

Cost-Effectiveness of 13-Valent Pneumococcal Conjugate Vaccine in Indian Adults Aged ≥ 60 Years

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INTRODUCTION

- In India, clinical guidelines recommend use of 13-valent pneumococcal conjugate vaccine (PCV13) followed by 23-valent pneumococcal polysaccharide vaccine (PPV23) among adults, especially those with risk conditions¹
- According to experts, vaccine uptake for the sequential strategy among older adults is low with persons frequently receiving PPV23 alone, likely due to lower costs and lack of awareness
- However, the added benefits of PCV13—including protection against non-bacteremic pneumonia and greater durability of effectiveness—are well-known

OBJECTIVE

- We evaluated the clinical impact and cost-effectiveness of single-dose PCV13 vs. single-dose PPV23 for all adults aged ≥ 60 years in India from the private/patient and government (govt./payer) perspectives

METHODS

Model Overview

- Lifetime risks and costs of invasive pneumococcal disease (IPD), including bacteremia and meningitis, and all-cause non-bacteremic pneumonia (AC-NBP) were projected using a probabilistic cohort model with a Markov-type process
- Model population included all adults aged 60-99 years in India (N=145.6M)^{2,3}:

 - Population was characterized by age (1-yr increments) and risk profile (healthy [immunocompetent without chronic medical conditions], at-risk [immunocompetent with ≥ 1 chronic medical condition], high-risk [immunocompromised])⁴

- Vaccination strategies included a single dose of PCV13 or, alternatively, PPV23 at model entry
- 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 AC-NBP, deaths due to IPD and inpatient AC-NBP, life-years (LYs) and quality-adjusted LYs (QALYs), and costs of vaccination and medical treatment for IPD and AC-NBP

Model Parameters

- Model population comprised all adults aged 60-99 years (60-64y, n=49.9M; 65-74y, n=65.9M; 75-84y, n=24.2M; 85-99y, n=5.6M)^{2,3}
- Proportion of disease that is vaccine-type (VT)^{5,6} was assumed to remain the same over the modelling horizon due to low uptake of PCVs among children
- PCV13 effectiveness (VE-PCV13) was assumed to be durable for 5 years and to wane to 0% by year 16 as follows: 5% annually during years 6-10, 10% annually during years 11-15, and no effectiveness beginning in year 16^{7,8}
- VE-PPV23 vs. VT-IPD was assumed to wane to 0% by year 10¹⁰; VE-PPV23 vs. VT-NBP assumed to be 0%^{1,12}
- Utility reductions for persons with IPD, inpatient AC-NBP, and outpatient AC-NBP were 0.13, 0.13, and 0.004, respectively, in the year in which the illness occurred^{13,14}
- Medical care costs⁴ were:
 - Private/patient: bacteremia, ₹485K; meningitis, ₹705K; inpatient AC-NBP, ₹342K; outpatient AC-NBP, ₹11K
 - Govt./payer: bacteremia, ₹65K; meningitis, ₹31K; inpatient AC-NBP, ₹27K; outpatient AC-NBP, ₹3K
- Vaccination costs include vaccine price (confidential; private/patient price=1.38x govt./payer price) and administration fee (private/patient: ₹400; govt./payer: ₹0)⁴
- Vaccine uptake⁴ varied by perspective:
 - Private/patient perspective: 7.5% among all risk groups
 - Govt./payer perspective: healthy, 7.5%; at-risk, 15%; high-risk, 30%
- Other model inputs are summarized in Table 1

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
- Benefits and costs were discounted at 5% annually
- Analyses were conducted from two alternative perspectives:
 - Private/patient: costs borne by patients utilizing private facilities
 - Govt./payer: costs borne by govt. for management of pneumonia in govt. facilities
- Probabilistic sensitivity analyses (PSA; 1,000 replications) were also conducted to account for uncertainty surrounding estimates of key model parameters

