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Streptococcus Pneumoniae: Overview

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ABSTRACT
Streptococcus pneumoniae is one of the major reasons for increased mortality rates in the world. It is gram-positive bacteria that can live in both aerobic and anaerobic conditions. It is an opportunistic invasive bacterium that finds any host cell and disrupts its normal functioning and invades it. It causes various diseases like otitis media, sinusitis, pneumonia and bronchitis. Children and people with various diseases are at higher risk of causing the infection. 92 serotypes have been found till now among which serotypes 6B, 6A, 9V, 14, 15A, 19F, 19A, and 23F are known as pediatric serotypes. Although conventional or long established microbiological approaches were applied, including present-day antigen recognition procedures in laboratories for the determination and prognosis of pneumococcal infections. In this regard, pneumococcal conjugate (i.e. PCV13, PCV15, and PCV20) and pneumococcal polysaccharide (PPSV23) vaccines are at present on the market. The time period of carriage goes fluctuates and is generally prolonged in children than in adults. In contrast, researchers do not understandably the interrelationship of carriage to the build-out of natural immunity. This review, will discuss the introduction of the bacterium, the serotypes, the diseases it causes, and the vaccines made.

Keywords: Streptococcus pneumoniae; aerobic; anaerobic; serotypes; pneumococcal.

INTRODUCTION

Infectious diseases have been a challenging topic that has negatively affected our society. The pathogens enter the body by host cell invasion and disrupt the normal functioning of the immune system. It spreads through direct or indirect contact, exchange of body fluids and animals or insect vectors. The pathogens can only be cleared from the body if the immune system is strong. Infants and elder people are at higher risk to have infectious diseases because of their weakened immune systems. Streptococcus pneumoniae, a major pathogen also known as pneumococcus is related to the respiratory system. It is a gram-positive and a pathogen that survives in both aerobic and anaerobic conditions. It takes benefit of entering in the mucosal surfaces to invade the respiratory tract **[1, 2].** As obesity is increasing in the population, it can

be said that people with obesity have a risk to get infected by the bacterium because obesity impairs B and T cells of the immune system. This is referred to as Community Acquired Pneumoniae (CAP) **[3].** Streptococcus pneumoniae was first isolated by Pasteur and Sternberg in 1881 from the saliva **[1].**

Coming to the structure, it has three major layers that can be divided into plasma membrane, cell wall, and the capsule. The cell wall has the peptidoglycan layer that supports the Cell Wall Polysaccharide and may have proteins too. The thickest layer is the capsule which protects the inner structures. Streptococcus pneumoniae is present in the nasopharynx of the human body which spreads in different body parts and causes a number of diseases in individuals. It is found more in children than in adults worldwide **[4,5].** Transmission is possible through person-to-person contact, or contaminated objects or places. There are 14.5 billion cases noted worldwide out of which the total death cases recorded for Streptococcus pneumoniae in children below 5 years is approximately 1.6 million per year. There are almost 100 million ear infections in small children. It causes more than 50 lakh cases of pneumoniae and 1 lakh of meningitis. It is the major reason of higher morbidity and mortality rates in the world **[5,6].**

DISEASES

The immune system's function is important for the body to protect it from any foreign microorganisms. As Streptococcus pneumoniae is a major pathogen that attacks the weakened immune system, it is really important to keep the immune system strong. This bacterium spreads through airborne droplets, and it degrades the functioning of cells. After it enters the host cells, it attacks other cells by horizontal dissemination and converts into more pathogenic. They have an interesting property that deceives the body cells and enters the cells and tissues. This bacterium is most seen in children, elderly people and the ones who have a weak immune system **[1, 2].**

The disease caused by Streptococcus pneumoniae is sinusitis, pneumonia, otitis media and bronchitis. The most dangerous one can be septicaemia. People have pneumonia when the bacterium enters the mucosal surfaces of the lungs and causes infection. The symptoms of the disease include high heart rates, coughing continuously, and having a high fever. Coinfection can be the cause of having the disease again due to past damage in epithelial cells weakening the function of the respiratory tract. The distributed invasive infections may include sepsis, arthritis, meningitis and endocarditis **[3-5].** Pneumococcal infections are more active with the patients having sickle cell anaemia or any blood-related diseases as they have a deficiency of antibodies in their bodies. The higher risk of having an infection is with the children having cochlear implants. According to the researchers, people having immunodeficiencies, cerebrospinal leakage, HIV infections, cardiovascular disease, pulmonary diseases or diabetes is known to have a great risk of Invasive Pneumococcal diseases **[6, 7].**

