Cost-Effectiveness of 20-Valent Pneumococcal Conjugate Vaccine Among Adults in Taiwan

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INTRODUCTION

- The Taiwan Centers for Disease Control (CDC) recommends vaccination with 13-valent pneumococcal conjugate vaccine (PCV13) followed by 23-valent pneumococcal polysaccharide vaccine (PPV23; PCV13→PPV23) among adults aged 18-64 years with immunocompromising (i.e., high-risk) conditions and all adults aged ≥65 years[1,2]
- A novel 20-valent pneumococcal conjugate vaccine (PCV20)—which targets a wider range of serotypes than earlier PCVs and offers longer-lasting immunity than PPV23—was licensed in Taiwan in December 2024[3]
- Most countries that include PCV20 in the adult vaccination program recommend its use alone (i.e., as opposed to in sequence with PPV23), resulting in more straightforward recommendations

OBJECTIVE

- To evaluate the cost-effectiveness of replacing currently recommended PCV13→PPV23 with PCV20 alone among high-risk adults aged 18-64 years and all adults aged ≥65 years in Taiwan

METHODS

Model Overview

- A probabilistic cohort model with a Markov-type process was used to project the lifetime clinical outcomes and economic costs of invasive pneumococcal disease (IPD) and all-cause non-bacteraemic pneumonia (NBP)
- Model population included high-risk population aged 18-64 years and all adults aged 65-99 years in Taiwan:
  - Population was characterised by age (in 1-yr increments) and risk profile (i.e., low [immunocompetent without underlying medical conditions], moderate [immunocompetent with ≥1 underlying medical condition], or high [immunocompromised])[4]
- Vaccination strategies included PCV20 alone and PCV13→PPV23; in the latter strategy, PCV13 alone was administered at model entry and PPV23 at the start of model year 2
- Clinical and economic outcomes for each strategy were projected annually based on age, risk profile, disease/fatality rates, vaccination status/type, time since vaccination, and unit costs and include cases of IPD and all-cause NBP, deaths due to IPD and all-cause NBP, life-years (LYs) and quality-adjusted LYs (QALYs), and costs of vaccination and medical treatment for IPD and all-cause NBP

Model Parameters

- Model population comprised adults at high-risk of pneumococcal disease aged 18-64 years (n = 0.8M) and all adults aged 65-99 years (n = 4.7M)[5-7] (Table 1)
- VE-PCV20 and VE-PCV13 against VT disease was assumed to be durable for 5 years and to wane to 0% by year 16[8]; VE-PPV23 vs. VT-IPD was assumed to wane to 0% by year 10[9]
- Vaccine serotype coverage was based on data reported in the Taiwan CDC surveillance reports from 2015-2019[8,11-14] (Figures 1 & 2); herd effects from paediatric vaccination were not considered
- QALY loss for persons with IPD, inpatient NBP, and outpatient NBP were 0.13, 0.13 and 0.004, respectively[15,16]
- Costs (in New Taiwan Dollar, NT$) included:
  - Medical care costs: IPD, NT$ 119,179; inpatient NBP, NT$ 48,195; outpatient NBP, NT$ 785[17]
  - Vaccines (prices employed are confidential): PCV20 price was assumed 10% > PCV13 price; PPV23 price assumed 40% of PCV13 price; vaccine administration fee assumed NT$ 0
- Vaccine uptake at model entry was based on assumption (18-49 years: 7.2%; 50-64 years: 20%; 65-74 years: 50%; 75-99 years: 35%); 100% of those who received PCV13 at model entry were assumed to receive PPV23 in model year 2, if alive
- Other model inputs are summarized in Table 1

