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Popular Article

Bovine Mastitis: Understanding the Zoonotic Risks and Implications for Public Health

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Abstract:

Bovine mastitis is an inflammation of the udder tissue in cows, typically caused by an infection. It's a major health concern in dairy farming, as it affects milk production and quality. Mastitis can result in the milk becoming contaminated, leading to reduced milk yield, changes in milk composition and potential economic losses for dairy producers.

Bovine mastitis, while primarily a concern for dairy cattle, can have zoonotic implications, meaning certain pathogens responsible for mastitis can be transmitted to humans. However, the zoonotic risk associated with mastitis varies depending on the specific pathogens involved and the management practices on the farm.

Causes of Bovine Mastitis:

1. **Bacterial Infections:** The most common cause, with pathogens like Staphylococcus aureus, Streptococcus uberis and Escherichia coli being frequently implicated. Contagious pathogens (e.g., Staphylococcus aureus) are spread from cow to cow, often via contaminated milking equipment, handlers' hands, or contact between cows. Environmental pathogens (e.g., E. coli, Streptococcus uberis) come from the cow's surroundings, such as dirty bedding, manure, or wet conditions.
2. **Physical Injury:** Trauma to the udder, such as rough handling, injury from milking equipment, or injury from rough pasture, can also cause mastitis.
3. **Poor Hygiene:** Inadequate cleaning of cow's udders before milking, dirty milking equipment, or unsanitary living conditions can increase the risk of infection.
4. **Weak immune system:** Cows with compromised immune systems (due to poor nutrition, stress, or other diseases) are more susceptible to infections.

Zoonotic Pathogens Associated with Bovine Mastitis:

1. **Staphylococcus aureus:**

Zoonotic potential: Staphylococcus aureus, a major pathogen causing both clinical and subclinical mastitis in cattle, is considered zoonotic. It can infect humans, particularly those who handle cows or their milk, such as dairy farm workers and veterinarians.

Human infections: S. aureus can cause skin infections, respiratory issues and in rare cases, more serious systemic infections, such as bacteremia or endocarditis. Methicillin-resistant S. aureus (MRSA), which is becoming more common in both humans and animals, poses an additional concern because of its resistance to many antibiotics.

Transmission: The pathogen can be transmitted through direct contact with infected cows, contaminated milk, or surfaces that have come into contact with infected milk or animals. Infected milk that is not pasteurized could potentially transmit the bacteria to humans.

2. **Escherichia coli (E. coli):**

Zoonotic potential: Certain strains of E. coli, particularly E. coli O157, have significant zoonotic potential. While E. coli is a common environmental pathogen associated with mastitis in cattle, its role in direct transmission from cows to humans is less frequent than Staphylococcus aureus.

Human infections: E. coli O157 is a major concern because it can cause severe gastrointestinal illness, including bloody diarrhea, hemolytic uremic syndrome (HUS) and kidney failure. Infections in humans are typically associated with the consumption of contaminated food, including raw or unpasteurized milk.

Transmission: E. coli can be transmitted through contaminated milk, especially if the milk is not pasteurized. Handling or consuming raw milk or milk products from infected cows increases the risk of zoonotic transmission.

3. **Brucella spp.:**

Zoonotic potential: Brucella is responsible for brucellosis, can infect cattle and cause mastitis. Brucellosis is a well-known zoonotic disease that can be transmitted to humans, causing flu-like symptoms, reproductive issues and, in rare cases, chronic systemic infections.

Human infections: Brucellosis in humans typically results from direct contact with infected animals (via handling tissues, fetuses, or reproductive fluids) or the consumption of unpasteurized dairy products. The disease can cause fever, muscle pain, fatigue, and complications like arthritis and endocarditis.

Transmission: The primary risk of transmission to humans is through the consumption of unpasteurized milk or contact with bodily fluids from infected cows. Pasteurization of milk effectively kills Brucella bacteria, preventing the zoonotic risk.

4. **Mycobacterium bovis:**

Zoonotic potential: Mycobacterium bovis, the causative agent of bovine tuberculosis (TB), can infect cattle and cause mastitis, though it is a relatively rare cause. M. bovis is zoonotic and can infect humans, causing tuberculosis.

Human infections: Transmission to humans usually occurs through inhalation of aerosolized bacteria from infected animals (e.g., during handling, milking, or slaughtering), but it can also occur through the consumption of unpasteurized milk.

Transmission: Pasteurization of milk effectively eliminates the risk of M. bovis transmission through dairy products. However, in regions where TB control measures are not rigorous, unpasteurized milk could present a risk.

5. **Other potential zoonotic agents**:

   Other bacteria that cause mastitis, like Streptococcus species, may pose a lesser zoonotic risk, but infections in humans are less common and typically result in mild illnesses. Fungal infections (such as Candida species) are not typically zoonotic but can occasionally cause infections in immunocompromised individuals.