SEROTYPES

The pneumococcal strains which produce a polysaccharide (PS) with different chemical structures and immunologic properties are called serotypes. The serotype-specific antisera have been practiced since the 20th century. During this period, the various serotypes were observed e.g. 32 serotypes were explained by Cooper et al in 1932 but the specific sera for all

the serotypes were not available. After the death of Danish Prince Valdemar in 1939, it was found that he had Pneumococcal Pneumonia caused by the serogroup 9. 9V serotype was then named after him. Later on, during World War II, researchers found 75 more serotypes in America **[8].**

Out of almost 90 immunological capsules produced by Pneumococci which are different in chemical structure, 20% of them can cause invasive diseases. The distribution of the serotypes and their antimicrobial resistance patterns vary according to the geographical trends **[9].** Till now approximately 92 serotypes of Streptococcus pneumoniae and the serotypes 6B, 6A, 9V, 14, 15A, 19F, 19A, and 23F are referred to as paediatric serotypes as they are related to the highest penicillin and erythromycin resistance proportions. The remaining multidrug resistance is seen more in serotypes 15A, 15B, 15C, 6C, 23A and 35B in the United States. It was observed first in children by nosocomial transmission. The seven-valent Pneumococcal Conjugate Vaccine (PCV7) included the serotypes 4, 6B, 9V, 14, 18C, 19F and 23F with the deterioration in penicillin resistance rates. In 21 countries in the European Union and European Economic Activity, multidrug resistance was studied in isolates of serotypes 19A, 14, 1, 19F, and 23F. 19A strains have been practiced in many countries in the past 5 years as it shows the highest Minimal Inhibitory Concentration for macrolides, lincosamides, β-lactams, tetracycline etc. **[9-11].**

VACCINES

In the early 1930s, the serotyping of pneumococci was developed and the results were satisfactory. This made the licensing of a Hexavalent Pneumococcal PS vaccine. Despite the use of antibiotics given by the researchers, the mortality rate remained high. Then in 1978, a 14-valent vaccine came out and in 1983, another 23-valent vaccine became available in The United States. 14-valent PS vaccine suddenly expanded to include 23 serotypes. The immunogenicity of the vaccine was however poor. Children tend to produce a small fraction of Anti-PS Ab than adults. The responses were given against the most common serotypes after the age of 4 or 5. To overcome the problem of low immunogenicity United States introduced PCV7 in 2000 **[12,13].**

The pneumococcal vaccines are available in two types: Pneumovax23 and Pneumococcal Conjugate Vaccines. The Pneumovax23 (PPV23) was introduced in 1983 whereas the Pneumococcal Conjugate Vaccine (PCV7) was introduced in 2000 as PCV7. PPV23 was for individuals between 2-64 years of age having chronic cardiovascular diseases and diabetes as well as for people above 64 years of age for all individuals. However, PPV23 came out to be successful for people below 75 years of age but not for children as it could not produce immunological memory **[14].** In South Korea, PCV7 was introduced in 2003 and PCV10 and PCV13 came in 2010. The vaccines were already recorded in National Immunization Program of South Korea till 2014. Presently 15-valent and 20-valent conjugate vaccines are still under development. Global vaccination programs are important in the fight against pneumococcal diseases **[12-14].**

The independent-serotype vaccines are also being studied. They usually include proteins, combination proteins and polysaccharides, and whole cell vaccines. Surface proteins are present in the protein vaccines that are conserved in the S. pneumoniae, for example, PspA and

inactivated pneumolysin where both were tested and the results came out to be different. The immunogenicity of the vaccine PspA was low while the inactivated pneumolysin had high immunogenicity. Research started producing live attenuated vaccines too. SPY1 vaccine is a live attenuated strain that does not have a capsule. Many modifications were done to this vaccine to make them more stable for protection **[15, 16].**

CONCLUSION

The invasive Streptococcus pneumoniae has been infecting almost billions of people in the world. It causes various diseases and children are really at a higher risk of getting infected with this dangerous bacterium. For a long the researchers have been working on the serotypes of this bacterium and are trying to make medicines as well as various vaccines to protect the world. Pneumococcal vaccines have been protecting the health sector of the world with great efforts. The researches give us a reasonable hope that in the future there will be fewer cases in comparison to what they are today and less mortality rates due to this disease. Still, the continuous research of novel serotypes and development of vaccines is worrisome as it is against opportunistic invasive infectious bacteria.

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