Figure 1. Percentage of IPD due to vaccine serotypes, by age

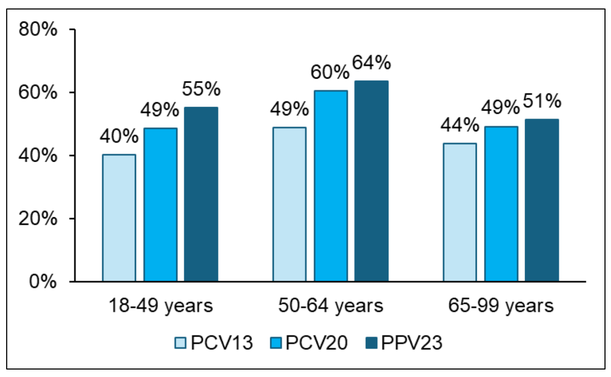


Figure 2. Percentage of pneumococcal NBP due to vaccine serotypes, by age

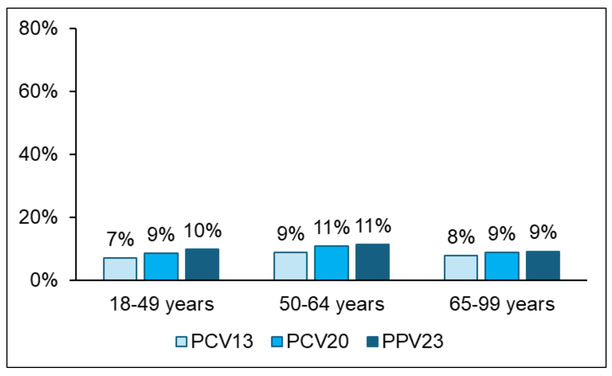


Table 1. Base case model input values, by age and risk profile

	Age (years)/Risk										
	18-49	50-64	65-74			75-84			85-99		
	High Risk	High Risk	Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk	Low Risk	Moderate Risk	High Risk
Population (thousands)[5-7]	361	452	1,374	1,201	382	479	563	213	169	211	88
Incidence of IPD (per 100K)[7,11,18]	4.6	6.2	1.9	6.0	8.1	2.9	6.9	7.6	4.6	8.2	6.5
Incidence of inpt NBP (per 100K)[7, 19-21]	272	859	213	1,041	2,359	683	1,981	2,869	1,056	3,063	4,435
Incidence of outpt NBP (per 100K) [7, 19-21]	889	2,260	1,028	3,106	4,166	1,422	4,297	5,763	1,853	5,600	7,511
General population mortality[22]	0.2	1.0	1.2	1.8	2.2	2.7	4.0	5.2	5.1	7.4	9.7
CFR for IPD (per 100)[7,10]	8.6	9.8	6.8	12.9	12.0	13.2	17.0	13.2	17.4	21.3	17.9
CFR for inpt NBP (per 100)[20,23]	10.5	11.4	4.5	6.7	10.0	8.6	10.7	11.4	11.6	11.7	15.6
CFR for outpt NBP (per 100)	0	0	0	0	0	0	0	0	0	0	0
Yr. 1 VE-PCV20/13 vs. VT-IPD[8,24]	65.2%	63.3%	75.0%	75.0%	60.0%	75.0%	75.0%	60.0%	75.0%	75.0%	60.0%
Yr. 1 VE-PCV20/13 vs. VT-NBP[8,24]	44.5%	41.1%	45.0%	45.0%	36.0%	45.0%	45.0%	36.0%	45.0%	45.0%	36.0%
Yr. 1 VE-PPV23 vs. VT-IPD[9]	17.0%	16.9%	55.9%	31.1%	16.2%	50.8%	28.2%	14.7%	37.6%	20.9%	10.9%
Yr. 1 VE-PPV23 vs. VT-NBP	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
General population health utility[25,26]	0.72	0.66	0.89	0.70	0.68	0.88	0.67	0.65	0.87	0.64	0.60

Abbreviations: CFR: case-fatality rate; inpt: inpatient; IPD: invasive pneumococcal disease; NBP; non-bacteraemic pneumonia; outpt: outpatient; PCV13: 13-valent pneumococcal conjugate vaccine; PCV20: 20-valent pneumococcal conjugate vaccine; PPV23: 23-valent pneumococcal polysaccharide vaccine; Yr: year

Analyses

- Cost-effectiveness was calculated in terms of cost per QALY gained and evaluated using a 3x GDP per capita willingness-to-pay (WTP) threshold
- Analyses were conducted from the healthcare system perspective with benefits and costs discounted 3% annually
- Base case analyses evaluated all PCV20 vs. PCV13→PPV23 among the full model population
- Subgroup analyses considering high-risk adults aged 18-64 years and all adults aged 65-99 years, respectively were also conducted
- Scenario analysis #1 considered hypothetical herd effects from paediatric vaccination with PCV20 starting in model year 4[7,14-17]
- Scenario analysis #2 assumed that only 50% of persons who received PCV13 in model year 1 received PPV23 in model year 2
- Probabilistic sensitivity analyses (PSA; 1,000 replications) were conducted to account for uncertainty surrounding estimates of key model parameters

RESULTS

Base Case

- PCV20 use resulted in 29 fewer IPD cases, 4,655 fewer all-cause NBP cases, and 160 fewer disease-related deaths among the model population
- With net costs (vaccination + medical) lower by NT$ 2.3B and 944 QALYs gained, PCV20 was dominant strategy compared to PCV13→PPV23 (Table 2)

Scenario and Sensitivity Analyses

- PCV20 was dominant among subgroups defined on age, with estimated cost savings (medical care and vaccination costs) of NT$ 132.4 million among adults aged 18-64 years and NT$ 2.2 billion among adults aged 65-99 years (Table 3)
- PCV20 remained dominant in both scenario analyses:
  - Scenario #1: Δ IPD cases: -23; Δ NBP cases: -3,993; Δ deaths: -135; Δ costs: -NT$ 2.3B; Δ QALYs: 815
  - Scenario #2: Δ IPD cases: -39; Δ NBP case: -4,654; Δ deaths: -161; Δ costs: -NT$ 789M; Δ QALYs: 953
- PSA yielded a dominant cost-effectiveness ratio in 100% of PSA simulations (Figure 3)

Table 2. Base case - clinical and economic outcomes for PCV20 vs. PCV13→PPV23 in high-risk adults aged 18-64 years and all adults aged 65-99 years

