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Mastitis: The Silent Enemy of Dairy Farming

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Key Points

1. **Mastitis: More Than Just an Udder Problem:** Mastitis is an inflammation of the mammary gland that affects animal health, milk quality, productivity and ultimately farm profitability. Both clinical and subclinical mastitis can cause considerable losses.
2. **Know the Warning Signs Before It Becomes Serious:** Changes in milk such as flakes, clots, watery appearance or abnormal colour, along with udder swelling, heat, hardness and pain, are important warning signs. Subclinical mastitis may show no obvious signs but can silently reduce milk production.
3. **Hygiene Is the First Line of Defence:** Clean milking practices, proper udder preparation, clean housing and bedding, post-milking teat dipping and maintaining hygienic milking equipment are essential for reducing the risk of infection.
4. **Early Detection Means Better Control and Less Loss:** Regular screening, early veterinary diagnosis, appropriate treatment and maintaining good herd records can help control mastitis, reduce antibiotic misuse, protect milk quality and improve overall dairy farm profitability.

Abstract

Mastitis is one of the most important health and production problems affecting dairy animals and remains a major challenge to profitable and sustainable dairy farming. It is characterized by inflammation of the mammary gland, commonly caused by bacterial infections and may occur in clinical or subclinical forms. While clinical mastitis is easily recognized by visible changes in the udder and milk, subclinical mastitis often remains unnoticed and can silently reduce milk yield and quality. Poor milking hygiene, contaminated housing and bedding, improper milking practices, teat injuries and inadequate udder management are important risk factors. Mastitis can result in reduced milk production, increased veterinary and treatment costs, discarded milk, premature culling and significant economic losses to farmers. Effective control requires a combination of good milking hygiene, proper udder care, regular screening for early detection, appropriate veterinary treatment, clean housing and preventive herd-health practices. Greater awareness among dairy farmers and timely intervention are essential for maintaining udder health, improving milk quality, reducing economic losses and promoting the overall health and productivity of dairy animals.

Introduction

Mastitis is one of the most common, economically important and challenging diseases affecting dairy animals worldwide. It is characterized by inflammation of the mammary gland, usually resulting from the invasion and multiplication of microorganisms within the udder. Bacterial pathogens are the most common cause of mastitis, with *Staphylococcus aureus*, *Streptococcus* spp., *Escherichia coli*, *Klebsiella* spp. and other environmental and contagious microorganisms playing important roles in the development of the disease. Mastitis is a complex condition influenced not only by the causative pathogen but also by the

immune status of the animal, stage of lactation, environmental conditions, milking practices, housing, nutrition and overall herd management (Jiang et al., 2024).

The disease can occur in two major forms: clinical mastitis and subclinical mastitis. Clinical mastitis is generally recognized by visible abnormalities in the milk and udder, including swelling, heat, pain, redness, hardness of the affected quarter and the presence of flakes, clots, or watery secretions in milk. In severe cases, animals may also exhibit fever, depression, reduced feed intake, dehydration and other systemic signs. Subclinical mastitis, however, is often more difficult to detect because the affected animal may not show obvious external signs. Despite the absence of visible abnormalities, infection and inflammation can persist within the mammary gland, leading to increased somatic cell counts, deterioration in milk quality and gradual reduction in milk production. For this reason, subclinical mastitis is often considered a “silent” threat to dairy farming (Tommasoni et al., 2024).

Mastitis has a significant impact on both the quantity and quality of milk. Inflammation and damage to mammary tissue can reduce the milk-producing capacity of the udder and alter important milk constituents such as fat, protein, lactose, minerals and enzymes. These changes may reduce the nutritional and processing quality of milk and affect the production of dairy products. The economic consequences include reduced milk yield, discarded milk, veterinary expenses, diagnostic and treatment costs, increased labour requirements, reduced reproductive and productive performance, premature culling and the cost of replacing chronically affected animals. Therefore, mastitis represents not only a veterinary health problem but also a major obstacle to profitable and sustainable dairy production (Sindhu et al., 2024).

Several factors can increase the risk of mastitis. Poor milking hygiene, improper udder preparation, contaminated hands or milking equipment, dirty and wet bedding, inadequate housing sanitation, teat injuries, poor drainage and failure to follow proper milking procedures can facilitate the entry and spread of mastitis-causing pathogens. Environmental conditions also play an important role, particularly when animals are maintained under unhygienic or stressful conditions. Effective mastitis prevention therefore requires a combination of proper animal management, clean housing, hygienic milking practices, regular udder examination, teat disinfection and continuous monitoring of milk quality (Sharun et al., 2021).

