Using a mathematical model to evaluate the impact of different PCV schedules: Preliminary results from the West Africa epidemiological scenario

Alessia Melegaro¹, Albert Jan van Hoek², Yoon Choi², Nigel Gay

1) DONDENA Centre, Bocconi University, Milan, Italy
2) Centre for Infections, Health Protection Agency, London, UK
Role of modelling

• Do we need models to design schedules?
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  **NO**
  
  Most vaccination schedules were not designed using models
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• Do we need models to optimise schedules?  
  – Modelling provides an additional tool  
  – Impossible to try out many schedules in the field  
  – Models let you do that
What type of model?

• Dynamic
  – Direct & indirect effects
• Age-structured
  – Fine age-stratification in infants
• Heterogeneity
  – Age-related
  – Country-specific
  – urban/rural, access to health care, etc.
• Quantify uncertainty
  – Univariate
  – Multivariate
  – Likelihood-based
Assessment of each schedule

- **Effectiveness:**
  - Define the model (type, structure, assumptions)
  - Estimate model parameters (data collection and analysis)
  - Assess effectiveness (model simulations)

- **How to compare:**
  - 1 case of IPD in 1yr old in 2011
  - 1 case of HCC in 45yr old in 2055?

- **Cost effectiveness:** Cost per discounted LY/QALY/DALY gained
  - Perspective / time horizon / discount rate
  - Vaccine, programme and healthcare costs
  - C/E threshold, incremental analysis
Pneumococcal challenges

- 90+ serotypes
  - Differ in many ways: virulence, duration of carriage, …
- Multiple carriage
- Competition between serotypes
  - Mechanism?
- Naturally acquired immunity?
  - Serotype-specific or not?
- Changing pre-vaccination baseline

Need to make simplifying assumptions to make progress!
# PCV C/E Tools

<table>
<thead>
<tr>
<th></th>
<th>Pneumo ADIP</th>
<th>PAHO TriVac</th>
<th>SUPREMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>10 cohorts</td>
<td>0-4 plus birth cohorts</td>
<td>Entire population</td>
</tr>
<tr>
<td>Vaccination</td>
<td>PCV</td>
<td>PCV, RV, Hib</td>
<td>PCV</td>
</tr>
<tr>
<td>Outcomes</td>
<td>DALY/LY</td>
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<tr>
<td>Time horizon</td>
<td>5 years</td>
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<td>Cross-sectional</td>
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<tr>
<td>Diseases captured</td>
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<tr>
<td>Herd immunity</td>
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</tr>
<tr>
<td>Serotype replacement</td>
<td>No</td>
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<td>PCV (6 others)</td>
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Schedule options

- Schedules
  - 1+0  2+0  3+0  2+1  3+1

- Age for primary series
  - 6,10,14w  2,3,4m  2,4,6m

- Age for booster
  - 9m  12m  15m

- Catch-up campaign
  - 1-2y  1-4y  and beyond!
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Model

- Originally developed to assess PCV7 in UK
  - Age-structured compartmental dynamic model
- Refined to assess PCV in developing countries
  - Demography, non-IPD
- Applied to W African scenario
  - Burkina Faso (AMP) and the Gambia (MRC)
- Reviewed by QUIVER
- Discussed with PCV experts
- Further model developments and analyses planned
- Present preliminary results
Modelled impact of PCV introduction

VT disease

NVT disease
Effect of catch-up campaign

- **VT (2+1)**
- **VT (2+1) and catch-up (1-4 yrs)**
- **NVT (2+1)**
- **NVT (2+1) and catch-up (1-4 yrs)**
LY gained by schedule

LY gained

Schedule

1+0  2+0  3+0  2+1

0  200000  300000  400000
Uncertainty in effectiveness
Impact of uncertainty in vaccine efficacy parameters

![Graph showing LY gained vs Increasing vaccine efficacy]
Uncertainty in cost-effectiveness
Impact of uncertainty in costs and mortality

Programme costs (in millions) vs. LY gained (in millions)
Next steps

PCV model
• Refine vaccine efficacy parameter set
  – Identify parameter combinations consistent with data from trials and other studies
• Develop full set of epidemiological scenarios for W Africa
  – Uncertainty in disease burden
  – Post-vaccination data from the Gambia
• Develop separate model for epidemic serotypes

Optimising schedules project
• Assess other antigens
• Combine results to assess schedules
Acknowledgements

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