

Estimating the time to elimination of vaccine serotype carriage in non-PCV vaccinated age groups through herd effects

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Project background

Pneumococcal conjugate vaccines (PCVs) reduce disease mainly through their impact on nasopharyngeal carriage acquisition of *Streptococcus pneumoniae* (the pneumococcus). Carriage is a precondition for any form of pneumococcal disease. The aim of this project is to understand the changing epidemiology of pneumococcal carriage in non-vaccinated age groups (through herd or indirect effects) following the introduction of childhood pneumococcal conjugate vaccines. Herd effects are likely to have a major impact on the potential cost-effectiveness of PCVs.

An extensive literature search on studies that provide estimates of changes in pneumococcal disease and nasopharyngeal carriage in non-targeted age groups from different countries following the introduction of PCVs was conducted by searching Embase, Medline and Web of Science from September 2010 to December 2015. These studies were combined with evidence identified by a previous systematic review of the same topic. In addition, data on PCV programme characteristics such as vaccine coverage, dosing schedule and use of catch-up campaigns were collected. In the proposed project, changes in pneumococcal carriage in non-targeted age groups will be analysed in order to develop data-driven public policy.

The data stems from a variety of countries with different vaccination policies where there are differences in the ecology and epidemiology of pneumococcal carriage and disease, and these add an extra layer of heterogeneity that may confound the changes in carriage apart from vaccine strategies. This project will therefore develop a Bayesian meta-logistic regression model (and parameterise the model) to capture the changes in carriage since the introduction of childhood PCVs and predict the time to carriage elimination in non-vaccinated population age groups.

Objectives

This project provides an ideal opportunity to work with public-health researchers, modellers and health economists to address a range of questions that may help policy makers. The specific objectives of the proposed MSc project are:

- Explore different data analysis methods to be applied to the data to determine methodological concerns such as clustering and variable classifications.
- Select one particular model type that correctly captures the changes in pneumococcal carriage and use it to:
 - Determine whether the indirect effects on pneumococcal carriage can eventually eliminate the circulation of vaccine serotypes, and if so, how long will it take to eradicate vaccine serotypes;
 - Explore any differences in carriage changes among serotypes, sero group and age groups;
 - Explore the PCV programme characteristics that may confound predicted pneumococcal carriage changes.

This project taps into a range of methodological and disciplinary approaches that include model development, parameter inference, statistical analysis, epidemiology, etc. It is part of a larger project that is currently assessing the extent of herd effects in unvaccinated population age groups. It will offer the mathematical challenge of developing an appropriate Bayesian meta-logistic regression model for the question asked and data available, and give experience of working with a broad team and integrating biological, medical and economics considerations into the mathematical modelling as appropriate.

This project will be supervised by Dr Tinevimbo Shiri (Research Fellow in Infectious Disease Modelling, Warwick Medical School), Stavros Petrou (Professor of Health Economics, Warwick Medical School) and Noel McCarthy (Professor of Evidence in Communicable Disease Epidemiology and Control, Warwick Medical School). It is anticipated that the outputs of this project will be summarised in the form of an article to be submitted to a peer-reviewed journal. Computing support will be provided. There is the potential for the student to be based off-site, although fortnightly meetings with the supervisors would be expected.