Looking back and moving forward: 100 years of Pneumococcal vaccination and of Saint Antonius Hospital

“Since the introduction of smallpox vaccination by Sir Edward Jenner in 1796, it took 184 years until the WHO could declare the world free of smallpox. How long will it take to eliminate pneumococcus from the world?”

Prompted by the centennial celebrations at Saint Antonius Hospital (Nieuwegein, The Netherlands), Ger Rijkers and his team have looked back over the past 100 years since the first successful vaccination against pneumococcal disease and discuss their thoughts on what the future holds for pneumococcal vaccination in the next 100 years.

The WHO reports that at least 1 million children die each year of pneumococcal disease, mainly in developing countries. In developed countries the majority of the burden is seen in elderly persons but individuals with HIV, sickle-cell anemia or chronic organ failure all experience a higher risk of infection with pneumococcal disease. The growing problem of widespread resistance to antibiotics has highlighted the need for vaccines against this pathogen.

In their editorial article in *Expert Review of Vaccines*, Rijkers and his colleagues Suzan van Mens and Heleen van Velzen-Blad explain that the pneumococcus problem is not a new one; high infection rates in the diamond mines of Witwatersrand (South Africa) prompted Sir Almouth Wright to experiment and perform the first successful vaccinations against pneumococcal disease in 1911.

Designing a vaccine against pneumococcal infection is complicated by the thick polysaccharide capsule that the bacterium is encapsulated within.

Rijkers states: “Pneumococci use a total of 92 structural and antigenically different polysaccharides, organized into serogroups and serotypes. Clinical protection against invasive pneumococcal disease is conferred by type-specific antibodies directed against the capsular polysaccharide. Cross-protection only occurs within a serogroup…but not across serotypes.”

A vaccine against pneumococci must therefore protect against the most prevalent serotypes. The first polysaccharide vaccine, whilst composed of the purified capsular polysaccharides of the most prevalent serotypes at the time, did not confer protection in infants, the group most at need of it. Rijkers and his group hypothesize on why this might be, asking:

“Babies are born with a fully functional immune system with one obvious exception: the ability to mount an antibody response to polysaccharide-encapsulated bacteria. This ability matures slowly during the first 18–24 months of life. Why would that be? Why would babies be born with such an obvious transient immunodeficiency and therefore susceptible to pneumococcal infections? The clue may be that this allows the mucosa of the upper respiratory tract to become colonized with pneumococci, the most important representative of the encapsulated bacteria. The price to pay would be a generally mild but sometimes recurrent otitis media, the (much greater) benefit would be that other pathogens such as Staphylococcus aureus are unable to reach the ideal.”

As neonatal B lymphocytes express little or no CR2, a complement receptor required for co-stimulation and consequent activation to produce polysaccharide-specific antibodies, their immune system remained unresponsive to the vaccine and protection was not generated. In 1931 when Walther Goebel and Oswald Avery made a breakthrough believed by many to
be of Nobel-prize-winning magnitude and conjugated a protein to polysaccharide to solve the two major drawbacks associated with polysaccharide vaccines: induction of immunological memory and antibody responsiveness in infants.

However, the now clearly disproved belief that antibiotics would soon make the study of infectious disease obsolete, meant that the principles of Avery and Goebel were not put into place until 50 years later. The current vaccine is composed of the capsular polysaccharides of the 23 most prevalent serotypes, which are accountable for approximately 90% of all pneumococcal infections.

Rijkers and his group were inspired to look back over the last 100 years of pneumococcal vaccination while looking at the past 100 years at Saint Antonius Hospital. Hearts and lungs have always been a priority at the hospital and it was at this hospital that surgeons in a multidisciplinary team pioneered with heart–lung machines in 1959 and performed the first lung transplantation in 1989.

Important medical advances have been made at Saint Antonius Hospital and Rijkers and his colleagues believe that similar advances must be made before the world can be free of pneumococcus. It look took 184 years from the introduction of vaccination by Sir Edward Jenner before Smallpox was eradicated and in their Expert Review of Vaccines article Rijkers and his colleagues outline the three major challenges that need to be overcome in the next 100 years to match that record.

Work by teams at newer institutes and established centers of excellence such as Saint Antonius Hospital must continue, “before we can eliminate pneumococcal disease from the world and protect vulnerable populations of society from virulent colonization.”

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NOTES FOR EDITORS

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Impact Factor: 4.214
Indexed on MEDLINE & EMBASE

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- Vaccine adjuvants
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