Cost-Effectiveness of Implementing 13-valent Pneumococcal Conjugate Vaccine for Adults Aged ≥19 Years With Underlying Conditions

Miwako Kobayashi[i], Charles Stoecker[2], Wei Xing[3], Bo-Hyn Cho[4], Tamara Pilishvili[1]

1. Division of Bacterial Diseases, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, GA; 2. Department of Global Health Management and Policy, Tulane University School of Public Health and Tropical Medicine, New Orleans, LA; 3. Weems Design Studio Inc., Contractor to Centers for Disease Control and Prevention, Division of Bacterial Diseases Control and Prevention, Atlanta, GA; 4. Immunization Services Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, GA

Background

- In the United States, approximately 30,000 cases of invasive pneumococcal disease (IPD) such as pneumococcal meningitis and bacteremia occur annually.
- Adults with underlying conditions continue to be at increased risk for pneumococcal disease.
- ACIP currently recommends U.S. adults aged ≥19 years with immunocompromising conditions, cerebrospinal fluid leaks, or cochlear implants to receive 13-valent pneumococcal conjugate vaccine (PCV13) in series with 23-valent polysaccharide vaccine (PPSV23).
- Adults aged ≥19 years with chronic medical conditions (CMC), such as chronic heart, lung, liver disease, diabetes mellitus, alcoholism, and cigarette smoking, are recommended to receive PPSV23 only.
- However, adults with CMC can have 2.3–15.4 times the incidence of IPD compared to adults without indication for pneumococcal vaccination.
- We sought to evaluate the cost-effectiveness of implementing PCV13 in series with PPSV23 for all adults aged ≥19 years with CMC.

Methods

- We used a probabilistic model following a cohort of 19-year-old U.S. adults.
- We used Monte Carlo simulation to estimate the impact on program, medical and non-medical costs, and pneumococcal disease burden when administering PCV13 in series with PPSV23 (**Figure 1**).
  - » Costs were in 2017 U.S. dollars [$] using the societal perspective.
- **Table 1** shows vaccine effectiveness (VE) assumptions for the base case.
- We performed one-way sensitivity analyses assuming higher PCV13 VE against serotype 3 disease.
  - » Assumed that VE of PCV13 against serotype 3 disease is 75% vs IPD and 45% vs NBPP for the 19-64 age group and 67% vs IPD and 32.5% vs NBPP for the 65+ age group.

Results

- In the base case, assuming no PCV13 effectiveness against serotype 3 disease, adding a dose of PCV13 upon CMC diagnosis cost $689,299 per QALY gained (**Table 2**).
- This declined to $79,416 per QALY if VE against ST3 was estimated to be equivalent to other PCV13-types.

Table 1. Vaccine effectiveness assumptions by age group used for the base case

Vaccine effectiveness		Age groups			
		19–64 years		≥65 years	
Vaccine type	Outcome	Value	Range	Value	Range
PCV13	PCV13-type IPD (-ST3, +ST6C)	75	(41.4, 90.8)	67	(11, 88)
PCV13	ST3 IPD	0	(0, 45)	0	(0, 26)
PCV13	PCV13-type NBPP (-ST3), CMC	45	(14.2, 65.3)	32.5	(3.9, 53)
PCV13	ST3 NBPP	0	(0, 45)	0	(0, 45)
PPSV23	PPSV23-type IPD	73	(56.0, 84.0)	67	(37, 73)
PPSV23	PPSV23-type NBPP	0	(0, 50)	0	(0, 50)

