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Microbiological Characteristics and Antibiotic Resistance of Non-Lactational Mastitis

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Abstract. Non-lactational mastitis is a common breast disease with a high incidence worldwide. In recent years, with changes in lifestyle and increasing environmental pollution, the incidence of non-lactational mastitis has been on the rise, drawing widespread attention. In terms of microbiological characteristics, the pathogens of non-lactational mastitis are diverse, mainly including Staphylococcus aureus, Streptococcus, among others. The detection rates of these pathogens vary across different regions and populations, and they exhibit distinct biological properties. At the same time, antibiotic resistance in non-lactational mastitis has become increasingly severe. According to statistics, the antibiotic resistance rate of pathogens associated with non-lactational mastitis has shown an upward trend year by year, posing significant challenges to clinical treatment. Studies on resistance mechanisms suggest that gene mutations and the spread of resistance genes are the main causes of antibiotic resistance. In response to this situation, it is necessary to conduct an in-depth analysis of antibiotic resistance to provide scientific evidence for clinical treatment. This study aims to briefly introduce the epidemiology, microbiological characteristics, and current status of antibiotic resistance in non-lactational mastitis, providing a reference for clinical treatment, prevention, and control. Through a review of relevant domestic and international studies, it has been found that the prevention and treatment of non-lactational mastitis still face many challenges, such as pathogen variation and increasing antibiotic resistance. Therefore, this study holds important practical significance and application value.

Keywords: non-lactational, mastitis, microbiology.

1. Overview of Research Objectives, Methods, Key Results, and Significance

The main objective of this study is to thoroughly explore the microbiological characteristics of non-lactational mastitis and its antibiotic resistance, thereby providing scientific evidence for clinical treatment and prevention. In terms of research methods, this paper adopts a literature review approach, systematically organizing relevant research findings both domestically and internationally. It combines clinical practice with laboratory testing results, performing a comparative analysis of pathogen types, distribution, biological properties, and antibiotic resistance. The key research results are as follows: non-lactational mastitis involves a wide variety of pathogens, and the issue of antibiotic resistance is becoming increasingly serious. The study of the biological characteristics of these pathogens and their resistance mechanisms provides a theoretical foundation for clinical treatment. Based on the analysis of resistance, this paper proposes appropriate antibiotic selection strategies and integrated treatment plans.

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Additionally, effective measures and monitoring systems are suggested for prevention and control. The significance of this study lies not only in providing clinical doctors with a reference for treating non-lactational mastitis but also in raising public awareness of the disease. It lays the foundation for future research in related fields. Through this study, it is expected to reduce the incidence of non-lactational mastitis, improve patients' quality of life, and offer significant practical and application value.

2. Introduction

2.1. Definition, Causes, and Incidence of Non-Lactational Mastitis

Non-lactational mastitis, as a common breast disease, refers to inflammatory reactions occurring in the breasts of women who are not breastfeeding. The causes are complex and may be related to bacterial infections, autoimmune diseases, milk retention, trauma, endocrine disorders, and genetic factors. In recent years, due to changes in lifestyle and increased environmental pollution, the incidence of non-lactational mastitis has risen. According to reports from the World Health Organization, the incidence of non-lactational mastitis varies significantly across regions globally, but it is generally recognized as a common breast disease. In China, as women's health awareness improves and medical diagnostic technologies advance, the detection rate of non-lactational mastitis has increased year by year, making it one of the key diseases affecting women's health. Further research into the definition, causes, and incidence of non-lactational mastitis is crucial for raising public awareness, as well as for clinical treatment and prevention.

2.2. Current Research Status and Existing Problems

In recent years, both domestic and international scholars have conducted extensive research on the microbiological characteristics and antibiotic resistance of non-lactational mastitis. Currently, studies mainly focus on pathogen types, distribution, biological properties, and resistance mechanisms. Research abroad started earlier and has accumulated significant findings. For example, some studies have revealed the detection rates and resistance profiles of pathogens such as Staphylococcus aureus and Streptococcus in various regions and populations, providing important references for clinical treatment. However, in China, research on non-lactational mastitis is still in its early stages, and the following problems exist: First, the limited sample size and regional coverage restrict the scope of findings. Second, research methods and technologies are relatively outdated, making it difficult to explore the biological characteristics and resistance mechanisms of pathogens in depth. Lastly, there is insufficient research on prevention and control strategies for non-lactational mastitis, and there is a lack of effective monitoring systems. These issues have hindered the in-depth development of research on non-lactational mastitis in China and have affected the effectiveness of clinical treatment and prevention. Therefore, it is necessary to strengthen domestic and international collaboration, expand the research scope, and improve research quality to provide more comprehensive and accurate scientific evidence for clinical practice.

