

# Cost-effectiveness of pneumococcal vaccination for at-risk and high-risk elderly in limited resource context: lessons learned from Thailand

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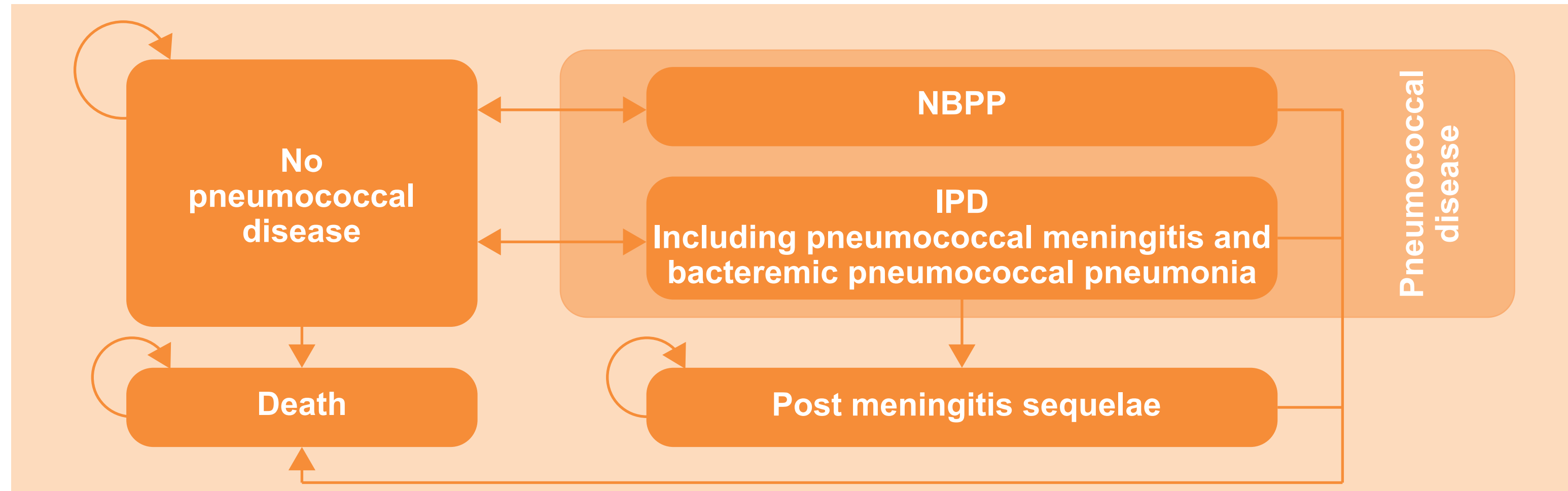
## Background

- Pneumococcal disease (PD), which includes invasive pneumococcal disease (IPD) and non-bacteremic pneumococcal pneumonia (NBPP) is one of major causes of morbidity and mortality in adults and associated with substantial economic burden<sup>1,2</sup>
- PD causes substantial burden of disease in the elderly in Thailand. In 2007, a population-based survey in Thailand found that, in adults aged 75 years and over, the IPD incidence was 26 per 100,000<sup>3</sup>
- The elderly and patients with comorbid conditions are at higher risk of PD. None of pneumococcal vaccines developed for children and adults has been included in Thailand's national immunization program (NIP). Including pneumococcal vaccines in the NIP may have the potential to decrease the burden of pneumococcal disease.<sup>4</sup>
- This study aims to evaluate the cost-effectiveness of pneumococcal vaccination for prevention of PD among at-risk and high-risk Thai elderly

## Methods

- A validated multistate Markov model was used to estimate the cost-effectiveness over a lifetime horizon<sup>5</sup> (Figure 1)
- The societal perspective was used, with costs and outcomes being discounted by 3%
- Three vaccination strategies were compared with no vaccination:
  - 23-valent pneumococcal polysaccharide vaccine (PPSV23)
  - 13-valent pneumococcal conjugate vaccine (PCV13)
  - PCV13+PPSV23 sequential vaccination strategies.
- The target populations were Thai elderly aged 65 years and over who are
  - At-risk (chronic respiratory disease, chronic heart disease, chronic liver disease, and diabetes)
  - High-risk (human immunodeficiency virus infection, organ transplantation, and chronic kidney disease)

Figure 1. Markov model structure



IPD, invasive pneumococcal disease; NBPP, non-bacteremic pneumococcal pneumonia.

