Cost effectiveness of vaccination against invasive pneumococcal disease among people 50 through 64 years of age: role of comorbid conditions and race

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
Pneumococcal polysaccharide vaccination was compared with no vaccination.

Type of intervention
Primary prevention (vaccination).

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised two hypothetical cohorts of immunocompetent high- and low-risk populations aged 50 to 64 years.

Setting
The setting was the community. The economic analysis was conducted in New York, USA.

Dates to which data relate
The effectiveness data were obtained from published and unpublished literature between 1991 and 2000. The resource data were obtained from unpublished and published sources between 1993 and 1999. The price year was 1995.

Source of effectiveness data
The effectiveness data were derived from a review of the literature.

Modelling
A Markov decision analysis model was constructed to compare the incremental cost-effectiveness ratios of pneumococcal polysaccharide vaccination versus no vaccination. Two hypothetical cohorts of vaccinated and unvaccinated people were followed until death occurred. Medical events were simulated as transitions of patients among a predefined set of health states (invasive pneumococcal disease, average health and death). For the first 6 years each cycle covered the events of one year, after which each cycle covered the events of 6 years.

Outcomes assessed in the review
The outcomes assessed in the review were:

the incidence of invasive pneumococcal disease,
the case-fatality rate,
the effectiveness and duration of protection from pneumococcal vaccination,
the mortality rates from all causes, and
quality of life weights.

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

**Sources searched to identify primary studies**
Not stated.

**Criteria used to ensure the validity of primary studies**
Not stated.

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

**Number of primary studies included**
The incidence of invasive pneumococcal vaccination and the case-fatality rates were obtained from unpublished data from the Centres for Disease Control and Prevention (1998). Adjustments were made for the proportion of the population with the underlying co-morbid conditions from the National Health and Nutrition Examination Survey III (1991 to 1994) and the National Health Interview Survey (1993) by ethnicity and region. The effectiveness and duration of protection of pneumococcal vaccination were derived from Shapiro et al. (see Other Publications of Related Interest). Mortality rates from all causes in the high-risk group were obtained from Schocken et al. (see Other Publications of Related Interest). Quality of life weights were obtained though calculations derived from two published studies.

**Methods of combining primary studies**
Not reported.

**Investigation of differences between primary studies**
Not reported.

**Results of the review**
The paper presented numerous results in the form of base-case, best-case and worst-case analyses. The most important results are reported here with the best- and worst-case values in brackets (best, worst).

The incidence of invasive pneumococcal disease in a general immunocompetent population aged 50 to 64 years was 50.7% (78.5%, 37.8%) in black people and 20.8% (29%, 13%) in nonblack people.

In a high-risk population aged older than 50 years, the incidence of invasive pneumococcal disease was 121.0% (347.6%, 78.3%) in black people and 61.6% (137.1%, 39%) in nonblack people.

The case fatality-rate was 9.8% (19%, 6.6%) in people aged 50 to 64 years, 14.1% (20.3%, 11.9%) in people aged 65 to 79 years, and 20.6% (25%, 14.6%) in people aged older than 85 years.
The effectiveness of pneumococcal vaccination was 93% (97%, 82%) for the first year, 90% (96%, 76%) for the second year, and 81% (92%, 52%) for the sixth year.

**Measure of benefits used in the economic analysis**
The health benefits were measured in terms of the number of cases of paralysis prevented and the quality-adjusted life-years (QALYs) gained. The health benefits were discounted at a rate of 3%.

**Direct costs**
The direct costs included the medical cost of vaccination and future medical costs. The vaccination costs were for the vaccine and administration, treatment of adverse effects, and invasive pneumococcal disease hospitalisation. The ambulatory costs were not included. The costs were discounted at a rate of 3%. The quantities and the costs were not reported separately. The cost of medical care was approximated using the Medicare payment rates. The average 1995 Medicare payment was used for pneumococcal vaccine and its administration. The medical costs for future survivors were derived from the 1993 Medicare Current Beneficiary Survey. The source of the quantities was not reported. The price year was 1995. The base-case analysis included only future medical costs related to invasive pneumococcal disease.

**Statistical analysis of costs**
No statistical analysis of the costs was carried out.

**Indirect Costs**
No indirect costs were included in the analysis.

**Currency**
US dollars ($).

**Sensitivity analysis**
A sensitivity analysis was performed in which the total future medical costs of the survivors were incorporated. One-way sensitivity analyses varied the uncertainty variables over reasonable ranges. Global best-case and worst-case (multi-way) analyses were also performed. Probabilistic sensitivity analyses were conducted for black and nonblack people in the general immunocompetent population. One thousand simulations were performed to generate a distribution of cost-effectiveness ratios according to the cost-effectiveness plane.

