Economic Evaluation of a Universal Childhood Pneumococcal Conjugate Vaccination Strategy in Ireland

- *Streptococcus pneumoniae* is a bacterial pathogen that affects children and adults worldwide. It causes a substantial disease burden and the availability of a pneumococcal conjugate vaccine has given the potential introduction of a universal childhood pneumococcal conjugate vaccination program a prominent place on the health policy agenda in many countries.

- In order to justify the universal administration of a 7-valent pneumococcal conjugate vaccine (PCV7, Prevenar®) to infants, the health outcome advantages that stem from incremental cases of preventable disease averted need to be balanced against the increased cost of universal administration of the conjugate vaccine.

- Pharmacoeconomic evaluation is the comparative analysis of alternative courses of action (in this case universal PCV7 vaccination versus no vaccination) in terms of costs and health outcomes. The results of a cost effectiveness analysis are presented as an incremental cost-effectiveness ratio (ICER) and this describes how much additional benefit is achieved for the additional cost incurred.

- A decision analytic model was constructed to follow a birth cohort of vaccinated and unvaccinated individuals from birth over a 10 year period. The base-case model includes the costs of universal infant vaccine administration as well as the healthcare costs associated with pneumococcal infection in infants. The model is based on a series of health states (i.e. meningitis, septicaemia, pneumonia and acute otitis media) that an individual can occupy at a given point in time and it is run in 6 monthly cycles, with the exception of the first year of age which is divided into three age bands: 0-2 months, 2-6 months and 6-12 months. The number of life years gained (LYG) from the vaccination programme was the primary health outcome measure, and this was compared to the nest cost i.e. the additional cost of universal vaccination minus the expected savings from reduced use of healthcare resources, due to a reduction in the burden of pneumococcal

disease. A sub-model was generated to analyse the impact that herd immunity would have on the cost-effectiveness of a universal PCV7 childhood vaccination programme in unvaccinated adults. The analysis was undertaken from the perspective of the Health Service Executive.

- A range of ICERs, based on different scenarios, are presented in this report. Such scenarios test whether alterations in the values of the main variables affect the results of the analysis. This will enable decision makers to judge whether universal infant PCV7 vaccination is likely to be cost-effective in Ireland.

- ***Base case model:***

- In the base case analysis (i.e. excluding herd immunity), the comparison of a universal PCV7 vaccination programme *vs* no vaccination resulted in an ICER of €98,279/LYG.

- Sensitivity analysis of the base case model highlights that the cost-effectiveness of a PCV7 vaccination strategy is sensitive to the following parameters:

  - Price of Prevenar® vaccine.
  - Incidence of pneumococcal infection.
  - Case fatality rates for pneumococcal infection.
  - The onset of protection from vaccination.
  - Duration of protection from vaccination.
  - Vaccine efficacy.

- Sensitivity analysis highlights that the model is robust (i.e. not sensitive) to the following parameters

  - Direct medical costs.
  - Cost of administering the vaccine.
  - Cost of long-term complications of meningitis.
  - Vaccine uptake.
  - Serotype distribution in Ireland.

- ***Herd immunity model:***
  - Inclusion of the effect of herd immunity in the analysis, results in an ICER of €5,913/LYG, which would be considered highly cost-effective.

  - Sensitivity analysis of the herd immunity model highlights that the results are sensitive to the following parameters;

    - An assumption that universal PCV7 vaccination indirectly protects adults against pneumonia, as well as, IPD. If the herd immunity effect is restricted to IPD alone, the ICER increases to €29,533/LYG, which would still be considered cost-effective.
    - Incidence of pneumococcal infection in adults, especially pneumonia.
    - Case fatality rates in adults.

  - Although variation of these parameters by +/-50% resulted in changes to the ICER this did not influence the overall conclusion of the evaluation, that this is a highly cost-effective intervention.

- Overall, the results reflect a conservative estimate of the cost-effectiveness of universal vaccination, as indirect costs and utility values (to give a health outcome measure in Quality Adjusted Life Years (QALYs)) were not included in the evaluation.

- In conclusion, a universal infant PCV7 vaccination programme could be considered highly cost-effective in the Irish healthcare setting from the perspective of the HSE, if viewed in terms of the herd immunity effect.

- The long-term impact of serotype replacement and antibiotic resistance, in addition to the herd immunity effect, on the overall cost-effectiveness of the programme remains to be seen.