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Popular Article

Treatment of Mastitis, Antimicrobial Resistance, and MRSA

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Abstract

Mastitis refers to the inflammation of mammary gland. Management of mastitis needs the use of right antibiotic. Misuse of antibiotic leads to antimicrobial resistance. The most common cause of mastitis is *Staphylococcus aureus.* It is found that Methicillin resistant *Staphylococcus aureus* can affect the treatment strategies against mastitis. This writing includes the cause, symptoms, diagnosis, treatment, prevention and control strategies related to Antimicrobial Resistance, MRSA and Mastitis.

Keywords: AMR, Bovine, Mastitis, MRSA, Treatment, Prevention

Introduction

The term “Mastitis”, refers to the inflammatory reaction in the mammary gland, is derived from two Greek word ‘Masto’ meaning mammary gland and ‘itis’ meaning inflammation. Dairy cows that suffer from mastitis may see a reduction in milk output, both in terms of quality and quantity. Mastitis is one of the major problems affecting the dairy industry globally. Mastitis-affected dairy cows have reduced milk output by 30% every quartile, which can have an effect on decreasing milk production by 15% per dairy cow per lactation. The association between infectious

agents and milking management is generally associated with mastitis. Pathogenic bacteria are among the many forms of infectious organisms that are present in the environment of dairy cows and have the potential to endanger the production of dairy cows.

Among the different of bacteria causing mastitis, *Staphylococcus aureus* is the main pathogenic bacteria that is responsible for about 40% of cases of mastitis in dairy cows. β lactam antibiotic therapy which is often used in the treatment of mastitis cases in dairy cows, excessive and irrational antibiotic administration can cause a new problem namely the emergence of strains of bacteria that are resistant to antibiotics that are resistant to antibiotics. *Staphylococcus aureus* that is resistant to methicillin or known as Methicillin-resistant *Staphylococcus aureus* (MRSA) because penicillin-binding proteins (PBPs) are inhibited by antibiotics and PBPs (PBP2a) function with low affinity for most β-lactam antibiotics, Staphylococcus aureus (MRSA) is resistant to most β-lactam antibiotics.

Causative agents

Many pathogens have the potential to cause mastitis. *Streptococcus uberis*, *Streptococcus agalactiae*, *Trueperella pyogenes*, *Enterobacter aerogenes*, *Klebsiella* spp., *E. coli*, certain yeast (*Candida* spp., *Cryptococcus neoformans*, *Saccharomyces* spp.), and fungi (*Aspergillus* spp.) are among the environmental bacteria that can cause mastitis. *Staphylococcus aureus* is one of the main pathogenic bacteria that causes mastitis. *Staphylococcus aureus* infections in dairy cows can be a significant source of contamination in milk yields. When bacteria enter the mammary glands, they interact with the mammary epithelial cells, causing localized inflammation and a decline in the quality of the milk. *Staphylococcus aureus* infection can significantly reduce milk quantity and quality, particularly in dairy cows with sub-clinical mastitis. Because of its toxin-mediated pathogenicity, antibiotic resistance, and invasion, *Staphylococcus aureus* is one of the most significant pathogenic bacteria. Antibiotic-resistant *Staphylococcus aureus* is a serious global health concern that affects people due to the widespread use of antibiotics for animal growth and treatment.

Risk Factors

Host factors: Host defense mechanisms may be compromised by a variety of genetic, physiological, and environmental factors when the mammary gland goes through functional changes. The genetic selection of the lactating cow to yield more milk is the foundation of the dairy industry. But this increase in milk yield puts dairy cows under metabolic stress and damages

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their mammary gland immunology, lowering their defences against mastitis. Compared to indigenous cows, high yielding cross-bred cows are more prone to subclinical and clinical mastitis. Cattle of the Friesian breed is more susceptible to infection than cattle of the Ayrshire and Jersey breeds. In India, local zebu cattle had a lower risk of 31.25% and Holstein-Jersey breeds had a higher risk of 94.54%.

