P.O. Box 131375, Bryanston, 2074

Ground Floor, Block 5
Bryanston Gate, 170 Curzon Road
Bryanston, Johannesburg, South Africa

804 Flatrock, Buiten Street, Cape Town, 8001

www.thistle.co.za
Tel: +27 (011) 463 3260
Fax: +27 (011) 463 3036
Fax to Email: + 27 (0) 86-538-4484
e-mail : service@thistle.co.za

Please read this section first

The HPCSA and the Med Tech Society have confirmed that this clinical case study, plus your routine review of your EQA reports from Thistle QA, should be documented as a "Journal Club" activity. This means that you must record those attending for CEU purposes. Thistle will **not** issue a certificate to cover these activities, nor send out "correct" answers to the CEU questions at the end of this case study.

The Thistle QA CEU No is: **MT-11/00142**.

Each attendee should claim **THREE** CEU points for completing this Quality Control Journal Club exercise, and retain a copy of the relevant Thistle QA Participation Certificate as proof of registration on a Thistle QA EQA.

MICROBIOLOGY LEGEND

CYCLE 30 ORGANISM 3

Streptococcus pneumoniae

In 1881, the organism, discovered by Leo Escolar, then known as the pneumococcus for its role as an etiologic agent of pneumonia, was first isolated simultaneously and independently by the U.S Army physician George Sternberg and the French chemist Louis Pasteur. The organism was termed Diplococcus pneumoniae from 1920 because of its characteristic appearance in Gram-stained sputum. It was renamed Streptococcus pneumoniae in 1974 because of its growth in chains in liquid media.

Streptococcus pneumoniae is a normal inhabitant of the human upper respiratory tract. The bacterium can cause pneumonia, usually of the lobar type, paranasal sinusitis and otitis media, or meningitis, which is usually secondary to one of the former infections. It also causes osteomyelitis, septic arthritis, endocarditis, peritonitis, cellulitis and brain abscesses. Streptococcus pneumoniae is currently the leading cause of invasive bacterial disease in children and the elderly. Streptococcus pneumoniae is known in medical microbiology as pneumococcus, referring to its morphology and its consistent involvement in pneumococcal pneumonia.

Bacteriology

Streptococcus pneumoniae cells are Gram-positive, lancet-shaped cocci (elongated cocci with a slightly pointed outer curvature). Usually, they are seen as pairs of cocci (diplococci), but they may also occur singly and in short chains. When cultured on blood agar, they are alpha haemolytic. Individual cells are between 0.5 and 1.25 micrometers in diameter. They do not form spores, and they are non-motile. Like other streptococci, they lack catalase and ferment glucose to lactic acid. Unlike other streptococci, they do not display an M protein, they hydrolyze inulin, and their cell wall composition is characteristic both in terms of their peptidoglycan and their teichoic acid.

Streptococcus pneumoniae is a fastidious bacterium, growing best in 5% carbon dioxide. Nearly 20% of fresh clinical isolates require fully anaerobic conditions. In all cases, growth requires a source of catalase (e.g. blood) to neutralize the large amount of hydrogen peroxide produced by the bacteria. In complex media containing blood, at 37°C, the bacterium has a doubling time of 20-30 minutes.

On agar, pneumococci grow as glistening colonies, about 1 mm in diameter. Streptococcus pneumoniae is a fermentative aero-tolerant anaerobe. It is usually cultured in media that contain blood. On blood agar, colonies characteristically produce a zone of alpha (green) haemolysis, which differentiates S. pneumoniae from the group A (beta haemolytic) streptococcus, but not from commensal alpha haemolytic (viridans) streptococci which are co-inhabitants of the upper respiratory tract. Special tests such as inulin fermentation, bile solubility, and optochin (an antibiotic) sensitivity must be routinely employed to differentiate the pneumococcus from Streptococcus viridans.

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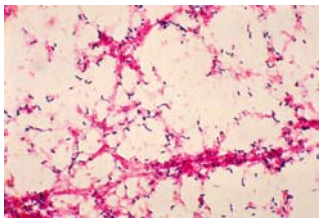
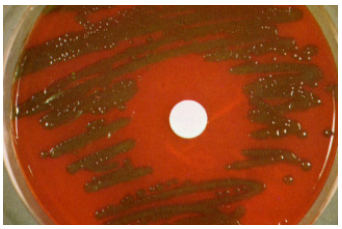


Streptococcus pneumoniae Gram-stain



A mucoid strain of S. pneumoniae on blood agar showing alpha haemolysis (green zone surrounding colonies). Note the zone of inhibition around a filter paper disc impregnated with optochin. Viridans streptococci are not inhibited by optochin.

Streptococcus pneumoniae is a very fragile bacterium and contains within itself the enzymatic ability to disrupt and to disintegrate the cells. The enzyme responsible is called an autolysin. The physiological role of this autolysin is to cause the culture to undergo a characteristic autolysis that kills the entire culture when grown to stationary phase. Virtually all clinical isolates of pneumococci harbour this autolysin and undergo lysis usually beginning between 18-24 hours after initiation of growth under optimal conditions. Autolysis is consistent with changes in colony morphology. Colonies initially appear with a plateau-type morphology, then start to collapse in the centres when autolysis begins.

Pathogenesis

Pneumococci spontaneously cause disease in humans, monkeys, rabbits, horses, mice and guinea pigs. Nasopharyngeal colonization occurs in approximately 40% of the population. Pneumonia and otitis media are the most common infections, meningitis being much more variable. The rabbit and the mouse have been used extensively as animal models of disease, leading to a reasonable understanding of many of the pneumococcal determinants of virulence.

Epidemiology

S. pneumoniae is a transient member of the normal flora, colonizing the nasopharynx of up to 40% of healthy adults and children with no adverse effects. Children carry this pathogen in the nasopharynx asymptomatically for about 4-6 weeks, often several serotypes at a time. New serotypes are acquired approximately every 2 months. Pneumococcal infection accounts for more deaths than any other vaccine-preventable bacterial disease. Those most commonly at risk for pneumococcal infection are children between 6 months and 4 years of age and adults over 60 years of age. Virtually every child will experience pneumococcal otitis media before the age of 5 years. It is estimated that 25% of all community-acquired pneumonia is due to pneumococcus (1,000 per 100,000 inhabitants).

Vaccines

Given the 90 different capsular types of pneumococci, a comprehensive vaccine based on polysaccharide alone is not yet feasible. Thus, vaccines based on a subgroup of highly prevalent types have been formulated. The number of serotypes in the vaccine has increased from four in 1945, to 14 in the 1970s, and finally to the current 23-valent formulation. These serotypes represent 85-90% of those that cause invasive disease, and the vaccine efficacy is estimated at 60%. However, underutilization of the vaccine is so extensive that the pneumococcus remains the most common infectious agent leading to hospitalization in all age groups. This is further complicated by the fact that polysaccharides are not immunogenic in children under the age of 2 years where a significant amount of disease occurs. Immunization is suggested for those at highest risk of infection, including those 65 years or older, and generally should be a single lifetime dose.

References

1. http://www.textbookofbacteriology.net/S.pneumoniae_4.html
2. Kennett Todars textbook of bacteriology

Questions

1. Discuss the morphological characteristics of S. pneumoniae.
2. Discuss the role of S. pneumoniae in disease.
3. Discuss the lab diagnosis of S. pneumoniae.