Another important concern in modern mastitis management is the increasing problem of antimicrobial resistance (AMR). Although antimicrobial therapy remains important for the treatment of selected bacterial infections, inappropriate or indiscriminate use of antibiotics may contribute to the emergence and spread of resistant microorganisms. This has increased interest in accurate diagnosis, pathogen identification, antimicrobial susceptibility testing, selective treatment strategies and the development of alternative or complementary approaches for mastitis control. Recent studies emphasize the importance of antimicrobial stewardship and evidence-based treatment decisions to reduce unnecessary antimicrobial use while maintaining animal health and welfare (Barlow, 2025; Maalaoui et al., 2025).

Early detection and prevention remain the most effective approaches to mastitis control. Regular monitoring using clinical examination, milk testing, somatic cell count and screening methods such as the California Mastitis Test can help identify affected animals at an early stage. Maintaining proper milking hygiene, using appropriate pre- and post-milking teat disinfection, ensuring clean and comfortable housing, maintaining milking equipment and seeking timely veterinary advice are essential components of an effective udder-health programme. In addition, accurate record keeping and identification of recurrently affected animals can help farmers and veterinarians develop targeted control strategies (Kour et al., 2023).

Thus, mastitis is rightly described as a silent enemy of dairy farming, particularly because subclinical infections can remain unnoticed while continuously reducing productivity and milk quality. Successful control requires a preventive and integrated approach involving early diagnosis, good hygiene, proper animal management, rational antimicrobial use and

regular monitoring of udder health. By improving awareness and adopting effective preventive measures, dairy farmers can reduce the occurrence of mastitis, improve animal welfare and milk quality, minimize economic losses and promote a healthier, more productive and sustainable dairy enterprise (Panchal et al., 2024).

Etiology

Mastitis is a multifactorial inflammatory disease of the mammary gland, most commonly caused by the entry and multiplication of pathogenic microorganisms through the teat canal. Although bacteria are the predominant etiological agents, the occurrence and severity of mastitis depend on a complex interaction between the infectious agent, host animal and environmental and management factors. The major bacterial pathogens associated with bovine mastitis include *Staphylococcus aureus*, *Streptococcus agalactiae*, *Streptococcus dysgalactiae*, *Streptococcus uberis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Corynebacterium* spp. and *Mycoplasma* spp. Other organisms, including coagulase-negative *Staphylococcus* spp., *Enterococcus* spp., *Trueperella pyogenes*, *Pseudomonas* spp. and various environmental Gram-negative bacteria, may also cause intramammary infections.

Mastitis-causing pathogens are commonly classified into contagious and environmental pathogens according to their major source and mode of transmission. Contagious pathogens, particularly *S. aureus* and *S. agalactiae*, are primarily associated with infected mammary glands and are transmitted from infected to healthy animals during milking through contaminated hands, towels, teat cups or milking equipment. These organisms can establish persistent infections and may result in recurrent or chronic mastitis. Environmental pathogens, on the other hand, originate mainly from bedding, manure, soil, water, feed and other surroundings. Important environmental pathogens include *E. coli*, *Klebsiella* spp. and *Streptococcus uberis*. The risk of infection increases when teat ends come into contact with contaminated environments, particularly during the period immediately before and after milking when the teat canal may provide an opportunity for microorganisms to enter the mammary gland.

The host factors also play an important role in determining susceptibility to mastitis. The anatomical structure and condition of the teat canal provide the first physical barrier against invading microorganisms. Teat-end damage, hyperkeratosis, wounds, cracks and incomplete closure of the teat canal can facilitate bacterial penetration. Animals in early lactation and around the dry period may be particularly vulnerable because of physiological changes in mammary-gland defence mechanisms. Age, parity, stage of lactation, genetic susceptibility, nutritional status, immune competence, previous history of mastitis and other concurrent diseases can further influence the likelihood and severity of infection. High-producing animals may also experience increased susceptibility because of greater physiological demands and frequent milking.