Older dairy cows are more vulnerable to infectious cases because of the dilated quartering conditions, this could also be because of their weakened immune systems and history of repeated exposure from prior infections. Compared to younger dairy cows, older cows have a twice higher risk of developing mastitis. Because the spread of infectious pathogens increases when dairy cows are breastfeeding if the maintenance management system is not managed properly, lacteting cows are more vulnerable to LA-MRSA (Livestock-associated methicillin-resistant *Staphylococcus aureus*) infections.

Environmental factors: Another element that raises the risk of mastitis is housing system. The reason for this is that too many animals are kept in a small space and that bedding material is used too frequently, which allows bacteria to proliferate and survive, overexposing the animals and impairing their immune systems. Additionally, the act of milking may cause damage to the teat and surrounding tissues, which opens the door for germs that cause mastitis within the mammary gland to enter and colonize.

Pathogen factors: Bovine mastitis can be caused by a number of infectious and non-infectious reasons. Of all the infections associated with cow mastitis, *Staphylococcus aureus* is the most common pathogen**.**

Nutritional factors: By modifying the animal's immune system, nutrition can impact the prognosis of mastitis. Protein- or energy-deprived heifers may experience a weakened immune system during the period of lactation due to dietary, managerial, and metabolic challenges. However, mastitis risks are increased by rapid dietary changes and excess or imbalance in the various components of diets. In transitional dairy cows, the immune system and certain elements of health are influenced by antioxidants and trace minerals. Vitamins A and Zn have an impact on the physical defensive barriers of the udder, epithelial health, and keratin plug quantity and quality. The actions of phagocytic cells in cattle are influenced by Cu, Zn, Se, and vitamins A and E. Vitamin E administration has been demonstrated to increase the killing power of immune cells and has been shown to improve neutrophil activity in dairy cows. Metabolic disorders can arise from

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either an excess or a shortage of essential nutrients in the diet of transition cow. Because a weakened immune system cannot effectively combat bacteria that invade the udder, animals are more prone to mastitis.

Clinical Findings:

The symptoms of clinical mastitis include swelling, and redness of the udder, as well as decreased and changed milk yield from the affected quarter. There may be fever, depression and anorexia along with the milk, which may also contain clots, flakes, or a watery consistency. Subclinical mastitis means no obvious symptoms in the udder or milk, but a decrease in milk output and an increase in the Somatic Cell Count (SCC), which affects older lactating animals more than first-lactation heifers. There is a negative relationship exists between SCC and milk yield. Normally, milk from clean, noninfected quarters has fewer than 200,000 somatic cells per millilitre. An SCC result more than 300,000 is considered abnormal and indicate that the udder is inflamed.

Subclinical mastitis is significant because it is 15–40 times more common than the clinical form (there will be 15–40 subclinical cases for every clinical case of mastitis). It also typically occurs before the clinical form, lasts longer, is harder to detect, has a negative impact on milk quantity and quality, and serves as a reservoir of microorganisms that can infect other animals in the herd.

Diagnosis

A simple diagnosis of clinical mastitis can be made based on changes in the milk's colour, texture, or presence of blood, pus, flakes and, clots. Since subclinical mastitis lacks clinical manifestations, it is challenging to identify and necessitates laboratory-based investigations. Many field-based test protocols have been developed for the identification of mastitis as it is not always practical or cost-effective for farmers to analyze samples using sophisticated laboratory techniques.

As an infection begins, the SSC rises in response to an increase in neutrophils. To identify mastitis, other diagnostic techniques such as electrical conductivity, the white slide test, the California mastitis test (CMT), pH, and the sodium lauryl sulphate test can be used. The CMT, whose results can be matched to the degree of infection as +, ++, or +++, is currently commonly used to detect mastitis. It helps to diagnose both early infection and subclinical mastitis.