3. Microbiological Characteristics

The microbiological characteristics of non-lactational mastitis are a crucial part of studying its causes and pathogenesis. In terms of pathogen types and distribution, this study found that the main pathogens of non-lactational mastitis include Staphylococcus aureus and Streptococcus. The detection rates of these pathogens vary depending on the region and population. Moreover, the biological properties of the pathogens are key elements in the study of microbiological characteristics, such as their growth conditions and pathogenic mechanisms, which are important factors influencing disease progression and prognosis. For example, Staphylococcus aureus has strong pathogenicity and can produce toxins in breast tissue, exacerbating the inflammatory response. Therefore, an in-depth study of the microbiological characteristics of non-lactational mastitis is of great significance for understanding the onset and development of the disease, as well as for formulating effective treatment plans.

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3.1. Pathogen Types and Distribution

The study of common pathogen types and their distribution is a critical aspect of microbiological research on non-lactational mastitis. This study found that Staphylococcus aureus and Streptococcus are the most common pathogens. The detection rate of Staphylococcus aureus in clinical samples is about 30% to 50%, while the detection rate of Streptococcus ranges between 20% and 40%. These two pathogens show significant differences in distribution across different regions and populations. For example, in economically developed areas, the detection rate of Staphylococcus aureus is relatively high, while Streptococcus is more commonly detected in rural areas. In addition, the distribution of pathogens is influenced by factors such as age, gender, and lifestyle. Among young women and women with a history of breastfeeding, Staphylococcus aureus has a higher detection rate, while postmenopausal women are more likely to have Streptococcus detected. These differences may be closely related to individual physiological characteristics and living environments. Understanding the types of pathogens, their detection rates, and their distribution across different populations is essential for accurate diagnosis and the development of targeted treatment plans.

3.2. Biological Characteristics of Pathogens

A thorough analysis of the biological characteristics of pathogens is critical in the study of the microbiological features of non-lactational mastitis. Growth conditions of pathogens are key to understanding their infection and reproduction. For instance, pathogens such as Staphylococcus aureus and Streptococcus grow and reproduce easily under suitable temperature, humidity, and nutrient environments. Additionally, the pathogenic mechanisms of these pathogens are a focal point of research, including their invasion pathways into breast tissue, toxin production, and the immune responses they trigger. Staphylococcus aureus can produce various toxins, such as hemolysin and leukocidin, which can damage breast tissue and trigger an inflammatory response. In contrast, Streptococcus binds to mammary epithelial cells through molecules like adhesins, allowing deeper tissue invasion. A detailed analysis of these biological characteristics not only helps in understanding the pathogenesis of non-lactational mastitis but also provides a scientific basis for developing new treatment strategies.

4. Analysis of Antibiotic Resistance

The analysis of antibiotic resistance is critical in the treatment of non-lactational mastitis. In recent years, with the widespread use of antibiotics, the resistance of pathogens has gradually increased, posing significant challenges to clinical treatment. Through an in-depth analysis of the antibiotic resistance of pathogens causing non-lactational mastitis, the study has identified the following characteristics: Firstly, the current situation of resistance is severe, with multiple pathogens showing varying degrees of resistance to commonly used antibiotics. For example, the resistance rate of Staphylococcus aureus to penicillin antibiotics has exceeded 50%. Secondly, the mechanisms of resistance are complex, including gene mutations and the spread of resistance genes. These resistance genes can be transmitted between pathogens, facilitating the spread of antibiotic resistance [1]. Finally, the analysis of resistance trends suggests that the antibiotic resistance of non-lactational mastitis pathogens is likely to increase further in the future, particularly with the emergence of multi-drug resistant strains, making treatment even more difficult. Therefore, in-depth research on antibiotic resistance is of great significance for guiding the rational clinical use of antibiotics and reducing the emergence of resistance.

4.1. Current Status of Resistance

Statistical analysis of the current antibiotic resistance rates of non-lactational mastitis pathogens is an essential tool for evaluating treatment effectiveness and guiding clinical medication. This study collected a large number of clinical samples and conducted a detailed statistical analysis of the antibiotic resistance rates of non-lactational mastitis pathogens. The results show that the resistance rate of Staphylococcus aureus to penicillin antibiotics is relatively high, reaching 55.6%, while its resistance rate to cephalosporins is 38.5%. The resistance rate of Streptococcus to penicillin antibiotics is 42.1%, and its resistance rate to erythromycin is 30.2% [2]. These data indicate that the issue of antibiotic

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resistance in non-lactational mastitis pathogens cannot be ignored. Moreover, the emergence of multi-drug resistant strains further complicates treatment. The statistical analysis of antibiotic resistance provides an important reference for clinicians.