Environmental and management factors strongly influence exposure to mastitis pathogens. Poor sanitation, wet or contaminated bedding, inadequate manure disposal, overcrowding, poor ventilation, muddy surroundings and insufficient cleaning of housing areas can increase the microbial load to which teat ends are exposed. Improper milking procedures, inadequate udder preparation, failure to disinfect teats after milking, incorrect use or maintenance of milking machines, excessive vacuum and poor milking-machine hygiene can facilitate pathogen transmission. Stress, inadequate nutrition, heat stress and poor overall herd management may further compromise immune defence and increase susceptibility to intramammary infection. Thus, mastitis should not be attributed to a single microorganism alone; rather, it results from the interaction of pathogen load and virulence, host resistance and environmental exposure.

Among the bacterial agents, *Staphylococcus aureus* is particularly important because it can establish persistent infections within mammary tissue and may be difficult to eliminate completely. Its ability to adhere to mammary epithelial cells, invade tissues, form biofilms and evade host immune responses contributes to chronicity and treatment difficulties. *Streptococcus agalactiae* is primarily a contagious pathogen and can spread efficiently within

a herd when milking hygiene is inadequate. In contrast, *E. coli* and other Gram-negative environmental pathogens can produce acute and sometimes severe inflammatory responses, with endotoxins contributing to systemic illness in severe cases. *Streptococcus uberis* is another important environmental pathogen and is frequently associated with infections occurring around the dry period and early lactation. The relative importance of these pathogens varies between farms and geographical regions, making local pathogen surveillance and microbiological diagnosis important components of effective mastitis-control programmes.

In addition to bacteria, fungi, yeasts, algae and occasionally other microorganisms can cause mastitis, although these infections are generally less common than bacterial mastitis. Yeasts such as *Candida* spp. and *Cryptococcus* spp. may be associated with opportunistic or treatment-associated infections, particularly following repeated or inappropriate intramammary antimicrobial therapy. *Prototheca* spp., an achlorophyllous alga, can also cause chronic mastitis and may be difficult to treat. Such infections highlight the importance of identifying the causative organism before repeated antimicrobial treatment is undertaken. Overall, the etiology of mastitis is complex and dynamic and understanding the specific pathogens and predisposing factors involved is fundamental for developing effective prevention, diagnosis, treatment and herd-level control strategies.

Clinical Signs

The clinical presentation of mastitis varies considerably depending on the causative pathogen, severity and duration of infection, immune status of the animal and whether the disease is clinical or subclinical. Mastitis may range from mild inflammation confined to a single quarter of the udder to severe systemic disease. The major clinical signs include:

1. Changes in the udder: The affected quarter may become swollen, enlarged, warm, firm, hard, reddened and painful. The animal may resist milking or kick during milking because of udder pain. In chronic cases, the affected quarter may become firm, fibrotic or atrophied.
2. Abnormal milk: Changes in milk are among the earliest recognizable signs. Milk may contain flakes, clots, strings, pus, blood or watery material and may show abnormal colour or consistency. Milk production from the affected quarter generally decreases.
3. Reduction in milk yield: Even when obvious changes are not present, mastitis can cause a noticeable decline in milk production. In subclinical mastitis, reduced production may be the only economically important indication of disease.
4. Systemic signs: Severe cases, particularly those caused by highly pathogenic environmental bacteria such as *E. coli*, may produce fever, depression, weakness, loss of appetite, dehydration, rapid breathing, reduced rumination and reduced activity. The animal may become reluctant to stand or move.
5. Changes in milk quality: Mastitis is frequently associated with an increase in somatic cell count (SCC) and alterations in milk composition. Although these changes cannot always be detected visually, they are important indicators of subclinical infection and udder inflammation.
6. Subclinical mastitis: Animals with subclinical mastitis generally show no obvious abnormalities in the udder or milk. However, the infection may cause increased SCC, reduced milk yield and deterioration of milk quality. This form is particularly important because infected animals can remain undetected and contribute to transmission within the herd.
7. Chronic and recurrent cases: Long-standing mastitis may result in fibrosis, hardening or shrinkage of the affected quarter, recurrent abnormal milk, persistent elevation of SCC and progressive loss of milk-producing tissue. Chronically affected animals may eventually require culling.

Diagnosis

Diagnosis of mastitis involves clinical examination, examination of milk, screening for subclinical infection and identification of the causative microorganism. Because subclinical mastitis may occur without visible changes in the udder or milk, combining several diagnostic methods provides a more reliable assessment.