- Model inputs
  - Clinical inputs were Thai-specific data. These include IPD incidence, NBPP incidence, IPD case fatality rate, NBPP case fatality rate, NBPP and meningitis in IPD cases, % PMS in IPD meningitis cases, and % NBPP hospitalized<sup>3,6</sup>
  - Vaccine efficacy against IPD and NBPP were 73% and 33.5%, respectively, for PPSV23, while for PCV13, it was set to 75% and 45% for all serotypes. Serotype distribution in Thailand is also included in the model<sup>7,8</sup>
  - Utility values were retrieved from literature review<sup>9-12</sup>
  - The vaccine acquisition costs are based on the Thai drug and medical supply information center, Ministry of Public Health. Other Thai-specific costs were obtained from literature review

## Results

### Clinical outcomes

- In the at-risk and high-risk elderly populations, when any of the vaccination strategies are implemented, more than 166 and 1026 people were saved from fatalities relating to IPD and NBPP, respectively (Table 1)

Table 1. Clinical outcomes for intervention and comparators in at-risk and high-risk elderly

Clinical outcomes	PPSV23	PCV13	PCV13+PPSV23	No vaccination
IPD cases				
At-risk	1175	1137	1043	1538
High-risk	116	112	103	151
NBPP cases				
At-risk	123,945	115,374	112,950	140,512
High-risk	10,312	9599	9397	11,691
IPD death cases				
At-risk	510	494	453	668
High-risk	25	24	22	33
NBPP death cases				
At-risk	7336	6850	6711	8297
High-risk	500	467	457	565

IPD, invasive pneumococcal disease; NBPP, non-bacteremic pneumococcal pneumonia; PCV13, 13-valent pneumococcal conjugate vaccine; PPSV23, 23-valent pneumococcal polysaccharide vaccine.

### Economic outcome

- Compared to no vaccination strategy, implementing PPSV23, PCV13, or PCV13+PPSV23 in the Thai NIP for the at-risk elderly would lead to the additional health care costs of around 1.6 billion Thai baht (THB), 2.8 billion THB, and 4.7 billion THB, respectively. In the high-risk elderly, these lead to additional health care costs of about 70 million THB, 125 million THB, and 240 million THB, respectively.

### Cost-effectiveness outcome

#### Base case

- Compared to no vaccination, incremental cost-effectiveness ratios (ICERs) of all vaccination strategies did not fall under the current suggested willingness to pay (WTP) threshold from Thai guideline of 160,000 THB, which is 1.6 times lower than the Thai gross domestic product per capita<sup>13</sup> (Table 2). Although the clinical results show that PPSV23 provided the lowest number of protective cases, it had the lowest ICER and became the most cost-effective strategy because of the relatively low cost
- When using the WTP threshold recommended by the World Health Organization (WHO), which was 761,366 THB, all vaccination strategies were considered cost effective in the chronic liver disease subgroup. The PPSV23 and PCV13 strategies were also cost effective in the high-risk population, with PPSV23 still being the most cost-effective strategy<sup>14</sup> (Table 2)

#### Scenario analysis (a scenario when PPSV23 price decrease by 42%)

- Compared to no vaccination, PPSV23 was cost effective in the chronic liver disease group and almost cost effective in the high-risk group when using the WTP threshold from the Thai guideline
- However, when using the WTP threshold recommended by WHO, PPSV23 was cost effective in all groups and subgroups, except the diabetes subgroup (Table 2)

#### One-way sensitivity analysis

- The percentage of NBPP hospitalized and the NBPP incidence rates in the 70-74 age category as well as for the 65-69 age category were the key model drivers between the 3 vaccination strategies when compared against no vaccination

Table 2. Incremental cost-effectiveness ratio of PPSV23, PCV13, and PCV13+PPSV23 vaccination strategies in each population when comparing with no vaccination strategy

Populations	ICER (THB/QALY)			
	PPSV23		PCV13	PCV13+PPSV23
	Base case	Scenario analysis	Base case	Base case
At-risk group	824,476	471,270	1,004,483	1,511,235
At-risk group - Chronic respiratory disease	885,867	398,077	1,124,718	1,838,374
At-risk group - Chronic heart disease	1,178,425	700,223	1,433,549	2,129,197
At-risk group - Chronic liver disease	337,343	155,499	429,062	694,903
At-risk group - Diabetes mellitus	1,558,621	895,413	1,887,193	2,859,056
High-risk group	517,489	164,629	669,171	1,187,140

ICER, incremental cost-effectiveness ratio; PCV13, 13-valent pneumococcal conjugate vaccine; PPSV23, 23-valent pneumococcal polysaccharide vaccine; QALY, quality-adjusted life year; THB, Thai baht.

## Limitations

- Herd protection and potential vaccine serotype replacement were not included in this Thai analysis due to lack of data
- Epidemiology changes of PD that occur in real life through antibiotic-resistant strains or serotype replacement are not known or considered in the model
- The cost-effectiveness results are dependent on clinical inputs such as the incidence and hospitalization of NBPP data. Due to the nature of the disease, there is large variation of incidence and hospitalization data between different countries

## Conclusions

- A national immunization program using pneumococcal vaccinations with PPSV23 for the Thai elderly population is the most cost effective among other vaccination strategies and can provide substantial health benefits
- To protect elderly who are at-risk or high-risk of PD, decision makers should consider inclusion of pneumococcal vaccination in the Thai NIP

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