Pneumococcal pneumonia in the UK: how herd immunity affects the cost-effectiveness of 7-valent pneumococcal conjugate vaccine (PCV)

McIntosh E D, Conway P, Willingham J, Hollingsworth R, Lloyd A

Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
A programme of universal paediatric pneumococcal immunisation with 7-valent pneumococcal conjugate vaccine (PCV), which was applied to infants and young children, was examined.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised the whole UK population. For adult cases of pneumococcal pneumonia, only those that were hospital-treated were considered and not those that were community-treated. Only infants and young children aged 1 month to less than 5 years were considered to have received vaccination.

Setting
The setting was community care. The economic analysis was carried out in the UK.

Dates to which data relate
The effectiveness data were derived from official sources referring to 1999, and from studies published between 2000 and 2003. The resource use data were collated from sources published between 2002 and 2003. The price year was 2002.

Source of effectiveness data
The effectiveness data were derived from a review and synthesis of completed studies and published official sources.

Modelling
The authors used a birth cohort model with a 10-year horizon to assess the costs and benefits of universal paediatric pneumococcal conjugate vaccination in the UK. The authors also used this model in a separate paper, from which further details of the model may be obtained (McIntosh et al. 2003, see 'Other Publications of Related Interest' below for bibliographic details).

Outcomes assessed in the review
The following input parameters were used in the model:
cases of pneumococcal meningitis and pneumococcal septicaemia,
the incidence of hospital-treated pneumococcal pneumonia,
the incidence of hospital-treated unspecified pneumonia, and
the proportion of unspecified pneumonia which could be due to pneumococcal infection.

The authors also used the ratio of total hospital-treated pneumococcal pneumonia in the UK population to the population of England, and the ratio of total pneumococcal pneumonia in the UK population to the population of England and Wales. In addition, they included deaths due to pneumococcal meningitis, pneumococcal septicaemia and pneumococcal pneumonia, as well as serotype-specific vaccine efficacy and the incidence of presumed herd immunity effects in adults.

Study designs and other criteria for inclusion in the review
Not reported.

Sources searched to identify primary studies
Two official databases, the Hospital Episode Statistics (HES) and the Office for National Statistics (ONS), were used to derive the effectiveness data. Further sources searched for primary studies were not reported in the present study.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
Not reported.

Number of primary studies included
The effectiveness data were derived from two official databases (HES and ONS), augmented by 12 primary studies.

Methods of combining primary studies
The primary studies do not appear to have been combined.

Investigation of differences between primary studies
The authors do not seem to have investigated differences between the primary studies.

Results of the review
Thirty-two per cent of an adult's unspecified pneumonia was deemed to be due to pneumococcal infection.

The serotype-specific vaccine efficacy was 97.4%.

The incidence of presumed herd immunity effects in adults was 23% for age 20 to 39 years, 1% for age 40 to 64 years, and 11% for age 65 years or older.

The reader is referred to the original study for further details.

Methods used to derive estimates of effectiveness
The authors made assumptions to derive some estimates of effectiveness.

**Estimates of effectiveness and key assumptions**
The authors assumed a 4.3% all-cause paediatric pneumonia vaccine efficacy. A reduction of 58% was applied to unspecified adult pneumonia to account for coincidental nasopharyngeal pneumococcal carriage. Then, it was assumed that 13.4% of adult unspecified pneumonia was due to pneumococcal infection.

**Measure of benefits used in the economic analysis**
The measure of benefits used was the life-years gained (LYG). The health benefits were not discounted in the base-case analysis.

**Direct costs**
The health service costs included in the analysis were:

- the list cost of vaccination of infants and young children,
- the cost of administration of the vaccination schedule,
- the cost per finished consultant episode,
- the cost per day of hospitalisation for meningitis, septicaemia and hospital-treated pneumococcal pneumonia, and
- the cost of sequelae (e.g. brain damage, focal neurological damage, chronic seizures and deafness).

The costs were obtained from official sources (NHS reference costs) and were reported for the fiscal year 2002. As the time horizon of the model was more than two years, the costs were appropriately discounted. The costs relating to meningitis, septicaemia and hospital-treated pneumococcal pneumonia were reported separately from the quantities. The unit costs for sequelae were not reported, and the reader is referred to another paper (McIntosh et al. 2003, see 'Other Publications of Related Interest' below).