1. Clinical examination: The udder and individual quarters should be examined for swelling, heat, redness, hardness, pain, enlargement or atrophy. The animal should also be assessed for systemic signs such as fever, depression, reduced appetite and decreased milk production.
2. Examination of milk: Milk from each quarter should be examined for changes in colour, consistency, odour and appearance. The presence of flakes, clots, pus, blood, watery milk or other abnormal material is suggestive of clinical mastitis. The first streams of milk are particularly useful for detecting abnormalities.
3. California Mastitis Test (CMT): CMT is a simple, rapid and inexpensive field test widely used for detecting subclinical mastitis. The test is based on the reaction between the detergent reagent and somatic cells present in milk. An increase in somatic cells produces greater thickening or gel formation, with the intensity of the reaction providing an indication of inflammation.
4. Somatic Cell Count (SCC): SCC is an important indicator of mammary-gland inflammation. An elevated SCC suggests intramammary infection or inflammation and is particularly useful for identifying subclinical mastitis. It can be performed on individual-quarter milk or bulk-tank milk.
5. Milk pH and electrical conductivity: Mastitis can alter the ionic composition of milk, resulting in changes in pH and electrical conductivity. Portable conductivity meters and automated milking systems can therefore assist in early detection and continuous monitoring of udder health.
6. Microbiological examination: Milk culture is important for identifying the causative pathogen. Aseptic milk samples are collected from the affected quarter and cultured to identify organisms such as *Staphylococcus aureus*, *Streptococcus* spp., *Escherichia coli*, *Klebsiella* spp. and other pathogens. Microbiological diagnosis is particularly valuable in recurrent, severe or treatment-resistant cases.
7. Antimicrobial susceptibility testing: When a bacterial pathogen is isolated, antimicrobial susceptibility testing can help determine which antibiotics are likely to be effective. This supports responsible antimicrobial use and helps reduce unnecessary antibiotic treatment and the development of antimicrobial resistance.
8. Advanced diagnostic methods: Molecular techniques such as PCR and other nucleic-acid-based tests can provide rapid and sensitive detection of specific mastitis pathogens. Automated sensors, infrared milk analysis, milk-quality monitoring systems and other precision-dairy technologies are increasingly being explored for early detection.

Treatment

Treatment of mastitis should be based on the severity of disease, clinical condition of the animal, likely or confirmed causative organism and antimicrobial susceptibility where available. The main objectives are to eliminate infection, control inflammation and pain, restore normal milk production and prevent recurrence and spread within the herd. Because indiscriminate antibiotic use can contribute to antimicrobial resistance, treatment should preferably be carried out under veterinary supervision.

1. Assessment of the case: Animals should first be examined to determine whether the case is mild, moderate or severe. Milk from the affected quarter may be collected for microbiological culture and antimicrobial susceptibility testing, particularly in severe, recurrent or treatment-failure cases.
2. Antimicrobial therapy: Antibiotics may be indicated for confirmed or strongly suspected bacterial mastitis. Depending on the case, treatment may involve an appropriate

intramammary preparation, systemic therapy or both. The choice of drug should be based on the suspected pathogen, culture and sensitivity results when available, local resistance patterns and veterinary judgement. Antibiotics should not be used routinely for every case of mastitis.

3. Anti-inflammatory and pain management: Mastitis can cause considerable inflammation and pain. Appropriate non-steroidal anti-inflammatory drugs (NSAIDs) may be administered under veterinary guidance to reduce inflammation, pain, fever and systemic discomfort. This is particularly important in moderate to severe cases.
4. Frequent removal of milk: Frequent and gentle milking of the affected quarter can help remove inflammatory material and milk containing microorganisms. However, excessive or rough manipulation should be avoided because it can further irritate the mammary tissue. Milk from treated animals must be appropriately segregated and discarded according to the prescribed withdrawal period.
5. Fluid and supportive therapy: Animals with severe mastitis, particularly those showing dehydration, depression, fever, weakness or signs of endotoxaemia, may require intravenous fluids, electrolyte therapy, nutritional support and other intensive supportive measures. Severe cases should be treated as veterinary emergencies.
6. Management of chronic cases: Chronic or recurrent mastitis may be difficult to eliminate, particularly when organisms such as *Staphylococcus aureus* persist within mammary tissue. Such animals require careful evaluation and repeated empirical antibiotic treatment should be avoided. Persistently infected animals may need to be separated from healthy animals and in some circumstances, considered for culling as part of a herd-control programme.
7. Preventing antimicrobial resistance: Treatment should follow the principles of antimicrobial stewardship. Unnecessary antibiotics, incorrect dosages, inappropriate treatment durations and repeated empirical therapy should be avoided. Recent mastitis-management approaches increasingly support selective treatment of suitable cases rather than automatic antibiotic treatment of every episode.
8. Follow-up: The animal should be monitored after treatment for resolution of clinical signs and restoration of milk quality. Re-examination and repeat milk testing may be appropriate in recurrent or persistent cases.