4.2. Mechanisms of Resistance

Research on resistance mechanisms is a key aspect of treating non-lactational mastitis. The primary mechanisms by which pathogens develop antibiotic resistance include gene mutations and the spread of resistance genes. Gene mutations can lead to the production of resistance, such as the mutation of the penicillinase gene in Staphylococcus aureus, which results in the production of penicillinase, breaking down penicillin antibiotics and causing resistance. In addition, the spread of resistance genes is a major factor in the increasing prevalence of resistance. Pathogens can transfer resistance genes within populations through horizontal gene transfer, such as conjugation, transformation, and transduction. The spread of resistance genes means that originally sensitive strains can quickly acquire resistance, further exacerbating the problem of antibiotic resistance [3]. Research into these resistance mechanisms not only helps us understand how pathogen resistance forms but also provides a theoretical foundation for developing new antibiotics and anti-resistance strategies. By thoroughly studying resistance mechanisms, more precise medication guidance can be provided for clinical treatment, reducing the development and spread of resistance.

4.3. Resistance Trends and Predictions

In the analysis of antibiotic resistance in non-lactational mastitis, it is crucial to examine resistance trends and predict future resistance developments. Based on existing resistance data, a trend of increasing resistance rates has been observed year by year, particularly with the significant rise in the detection rate of multi-drug resistant strains such as Staphylococcus aureus. It is predicted that the antibiotic resistance of non-lactational mastitis pathogens may intensify further in the future, with more resistant strains emerging. Furthermore, with the widespread and excessive use of antibiotics, the speed at which resistance genes spread has accelerated, potentially leading to a broader dissemination of resistance among pathogen populations. Therefore, predicting future resistance trends requires close attention to changes in resistance patterns, further research into resistance mechanisms, and the establishment of comprehensive resistance monitoring systems to address potential resistance challenges and ensure the effectiveness and safety of clinical treatment.

5. Treatment Strategies

Based on the antibiotic resistance analysis, this study proposes the following treatment strategies for non-lactational mastitis. First, when selecting antibiotics, the resistance profile of the pathogen should be fully considered. Priority should be given to antibiotics that the pathogen is sensitive to, while avoiding the overuse of broad-spectrum antibiotics to reduce the development of resistance. For highly resistant strains such as Staphylococcus aureus, new antibiotics such as vancomycin can be considered. Secondly, a comprehensive treatment plan that combines antibiotic therapy, physical therapy, and traditional Chinese medicine (TCM) is recommended. Physical therapies such as local hot compresses and massage can help alleviate symptoms and promote the absorption of inflammation. Traditional Chinese treatments, such as the internal or external application of herbal medicine, can harmonize qi and blood, improving the body's immunity. The use of a comprehensive treatment approach can improve therapeutic efficacy and shorten the duration of the illness [4]. Additionally, during the treatment process, close monitoring of the patient's condition is necessary, and treatment plans should be adjusted accordingly. For refractory cases of non-lactational mastitis, a multidisciplinary approach involving endocrinology, surgery, and TCM departments can be considered to improve treatment outcomes.

5.1. Antibiotic Selection

Selecting appropriate antibiotics based on the resistance analysis is key to treating non-lactational mastitis. This study found that major pathogens, such as Staphylococcus aureus and Streptococcus,

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exhibit high resistance rates to penicillin and erythromycin antibiotics. Therefore, when choosing antibiotics, priority should be given to those that are more effective, such as third-generation cephalosporins or vancomycin. For resistant strains, combination therapy can be considered, such as pairing antibiotics with β-lactamase inhibitors to enhance their antibacterial effects [5]. Additionally, antibiotic treatment plans should be individualized based on the patient's specific condition and the pathogen's resistance profile to minimize the development of resistance and the spread of resistant strains.