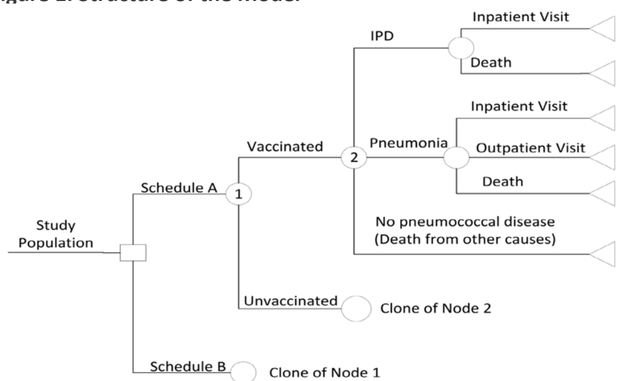
CMC: chronic medical condition, IPD: invasive pneumococcal disease, NBPP: non-bacteremic pneumococcal pneumonia, PCV13: 13-valent pneumococcal conjugate vaccine, PPSV23: 23-valent pneumococcal polysaccharide vaccine, ST3: serotype 3, ST6C: serotype 6C

Table 2. Base Case and One-Way Sensitivity Analysis of Adding PCV13 at diagnosis of Chronic Medical Conditions

	No PCV13 (A)	Adding PCV13, Base Case (B)	Adding PCV13, Base Case vs. No PCV13, (B)-(A)	Adding PCV13, Higher VE* for ST3 Disease vs. No PCV13
Health Outcomes				
IPD Cases	9,121	9,068	-54	-141
Hospitalized NBPP Cases	144,896	144,577	-319	-2,244
Non-hospitalized NBPP Cases	200,824	200,258	-565	-3,427
Deaths due to IPD	880	876	-4	-12
Deaths due to NBPP	5,304	5,293	-10	-77
Discounted QALYs gained	-53,314	-53,141	174	904
Discounted life-years gained	-83,087	-82,831	255	1,382
Costs (million $)				
Total Cost	3,426	3,546	$120	$72
Medical Costs	3,254	3,243	-$11	-$59
Vaccine Costs	172	303	$131	$131
Cost Ratios ($)				
Cost/QALY	—	—	689,299	79,416
Cost/Life-year	—	—	468,449	51,981

IPD: invasive pneumococcal disease, NBPP: non-bacteremic pneumococcal pneumonia, QALY: quality-adjusted life year, ST3: serotype 3, VE: vaccine effectiveness
*Assume that VE of PCV13 against serotype 3 disease is 75% vs IPD and 45% vs NBPP for the 19-64 age group and 67% vs IPD and 32.5% vs NBPP for the 65+ age group

Figure 1. Structure of the Model



Schedule A refers to the base-case scenario where adults with chronic medical conditions receive PPSV23 only.
Schedule B refers to the alternative scenario where adults with chronic medical conditions receive PCV13 followed by PPSV23 a year later.
IPD: invasive pneumococcal disease; Pneumonia; non-bacteremic pneumococcal pneumonia.
The figure shows pneumococcal disease related outcomes in the cost-effectiveness model.

Summary and Conclusions

- Administering PCV13 in series with the recommended PPSV23 for adults with CMC was not economically favourable.
- Results were sensitive to estimated PCV13 VE against serotype 3 disease.

References

Table 1. Footnote

[i] Source: Bonten et al. 2015 for 19–64 year old. Pilishvili et al.2018 for age ≥65 years
[iii] Source for adults aged ≥65 years from Pilishvili et al. 2018. For adults aged 19–64 year olds, we assumed that the upper range will be as high as what we estimated for ST3 NBPP.
[iii] Source: Bonten et al. 2015 for age 19–64 years Suaya et al. 2018.
[iv] We assume PCV13 ineffective against ST3 pneumonia based on results from serotype 3 IPD For the upper bound of effectiveness, we use the effectiveness of PCV13 against all vaccine-type pneumonia from Bonten et al. 2015.
[v] Source: Falkenhorst et al. 2017. For 19–64 year olds, pooled estimate from case-control studies was used. For ≥65 years old, we asumed the point estimate to be the same as PCV13.
[vi] Source: Schiffner-Rohe et al. 2016, Falkenhorst et al. 2017, Tin Tin Htar et al. 2017.

Contact Info

Miwako Kobayashi, MD, MPH
mkobayashi@cdc.gov