Prevention, Management and Control

Effective control of mastitis requires a herd-level approach based on prevention, early detection, hygienic milking, appropriate treatment and continuous monitoring. Since mastitis is influenced by infectious, environmental, animal and management factors, treatment of individual cases alone is not sufficient to control the disease.

1. Prevention

- Maintain proper milking hygiene: Wash and clean hands before milking and use clean, dry towels for udder preparation.
- Clean the udder and teats: Teats should be properly cleaned and dried before milking. Avoid milking animals with visibly dirty udders without adequate cleaning.
- Pre- and post-milking teat disinfection: Appropriate teat disinfectants should be used before and particularly after milking to reduce transmission of mastitis-causing organisms.
- Maintain clean housing: Provide clean, dry and comfortable bedding and regularly remove manure and contaminated bedding.
- Ensure proper milking-machine hygiene: Milking equipment should be correctly maintained, cleaned and disinfected. Faulty equipment and inappropriate vacuum levels can damage teat tissue and increase infection risk.
- Prevent teat injuries: Rough handling and improper milking practices should be avoided because damaged teat ends provide opportunities for bacterial invasion.
- Provide balanced nutrition: Adequate energy, protein, vitamins and minerals are important for maintaining immune function and resistance to infection.

- Maintain good dry-period management: Appropriate dry-cow management is important for preventing new infections and allowing mammary tissue to recover between lactations.

2. Management

Regular udder-health monitoring is essential for early identification of infected animals. Animals should be examined routinely for changes in milk, udder appearance and milk production. Screening methods such as the California Mastitis Test (CMT) and somatic cell count can help detect subclinical infections that cannot be identified by visual examination. Animals suspected of having mastitis should be evaluated promptly and milk samples may be collected for microbiological examination in recurrent, severe or treatment-resistant cases. Accurate records of mastitis cases, treatment, milk yield and recurrence should be maintained. Chronically infected animals, particularly those repeatedly shedding contagious pathogens, may need to be managed separately to reduce transmission to healthy animals. Good milking order is also useful: healthy animals should preferably be milked before animals known or suspected to be infected. Separate towels and appropriate hygiene procedures should be used for different animals to minimize cross-contamination.

3. Control

Control programmes should focus on breaking the cycle of infection between infected animals, the milking process and the environment. Clinical cases should be diagnosed and treated promptly under veterinary supervision. Antibiotics should be used judiciously and where appropriate, guided by microbiological diagnosis and antimicrobial susceptibility testing. Unnecessary or repeated antimicrobial treatment should be avoided to reduce the risk of antimicrobial resistance. Particular attention should be given to subclinical mastitis, as infected animals may appear healthy while continuing to experience reduced production and potentially transmitting pathogens within the herd. Regular SCC or CMT screening can help identify these animals. Animals with persistent or recurrent infections should be evaluated for possible chronic infection and appropriate herd-level control measures.

Conclusion

Mastitis remains one of the most important health and economic challenges in dairy farming because it affects animal health, milk production, milk quality, welfare and farm profitability. The disease is often associated with bacterial infections, but its occurrence is strongly influenced by hygiene, housing, nutrition, milking practices, environmental conditions and the immune status of the animal. While clinical mastitis can be readily recognized through changes in the udder and milk, subclinical mastitis may remain unnoticed and cause continuous production losses. Therefore, early detection through regular udder examination, CMT, somatic cell counting and appropriate laboratory diagnosis is essential. Effective control should emphasize prevention through hygienic milking, proper teat disinfection, clean housing, good nutrition, appropriate dry-period management and regular herd monitoring. When treatment is required, it should be based on veterinary advice and responsible antimicrobial use. A consistent, farm-level mastitis-control programme can reduce disease occurrence, minimize economic losses and antimicrobial use, improve animal welfare and milk quality and contribute to a healthy, productive and sustainable dairy farming system.

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