased vocalization. The incision site was inspected daily for dehiscence, bleeding, discharge, or swelling. Over the next two weeks, the owner kept the doe in a small pen for monitoring and used an Elizabethan collar to prevent chewing at the incision. The doe's condition steadily improved over the next two weeks, and the edema and emphysema resolved. The incision site healed appropriately over the next month, and the doe continued to do well at home.

Conclusion:

Mastitis is an economically important disease of small ruminants, and it most commonly occurs in the subclinical form. If subclinical mastitis progresses to clinical mastitis, it can result

in severe disease, permanent damage to the mammary gland, or death. Routine measurement of an individual animal's somatic cell count can help reduce the impact of subclinical mastitis on milk quality and production in addition to decreasing cases that can progress to clinical mastitis.

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