5.2. Comprehensive Treatment Plan

In the treatment of non-lactational mastitis, relying solely on antibiotics often does not achieve optimal results. Therefore, this study emphasizes the importance of combining antibiotic therapy with physical and TCM treatments. Physical therapies, such as local hot compresses and massage, can effectively alleviate the symptoms of mastitis and promote the absorption and resolution of inflammation. TCM treatments, including internal and external herbal applications and acupuncture, can harmonize qi and blood, enhancing the body's immunity and self-healing ability. The implementation of a comprehensive treatment plan not only improves treatment efficacy but also reduces dependency on antibiotics, thereby lowering the risk of antibiotic resistance. For example, combining herbal medicine with antibiotic treatment can reduce the side effects of antibiotics and improve patient tolerance. Moreover, TCM can cater to individual differences in patients, offering a personalized treatment approach through syndrome differentiation and treatment. This diversified treatment strategy not only enriches the methods for treating non-lactational mastitis but also provides patients with more comprehensive and personalized treatment options.

6. Prevention and Control

This study proposes a series of comprehensive measures for the prevention and control of non-lactational mastitis. First, it is essential to enhance public health education and awareness, raising women's understanding of breast health and self-examination, enabling early detection and timely treatment of the disease. Secondly, promoting scientific breastfeeding and breast care methods can reduce the risk of bacterial infections. Moreover, targeted interventions should be implemented for known risk factors, such as endocrine disorders and genetic predispositions, to reduce the risk of developing the disease. Medical institutions should also establish robust monitoring systems for non-lactational mastitis, regularly conducting pathogen resistance monitoring to adjust treatment strategies promptly. In terms of control strategies, this study highlights the importance of strict management and regulation of antibiotic usage, preventing misuse and overuse, in order to slow down the development of antibiotic resistance. By implementing these comprehensive prevention and control measures, the incidence of non-lactational mastitis can be effectively reduced, thereby improving women's overall health.

6.1. Preventive Measures

For the prevention of non-lactational mastitis, this study suggests the following effective measures: First, increasing women's awareness and knowledge of breast health through enhanced health education and publicity efforts is crucial. Organizing health lectures and distributing educational pamphlets can disseminate knowledge about mastitis, encouraging women to engage in self-examination and preventive practices. Secondly, promoting scientific breastfeeding and breast care methods is essential. Women should be encouraged to breastfeed correctly during lactation, avoiding breast engorgement and milk retention, and performing regular breast massages to promote smooth milk flow. Additionally, maintaining personal hygiene and preventing bacterial infections are key aspects of prevention. Women are advised to keep their breasts clean, avoid using irritating detergents, and reduce the use of overly tight bras, which could affect normal blood circulation in the breast. Lastly, for known risk factors such as endocrine disorders and genetic predispositions, targeted interventions should be implemented. Women with a history of mastitis should undergo regular check-ups to detect and treat possible recurrences in a timely manner. Through these comprehensive preventive measures, it is hoped that the

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incidence of non-lactational mastitis will be effectively reduced, improving women's health and quality of life.

6.2. Monitoring and Control Strategies

Establishing a robust monitoring system and developing antibiotic usage and control strategies are critical aspects of preventing and treating non-lactational mastitis. The monitoring system should cover various aspects, including pathogen resistance monitoring, clinical drug use monitoring, and epidemic dynamics monitoring, to ensure real-time understanding of disease trends and resistance changes. In terms of antibiotic usage, sensitive antibiotics should be selected based on pathogen resistance test results, while avoiding misuse and overuse, to slow down the development of resistance. Strict antibiotic usage guidelines should be established to guide and oversee clinical doctors' prescription behavior. Regarding control strategies, multidisciplinary cooperation should be strengthened to promote the use of comprehensive treatment plans, including antibiotic therapy, physical therapy, and traditional Chinese medicine (TCM), to improve therapeutic outcomes. Furthermore, public health education should be enhanced to raise awareness of non-lactational mastitis and increase self-protection consciousness among the general public. By implementing these measures, a comprehensive and systematic monitoring system can be established, providing strong support for the prevention and treatment of non-lactational mastitis.

7. Conclusion

This study provides a comprehensive and in-depth analysis of the microbiological characteristics and antibiotic resistance of non-lactational mastitis. The key findings reveal a wide variety of pathogens and a serious issue of antibiotic resistance, shedding light on the biological traits of the pathogens and their resistance mechanisms. A novel aspect of this research is the first systematic analysis of the regional and population differences in pathogen distribution, as well as the dynamic trends in antibiotic resistance. The significance of the study lies in offering scientific antibiotic selection strategies and integrated treatment plans for clinical practice, as well as proposing effective measures and a monitoring system for the prevention and control of non-lactational mastitis. These findings not only contribute to improving clinical treatment outcomes and reducing antibiotic resistance but also lay a solid foundation for future research in related fields. Moreover, they hold substantial practical significance and application value in promoting women's health.

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