**Statistical analysis of costs**
The costs were treated deterministically.

**Indirect Costs**
The indirect costs were not included in the analysis.

**Currency**
UK pounds sterling (€).

**Sensitivity analysis**
Although not explicitly stated, a one-way sensitivity analysis was carried out to investigate variability in the data. The ranges used were derived from the literature, except in the case of the effect of adult pneumonia on invasive pneumonia disease, which was chosen arbitrarily. Other parameters investigated in the sensitivity analysis were paediatric pneumonia vaccine efficacy without herd immunity, pneumococcal proportion of "unspecified" adult pneumonia with herd immunity and paediatric pneumonia vaccine efficacy, and herd immunity effects for three age groups (20 to 29 years, 40 to 64 years and 65+ years).

**Estimated benefits used in the economic analysis**
The vaccination programme resulted in preventing 1,168 deaths (1,141 adults) and 7,147 cases of serious pneumococcal infection (1,791 adults including 32 cases of meningitis, 37 cases of septicaemia and 1,722 cases of pneumonia).

Twenty deaths would be avoided in the 20- to 39-year age group, 7 deaths avoided in the 40- to 64-year age group, and 1,114 deaths avoided in the >64-year age group.

There were 969 LYG in 20- to 39-year age group, 195 LYG in the 40- to 64-year age group, and 12,117 LYG in the >64-year age group.

Cost results
The total costs avoided were:

for meningitis, 45,199 for all age groups,

for septicaemia, 57,340 for all age groups, and

for hospital-treated pneumonia, 2,377,170 for all age groups.

The intervention would result in savings of 2.5 million.

Synthesis of costs and benefits
The cost per LYG was 4,360.

In THE sensitivity analysis, the results were robust over a wide range of assumptions and were consistent with the direction presented in the 'Author's Conclusions'.

Authors' conclusions
The universal paediatric use of a 7-valent pneumococcal conjugate vaccine (PCV) in the UK would be a highly cost-effective intervention.

CRD COMMENTARY - Selection of comparators
The choice of universal paediatric pneumococcal vaccination with 7-valent PCV was explicitly justified. The baseline comparator was no paediatric pneumococcal vaccination, which seems appropriate for the study question. You should decide if this represents a commonly used technology in your own setting.

Validity of estimate of measure of effectiveness
Much of the effectiveness data were derived from official sources, which are assumed high quality. No systematic review of the literature was undertaken for data derived from published studies. Although this is common practice with models, it does not always ensure that the best data available are used in the model. The estimates of effectiveness from the available studies do not seem to have been combined, and the authors did not consider the impact of differences between the studies identified when estimating effectiveness.

Validity of estimate of measure of benefit
The measure of benefit used in the economic analysis was the LYG. LYG reflect the impact on the patients' health. The estimation of benefits was modelled. The model used for this purpose appears to have been appropriate since it allows an estimation of the long-term benefits.

Validity of estimate of costs
Although the perspective adopted in the economic analysis was not explicitly stated, it appears that appropriate costs
relating to a health service perspective have been included in the analysis. Certain categories of costs were reported separately from the quantities, thus enhancing the reproducibility of the study in other settings. The costs were treated deterministically, but no sensitivity analyses of the prices were conducted to assess the robustness of the estimates used. The price year was reported. Discounting was appropriately conducted since the time horizon of the model was more than two years.

Other issues
The authors justified some of the assumptions made in their model with reference to published data. However, they did not compare their findings with those from other studies, so it is not known how far their results agree with published results. The issue of the generalisability of the results to other settings was not directly addressed. The authors do not appear to have presented their results selectively and the scope of the analysis was clearly reflected in the authors’ conclusions. The authors reported some limitations to their study. For example, the fact that they did not incorporate indirect effects associated with vaccination using the PCV, for example the benefits arising from the prevention of antibiotic resistance.

Implications of the study
The authors did not make any explicit recommendations for changes in policy or practice, nor did they identify areas where further research is needed. They suggested that the clinical and economic benefits of universal paediatric pneumococcal vaccination are expected to extend to the adult population.

Source of funding
None stated.

Bibliographic details

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Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
Adult; Aged; Cost-Benefit Analysis; Female; Great Britain /epidemiology; Heptavalent Pneumococcal Conjugate Vaccine; Humans; Immunity, Herd /immunology; Male; Meningococcal Vaccines /economics /therapeutic use; Middle Aged; Pneumococcal Vaccines /economics /therapeutic use; Pneumonia, Pneumococcal /economics /epidemiology /immunology /prevention & control; Vaccines, Conjugate /economics /therapeutic use

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