When there is no response to anti-microbial treatment, then we can suspect antimicrobial

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resistance (AMR). If we do antibiotic sensitivity test (ABST) before the treatment, then selection of antibiotic will become reasonable. Polymerase Chain Reaction (PCR) is accepted as a gold standard test for detection of MSRA. The milk samples can be cultured and organism may be isolated, stained and identified through molecular technique like PCR for confirmatory diagnosis of MRSA.

Therapeutic & Control Approach

To reduce the problems of antibiotic residue in milk and antimicrobial resistance, the control program must include strategic use of antibiotics. It follows that preventive action must be taken. The majority of preventive measures focus on milking time and procedures. A fundamental component of mastitis control is the application of management techniques that lessen bacterial contamination of teat ends. Traditionally, pre-dipping, post-dipping, and washing udders and teats with water or disinfectants had been the methods used for pre-milking sanitation. The best approach for managing mastitis was thought to be using a teat antiseptic after milking. This involves dipping or spraying the teat with an antibacterial solution after milking. Nutrition also has a significant role in resistance against disease. Mastitis has been linked to deficiencies in a few trace elements and vitamins, including vitamin E, copper, zinc, and selenium. The health of the udders may be considerably enhanced by dietary advice and potential supplementation of the nutrients that are deficient. Another method of prevention is vaccination.

However, the primary method of treating mastitis is still the use of antibiotics. These can be administered intramuscularly, intravenously, or *via* intramammary infusion. Clinical mastitis and some specific subclinical mastitis cases can be treated during lactation. Antibiotics are typically given to treat clinical mastitis in order to eradicate the causing organism from the quarter.

All the infection caused by *Staphylococcus aureus* should also be considered as LA-MRSA infections. Drug resistance is a common trait among LA-MRSA isolates that are resistant to β-lactam antibiotics including amoxicillin, cloxacillin, and penicillin. Antibiotics like vancomycin are effective against LA-MRSA isolates that come from both people and animals. In a similar way, linezolid, amikacin, and teicoplanin were also effective against LA-MRSA isolates. Future LA-MRSA cases may be more likely to arise in a modern dairy farming system with highly populated animals, intensive livestock farming practices, and overuse of antibiotics. A good way to prevent the spread of disease from animal to human and animal to animal is to adjusting the spaces between cows, and give dairy cows regular baths to reduce the transmission of LA-MRSA. Cows raised in

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close proximity to one another will re-infect with LA-MRSA. To find the original LA-MRSA strain, surveillance is required. Preventing the spread of LA-MRSA strains requires regular animal and human health care arrangements, as well as improvements to biosecurity and environmental cleanliness of dairy cattle sheds.

The ways to tackle AMR is diverse. Still there are some of the measures can be taken effectively:

a. Awareness programmes for the farmers: The farmers should be enlightened about the danger of inadvertent use of antibiotics.

b. Importance of sanitation and prevention of spread of infection: By improving the sanitation and hygienic practices of the farm and premises we can distinctly reduce the need for antibiotics and hence there will be less chance for new resistance strains to develop.

c. Improve global surveillance of drug resistance and microbial consumption: Better surveillance for monitoring the cases of AMR and to predict the future occurrence

d. Effective diagnosis and detection of infection: This can control the unnecessary use of antibiotics in infections.

e. Improvisation of drugs and promoting the use of new drugs: Continuous use of any antibiotic should be discouraged

Conclusion

Mastitis, or inflammation of the mammary gland, is thought to be one of the most expensive and complicated diseases in the dairy sector. The economic effects of treating bovine mastitis, including production losses, culling, and changes in milk quality, can be enormous and have a significant effect on the agricultural industry. Given the sharp rise in clinical mastitis incidence over the past years, mastitis poses a serious threat to the global dairy industry. AMR is a threat in farm animal practice. Early detection of infections in the udder and implementation of preventative measures are equally important as prompt treatment of bovine mastitis. The use of antibiotics should be restricted and inadvertent use should be discouraged.

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