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

	50-64 Years		65-74 Years		75-84 Years		85-99 Years					
	Healthy	At-Risk	Healthy	At-Risk	Healthy	At-Risk	High-Risk	Healthy	At-Risk	High-Risk		
Incidence of bacteremia (per 100K) ^{15,16}	2.1	6.1	17.9	3.8	10.2	24.9	6.4	15.9	24.4	9.1	21.9	22.9
Incidence of meningitis (per 100K) ^{15,16}	0.1	0.4	1.2	0.2	0.7	1.6	0.4	1.0	1.6	0.6	1.4	1.5
Incidence of inpatient AC-NBP (per 100K) ^{15,17}	90	434	1,208	204	905	2,005	826	2,308	3,384	1,440	3,709	4,763
Incidence of outpatient AC-NBP (per 100K) ^{17,18}	250	902	1,690	550	1,661	2,255	848	2,560	3,475	1,180	3,564	4,837
General population mortality ¹⁹	1.0	1.4	1.9	2.3	3.5	4.5	4.7	6.9	9.2	9.6	14.3	18.9
Case-fatality rate for IPD (per 100) ¹⁶	6.1	24.3	37.7	10.1	31.6	42.9	16.7	40.1	44.3	27.4	48.5	38.4
Case-fatality rate for inpatient AC-NBP (per 100) ²⁰	1.0	2.5	5.4	2.8	4.6	6.8	6.7	8.4	9.1	7.9	8.4	11.0
Yr. 1 VE-PCV13 vs. VT-IPD (%) ^{8,21,22}	79.2	79.2	63.3	75.0	75.0	60.0	75.0	60.0	75.0	75.0	60.0	
Yr. 1 VE-PCV13 vs. VT-NBP (%) ^{8,21,22}	51.3	51.3	41.1	45.0	45.0	36.0	45.0	45.0	36.0	45.0	36.0	
Yr. 1 VE-PPV23 vs. VT-IPD (%) ^{10,23}	58.3	32.3	16.8	55.7	30.9	16.1	50.8	28.1	14.6	37.9	20.5	10.6
General population health utility ²⁴	0.93	0.72	0.69	0.93	0.73	0.71	0.89	0.68	0.66	0.82	0.60	0.56

RESULTS

- From the private/patient perspective, use of PCV13—in lieu of PPV23—was cost saving (costs lower by ₹2.7 billion), making PCV13 the dominant strategy (Table 2)
- From the govt./payer perspective, use of PCV13 vs. PPV23 increased total costs (by ₹37 billion) and total QALYs (by 90K), yielding an ICER of ₹417,458 (Table 3)
- In PSA, 70.2% of replications were cost saving (in the southeast quadrant) from the private/patient perspective (Figure 1); 92.1% of replications were below 3x GDP per capita (cost/QALY < ₹600,000) from the govt./payer perspective (Figure 2)

Table 2: Base case results - private/patient perspective

	PCV13	PPV23	Difference
No. of cases			
IPD	276,489	281,089	-4,600
Inpatient AC-NBP	35,449,908	35,558,702	-108,795
Outpatient AC-NBP	39,630,365	39,764,525	-134,160
No. of deaths	2,921,458	2,930,922	-9,464
No. of LYs/QALYs (discounted)			
LYs	1,332,467,431	1,332,424,680	42,751
QALYs	1,018,920,718	1,018,881,355	39,363
Costs (millions)			
Medical care	₹ 7,390,279	₹ 7,420,861	-₹30,583
Vaccination	₹ 47,490	₹ 19,651	₹27,839
Total costs (Medical + Vaccination)	₹ 7,437,769	₹ 7,440,512	-₹2,744
Cost per LY	--	--	Dominant
Cost per QALY	--	--	Dominant

Table 3: Base case results - govt./payer perspective

	PCV13	PPV23	Difference
No. cases			
IPD	269,028	279,668	-10,640
Inpatient AC-NBP	35,316,793	35,558,868	-242,075
Outpatient AC-NBP	39,475,214	39,764,702	-289,488
No. deaths	2,908,182	2,930,382	-22,199
No. LYs/QALYs (discounted)			
LYs	1,332,528,784	1,332,428,027	100,758
QALYs	1,018,973,984	1,018,883,678	90,306
Costs (millions)			
Medical care	₹655,327	₹661,610	-₹6,284
Vaccination	₹59,590	₹15,607	₹43,983
Total costs (medical + vaccination)	₹714,916	₹677,217	₹37,699
Cost per LY	--	--	₹374,156
Cost per QALY	--	--	₹417,458

Figure 1: PSA scatterplot - private/patient perspective

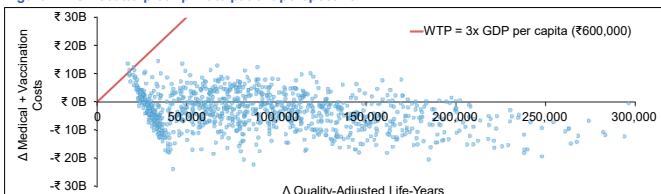
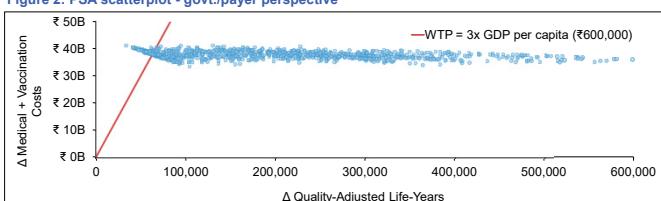


Figure 2: PSA scatterplot - govt./payer perspective



CONCLUSIONS

- CEAs suggest that PCV13 use in lieu of PPV23 among adults aged ≥ 60 years would be cost saving from the private/patient perspective and would be cost-effective (under a 3x GDP per capita threshold) from the govt./payer perspective
- Considering the burden of pneumococcal disease and current pneumococcal vaccine coverage, further evaluation of adult pneumococcal vaccination strategies in India is warranted

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