

Streptococcus pneumoniae bacteria characteristics



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Introduction

Streptococcus pneumoniae lives in the upper respiratory tract of a human body. This bacterium is the cause of pneumonia, especially lobar pneumonia, otitis media and paranasal sinusitis, or meningitis, that is usually secondary to the infections mentioned. Streptococcus pneumoniae can also be the cause of endocarditis, septic arthritis, cellulitis, osteomyelitis, brain abscesses, and peritonitis. Currently streptococcus pneumoniae is the main cause behind the invasive bacterial diseases among the elderly and children. In the microbiology of medicine Streptococcus pneumoniae can be also known as pneumococcus, due to its morphology and its constant contribution to pneumococcal pneumonia.

Bacteriology

Streptococcus pneumoniae cells are Gram-positive; their cocci are lancet-shaped (elongated with a slightly pointed outer curvature). These cells are seen usually in pairs of cocci (diplococci), but they can also exist in short and single chains. The cells are seen as alpha hemolytic in blood agar culture. The size of individual cells varies between 0.5 and 1.25 micrometers in diameter. These cells do not form spores and they are nonmotile. Streptococcus pneumoniae ferment glucose to lactic acid and lack catalase, similar to other streptococci, but they differ from other streptococci by not displaying an M protein, and hydrolyzing inulin, the cell wall of this bacteria is characterized by its composition in terms of teichoic acid and peptidoglycan.

Identification

The identification of streptococcus pneumonia and distinction between it and other streptococci involves hemolytic activity, and optochin sensitivity or Gram-positive staining. In hemolytic activity test, Pneumococci show alpha hemolysis on agar that contains human, sheep, horse and rabbit erythrocytes, but under anaerobic conditions, the cells switch to beta hemolysis based on an oxygen-labile hemolysin. Typically, in optochin sensitivity test, “ Pneumococci form a 16-mm zone of inhibition around a 5 mg optochin disc, and undergo lysis by bile salts (e. g. deoxycholate)”.

Cell Surface Structure

The cell surface structure of Streptococcus pneumonia is composed of a capsule made of polysaccharide forms envelops around the pneumococcal cells, and they are the determinants of virulence in the cell. Another component is the cell wall that contains six layers formed from peptidoglycan, teichoic acid and lipoteichoic acid that differs from teichoic acid by its lipid moiety that attaches it to the cell membrane. Also, Pilli are Hair-like structures extending in many strains of pneumococcus from the surface of the cell, they additionally have a part in the colonization of the upper respiratory tract. Finally, surface proteins that count to more than 500 in pneumococcus, some of them are lipoproteins associated with the membrane, others with the cell wall.

Pathogenesis

Pneumococci can be the source of disease among humans, horses, monkeys, guinea pigs and mice, nearly 40% of the infected population have the

occurrence of nasopharyngeal colonization. The most widespread diseases are Pneumonia and otitis media, meningitis is variable.

Colonization

Pneumococci are fixed firmly by multiple mechanisms to the nasopharyngeal epithelium, generating a type-specific immunity for most of the individuals. However, for other people the infection progresses to the middle ear, and may cause inflammation in this region due to the cell wall components of the pneumococcus, which imposes a major cytotoxicity on the walls of cochlea through pneumolysin.

In healthy tissues experiment, 100, 000 bacteria/ml are required to activate an inflammatory response. On the other hand, a low number of bacteria (10 bacteria) are developed if it supplies a pro-inflammatory signal. Significant tissue damage is induced by this inflammation.

Invasion

The ability of the bacteria to grow and invade is mainly due to their capability to resist the host phagocytic response, activating several inflammatory cascades through components from the cell wall, as well as the additional pathway of complement activation, the coagulation cascade and the cytokine cascade.

Additionally, after the beginning of lyse in Pneumococci due to autolysis, or as a reaction towards antimicrobial agents and host defensins, pneumolysin, cell wall components and other substances are released, leading to larger inflammation and several cytotoxic effects. Pneumolysin and Hydrogen

peroxide which are produced by the bacteria kill body cells inducing nitric oxide production, which can have a great function in septic shock.

The Vaccines

An increase in the number of serotypes was happened since 1945, after being 4; it increased to 14 in 1970s, reaching the final current 23-valent formulation. The efficacy of this vaccine was estimated at 60%, and the serotypes represent 85-90% of those causing invasive diseases. The two most common types of vaccines are the 7-valent conjugate vaccine, recommended for children less than two years of age, it contains seven serotypes causing 38 to 86% of pneumococcal diseases, it's used on large scale in developed countries where it proved its effectiveness. The second vaccine is the 23-valent unconjugated polysaccharide vaccine, for use with children more than two years old, containing 23 serotypes responsible for 88% of pneumococcal diseases.

What are pneumococcal diseases?

Streptococcus pneumonia causes a several number of diseases such as, Pneumonia, meningitis and sepsis, which makes it the No. 1 vaccine-preventable fatal disease globally. Pneumococcal diseases are spread person to person through touching contaminated surfaces, sharing utensils, coughing on someone or kissing.

Pneumonia is a severe acute respiratory disease that infects lungs, making it harder to absorb oxygen and filling it with fluid and pus. Meningitis is an infection that causes an inflammation of the line between the spinal cord and the brain. Sepsis is a severe infection that progresses quickly after a lack of

oxygen that reaches important body organs resulting in a multi-organ failure and septic shock.

Who is at risk? Where?

Pneumococcal diseases are main global public health dilemma. In reference to WHO estimations, 800, 000 to 1 million children less than five years old die after being infected by pneumococcal diseases, with a minimum of one child death every minute. However, 90 % of these deaths take place in developing countries. “ Ten countries in Asia and sub-Saharan Africa account for more than 60% of pneumococcal diseases worldwide. Among Indian children, pneumonia causes a quarter of all deaths”.

Recommendations

WHO recommends that the prioritization of introducing 7-valent vaccine should happen when more than 50, 000 children die each year, or the mortality rate among children under five is more than 50 per 1000 live births. Also according to WHO recommendations is that countries having high frequency of HIV, or additional pneumococcal disease risk-increasing conditions, to vaccinate with 7-valent. The three dose infants schedule is the main efficient vaccination strategy. However, low awareness of the impacts of these diseases among the public, politicians, decision makers and stakeholders of the developed and developing world, has greatly affected its spread in the developing countries. Pneumococcal diseases were not regarded as vaccine-preventable nor a major killer until recently.

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