**Estimated benefits used in the economic analysis**
In the general immunocompetent population, one-time vaccination of people aged 50 to 64 years gained an average health benefit of 0.92 quality-adjusted days per vaccinee among black people and 0.5 quality-adjusted days among nonblack people.

In a high-risk population, one-time vaccination of people aged 50 to 64 years gained an average health benefit of 1.31 quality-adjusted day per vaccinee among black people and 0.66 quality-adjusted days among nonblack people.

**Cost results**
The total costs were not reported, whereas the incremental costs were.

In the general immunocompetent population, when excluding the survivors' future medical costs, vaccination saved $3.69 per black person vaccinated and cost $5.96 per nonblack person vaccinated. When including future medical costs, vaccination cost $17 per person vaccinated. The estimated adverse effects added $0.03 to the vaccination costs.
In the high-risk population, when excluding the survivors' future medical costs, vaccination saved $27.55 per black person vaccinated and $5.92 per nonblack person vaccinated. When including future medical costs, vaccination cost $52.85 per black person vaccinated and $34.43 per nonblack person vaccinated. The estimated adverse effects added $0.03 to the vaccination costs.

**Synthesis of costs and benefits**
In the general immunocompetent population, when excluding the survivors' future medical costs, vaccination was cost-saving in black people. The cost per QALY gained was $4,351 in nonblack people. When including future medical costs, the cost per QALY gained was $6,459 for black people and $12,374 for nonblack people.

In the high-risk population, when excluding the survivors' future medical costs, vaccination was cost-saving in black and nonblack people. When including future medical costs, the cost per QALY gained was $14,721 for black people and $19,128 for nonblack people.

In the general immunocompetent population, when excluding the survivors' future medical costs, the cost per QALY gained in the global worst-case ranged from $21,513 for black people to $68,871 for nonblack people. In the high-risk population, this cost ranged from $11,548 for black people to $39,000 for nonblack people.

In the global best-case, when excluding the survivors' future medical costs, vaccination was cost-saving for black and nonblack people in each population.

In the probabilistic sensitivity analyses, the 95% probability interval for the cost-effectiveness ratio ranged from cost-saving to $1,594 per QALY gained for black people to $12,273 per QALY gained for nonblack people.

The costs per QALY gained for low-risk people with case-fatality rates from 1998 were $2,477 for black people and $8,195 for nonblack people, when excluding the survivors' future medical costs.

**Authors’ conclusions**
The findings suggest that expanding the recommendation of the Advisory Committee on Immunisation Practices for vaccination to the general population aged 50 to 64 years may be cost-effective, especially for black people. Vaccination both saved medical costs and improved health under the most reasonable assumptions.

**CRD COMMENTARY - Selection of comparators**
The reason for the choice of the comparator, no vaccination, was clear.

**Validity of estimate of measure of effectiveness**
The principal input parameters for the model were derived from published and unpublished data. However, it was unclear whether a systematic review of the literature was conducted to identify relevant research and minimise biases. The estimate of effectiveness seems to have been derived credibly from the primary studies. The estimates were investigated by sensitivity analyses, using what appear to have been appropriate ranges.

**Validity of estimate of measure of benefit**
The estimation of benefits was modelled. The decision analysis model used to derive a measure of health benefit was appropriate. It was unclear if the quality of life estimates derived from two published studies reflected aggregated preferences of patients for different health outcomes. The benefits arising from preventing pneumococcal pneumonia were not included.

**Validity of estimate of costs**
Although the authors reported that the costs were estimated from a societal perspective, the indirect costs were not
included. The ambulatory costs were also not included in the analysis. The quantities and the costs were not reported separately. The sensitivity analyses included cost parameters using a best-case, worst-case approach, which was consistent with the effectiveness analysis. Discounting was reported.

**Other issues**

The generalisability of the results was discussed and adequate comparisons were made with studies dealing with the same topic. The authors highlighted the limitations of their study and do not appear to have reported their results selectively. This cost-effectiveness analysis did not address the implications of pneumococcal revaccination.

**Implications of the study**

These cost-effectiveness results can inform the deliberations of the Advisory Committee on Immunisation Practices and other organisations considering recommendations for a general evaluation at age 50 years. Since disease risk increases with age, the findings also highlighted the importance of addressing the effectiveness of revaccination for people aged 65 years of age or older and the current epidemiology of pneumococcal disease in formulating vaccination policy.

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**Other publications of related interest**


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