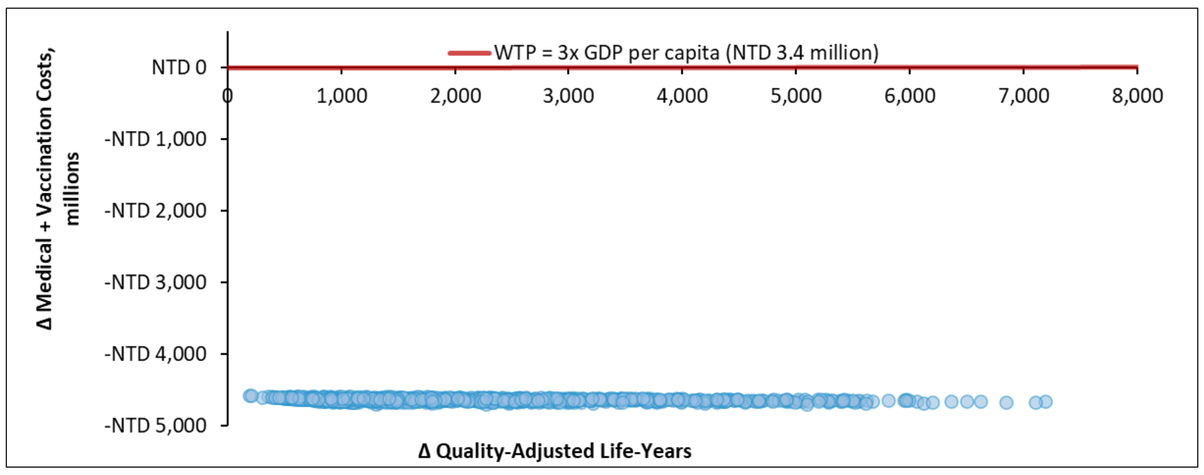
	PCV13→PPV23	PCV20	Difference
No. cases			
IPD	5,511	5,482	-29
Inpatient NBP	1,934,376	1,932,893	-1,483
Outpatient NBP	3,716,882	3,713,710	-3,171
No. deaths	236,583	236,423	-160
LYs (discounted)	69,827,105	69,828,283	1,178
QALYs (discounted)	50,672,027	50,672,971	944
Costs (millions)			
Medical care	NT$ 63,671.5	NT$ 63,607.1	-NT$ 64.4
Vaccination	NT$ 11,482.8	NT$ 9,199.2	-NT$ 2,283.6
Total healthcare costs (Medical + Vaccination)	NT$ 75,154.3	NT$ 72,806.3	-NT$ 2,348.0
Cost per QALY	--	--	Dominant

Table 3. Results from scenario analyses

Scenario #1: High-risk adults aged 18-64 years			
	PCV13→PPV23	PCV20	Difference
LYs (discounted)	15,147,799	15,147,967	168
QALYs (discounted)	10,125,955	10,126,079	125
Costs (millions)			
Total healthcare costs (Medical + Vaccination)	NT$ 13,301.0	NT$ 13,168.6	-NT$ 132.4
Cost per QALY	--	--	Dominant
Scenario #2: All-risk adults aged 65-99 years			
	PCV13→PPV23	PCV20	Difference
LYs (discounted)	54,679,306	54,680,316	1,010
QALYs (discounted)	40,546,073	40,546,892	819
Costs (millions)			
Total healthcare costs (Medical + Vaccination)	NT$ 61,853.3	NT$ 59,637.7	-NT$ 2,215.6
Cost per QALY	--	--	Dominant

Abbreviations: IPD: invasive pneumococcal disease; LYs: life years; NBP: non-bacteraemic pneumonia; PCV13: 13-valent pneumococcal conjugate vaccine; PCV20: 20-valent pneumococcal conjugate vaccine; PPV23: 23-valent pneumococcal polysaccharide vaccine; QALYs: quality-adjusted life years

Figure 3. Scatterplot of results of PSA for PCV20 vs. PCV13→PPV23 in high-risk adults aged 18-64 years and all adults aged 65-99 years in Taiwan



Abbreviations: GDP: gross domestic product; NTD: New Taiwan Dollar; PSA: probabilistic sensitivity analysis; WTP: willingness-to-pay

LIMITATIONS

- Although some serotype replacement may occur in the real world, it was not considered in the scenario assuming paediatric herd effects
- The model did not include other potential downstream adverse outcomes and costs associated with pneumonia, which may conservatively bias against use of PCV20
- The model did not consider the cost of vaccine administration, however, as PCV20 only requires one administration, unlike the sequential strategy, PCV20 would yield greater cost savings if the cost of vaccine administration had been considered

CONCLUSIONS

- Use of PCV20—in lieu of current recommendations in Taiwan—among high-risk adults aged 18-64 years and all adults aged ≥65 years would substantially reduce the numbers of cases and deaths due to pneumococcal disease
- Results suggest that vaccinating adults with a single dose of PCV20 would be an efficient use of healthcare resources and prove cost-saving from the Taiwanese healthcare system perspective

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