Factors Influencing the Zoonotic Risk:

- **Pasteurization:** The most important factor in reducing the zoonotic risk from bovine mastitis is the pasteurization of milk. Pasteurization effectively kills most pathogenic bacteria, including S. aureus, E. coli, Brucella, and Mycobacterium bovis, which could otherwise be transmitted to humans.
- **Farm Hygiene and Handling Practices:** Proper milking hygiene, including the use of clean equipment and sanitization of the udder, reduces the likelihood of contamination of milk with harmful pathogens.
- **Worker Safety:** Individuals who are directly involved in the handling of cows, milking, or working in dairy facilities should follow strict hygiene protocols, including wearing protective clothing, washing hands thoroughly, and avoiding direct contact with milk that hasn't been pasteurized.
- **Animal Health Management:** Regular veterinary care, including monitoring for mastitis and controlling infections like brucellosis and tuberculosis, is crucial to minimize the risk of zoonotic diseases. Culling infected animals may also be necessary in certain cases.
- **Regulations:** In many countries, there are strict regulations in place to ensure the safety of milk and dairy products, which include mandatory pasteurization and regular testing of dairy herds for zoonotic pathogens. Compliance with these regulations significantly reduces the risk of zoonotic transmission.

Preventing Zoonotic Transmission:

- **Pasteurization:** This is the most effective method to eliminate the risk of zoonotic diseases from milk. Raw milk should be avoided, especially in areas where dairy animals may have undiagnosed infections.

- **Good Farm Hygiene:** Maintaining a clean environment for cows, proper milking equipment, and adequate cow health management practices can reduce the risk of mastitis and zoonotic transmission.
- **Vaccination and Testing:** Regular testing for zoonotic pathogens like Brucella and Mycobacterium bovis and vaccination programs for diseases like brucellosis and tuberculosis are important for controlling zoonotic risks at the farm level.

Symptoms of Mastitis:

- **Visible signs in milk:** Milk may appear clotted, watery, or contain blood or pus. There might also be a decrease in milk yield or changes in milk composition.
- **Physical signs in the udder:** The udder may become swollen, hot to the touch, and painful. There could also be redness, hardness, or abnormal texture in the udder.
- **Systemic signs:** In severe cases, cows may exhibit fever, loss of appetite, lethargy, or even sepsis in extreme situations.

Types of Mastitis:

1. **Clinical Mastitis:** This is evident with visible changes in milk and the udder. It can be either subclinical (with visible signs) or acute (severe, with systemic illness).
2. **Subclinical Mastitis:** This form is more difficult to detect, as there are no visible changes in the milk or udder, but it leads to elevated somatic cell counts (SCC) in milk. Subclinical mastitis is often identified through regular milk testing, as it can reduce milk quality and production over time.

Diagnosis:

1. **Somatic Cell Count (SCC)**:

   The SCC is used as an indicator of mastitis. Somatic cells are primarily white blood cells, which increase in number during inflammation. Elevated SCC suggests inflammation and infection in the udder. A high somatic cell count (SCC) in milk is a strong indicator of mastitis. SCC reflects the degree of inflammation in the udder. An elevated SCC (typically >200,000 cells/mL for individual cows, or >300,000–400,000 cells/mL for bulk tank milk) suggests the presence of mastitis, even in subclinical cases where no visible symptoms are apparent.

   a. The SCC is measured using automated instruments such as a fluorometric or electrical conductivity method. Milk samples from each quarter are tested, and the SCC is reported in cells per milliliter of milk.

   b. While a high SCC is a strong indicator of inflammation or infection, it does not identify the causative pathogen. It's a screening tool rather than a definitive diagnostic test.

2. **CMT (California Mastitis Test)**:

   The California Mastitis Test (CMT) is a simple, on-farm, indirect diagnostic tool that detects subclinical mastitis. It is a diagnostic tool that helps detect subclinical mastitis by mixing milk with a reagent that reacts with somatic cells. The CMT is used to quickly assess the somatic cell count and detect subclinical mastitis, which may not show visible signs like swelling or abnormal milk. A small amount of milk from each quarter is mixed with a reagent. The reagent reacts with the DNA in somatic cells. The reaction forms a gel or thickening that correlates with the SCC level.

Scoring system:

Negative (no reaction)	: No gel formation
Trace (slight gel formation)	: Mild inflammation
1+ (light gel)	: Moderate inflammation
2+ (medium gel)	: Significant inflammation
3+ (heavy gel)	: Severe inflammation

The CMT does not identify the specific pathogen causing mastitis, nor does it distinguish between contagious and environmental mastitis.

3. **Bacteriological Culture (Milk Culture):**

Milk culture is the gold standard for identifying the specific bacterial pathogen responsible for mastitis. This test helps to determine the causative agent (e.g., Staphylococcus aureus, Streptococcus uberis, Escherichia coli, etc.) and allows for antibiotic susceptibility testing to guide treatment. A sterile sample of milk is collected from the affected quarter(s) and cultured on a suitable medium (e.g., Blood agar, MacConkey agar). The culture is incubated to allow bacterial growth, and colonies are identified based on their morphology, staining characteristics, and biochemical properties.

This identifies the bacterial species responsible for the infection. It also helps in determining which antibiotics are effective against the isolated pathogen, helping veterinarians choose the best treatment. However, milk culture can take several days to yield results, which may delay treatment decisions. Additionally, some pathogens may not grow well in culture or require special media or conditions.

4. **PCR (Polymerase Chain Reaction):**

PCR is a molecular technique used to detect the DNA of specific pathogens in milk samples. It offers a faster and more sensitive method for detecting mastitis-causing pathogens compared to traditional culture methods, particularly for hard-to-culture organisms. A milk sample is processed, and DNA is extracted. Specific DNA sequences of pathogens (e.g., Staphylococcus aureus, Mycoplasma bovis, E. coli) are amplified and detected using fluorescent probes or gel electrophoresis. It can detect low concentrations of pathogens and can identify organisms that are difficult or slow to culture, such as Mycoplasma bovis, or viruses, like bovine leukemia virus (BLV).

However, PCR requires specialized equipment and expertise, and it may be more expensive than

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traditional culture. It is typically used for research or specialized diagnostics rather than routine clinical use.

5. **Milk Conductivity Testing:**
   Milk conductivity measures the electrical conductivity of milk, which increases during mastitis due to elevated sodium and chloride levels in the milk as a result of inflammation. It serves as an indirect indicator of mastitis, especially subclinical cases, and is often used in automated milk testing systems. Electrical conductivity is measured with a probe, and the readings are compared to baseline values (which are typically established from healthy cows). An increase in milk conductivity often correlates with a higher SCC, indicating inflammation or infection in the udder. While it is a good screening tool, it does not directly identify the pathogen and may not detect all types of mastitis.
6. **Direct Microscopic Examination:**
   Direct microscopic examination of milk can be used to observe the presence of somatic cells, bacteria, or other microorganisms. This method is typically used in combination with other tests to quickly assess milk quality and detect bacterial contamination. A drop of milk is placed on a slide, stained (e.g., Gram stain), and examined under a microscope. The presence of bacteria (e.g., cocci or bacilli) or a high number of somatic cells can suggest mastitis. It can help confirm the presence of bacteria and distinguish between Gram-positive and Gram-negative organisms, though it does not provide definitive identification of species. This method is less sensitive than culture and does not provide specific identification of pathogens.
7. **Enzyme-Linked Immunosorbent Assay (ELISA):**
   ELISA tests are used to detect antibodies or antigens related to mastitis-causing pathogens in milk. It can be used to identify exposure to certain pathogens (e.g., Streptococcus agalactiae, Mycoplasma bovis) or to monitor the immune response to infection. Milk samples are mixed with specific antibodies or antigens, and an enzyme-linked reaction is measured. The presence of the target antigen or antibody indicates exposure or infection. It can identify specific pathogens, including those that are difficult to culture, and may be useful for detecting subclinical infections or monitoring vaccination responses. ELISA tests typically indicate exposure rather than active infection, and they may not be as specific or sensitive as culture or PCR.

Treatment:

- **Antibiotics:** In cases caused by bacterial infections, antibiotics are commonly used. However, appropriate withdrawal periods must be observed before milk can be sold, as antibiotics can contaminate milk.
- **Anti-inflammatory drugs:** These can help reduce swelling and pain.
- **Udder sanitization:** Keeping the udder clean and dry, along with proper milking techniques, helps

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in preventing new infections.

- **Supportive care:** For severe cases, fluid therapy and systemic antibiotics may be necessary.

Prevention:

- **Good Hygiene:** Ensure cleanliness of the cow's environment, milking equipment, and workers. Regular cleaning of udders before milking is crucial.
- **Proper Milking Techniques:** Gentle milking practices, proper machine maintenance, and avoiding over-milking can help prevent trauma to the udder.
- **Nutrition and Health Management:** A balanced diet, stress reduction, and regular veterinary care contribute to overall cow health, making them less susceptible to infections.
- **Culling Chronically Infected Cows:** Removing cows that have repeated, untreatable infections can reduce the spread of contagious mastitis pathogens.

Conclusion:

In summary, bovine mastitis is a complex disease that requires a multifaceted approach for management and prevention. Early detection and proper treatment are critical for maintaining cow health and milk quality.

While not all cases of bovine mastitis involve zoonotic pathogens, certain bacteria that cause mastitis can indeed pose a risk to human health, especially through the consumption of raw milk or direct contact with infected animals. However, with proper dairy farm management, including pasteurization and good hygiene practices, the zoonotic risk can be minimized.

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