Economic Assessment of Routine PCV20 for Children

Charles Stoecker
Tulane University
School of Public Health and Tropical Medicine

ACIP
June 22, 2023

Conflicts of Interest

- Dr. Stoecker has no conflicts of interest to declare.

Acronyms

- PCV: pneumococcal conjugate vaccine
- PCV13: 13 valent PCV
- PCV15: 15 valent PCV
- PCV20: 20 valent PCV
- PPSV23: 23 valent pneumococcal polysaccharide vaccine
- VE: vaccine effectiveness
- VT: vaccine type
- ST: serotype
- AOM: acute otitis media
- NBP: non-bacteremic pneumonia
- IPD: invasive pneumococcal disease
- IPT: inpatient
- OPT: outpatient
- QALY: quality adjusted life year
- IC: immunocompromised
- CMC: chronic medical conditions, but not IC
- CPI: Consumer price index
- NIS: National Immunization Survey
- ABCs: Active Bacterial Core Surveillance System

Policy Question 1

- Should PCV20 be recommended as an option for pneumococcal conjugate vaccination according to currently recommended dosing and schedules, for U.S. children aged <2 years?
- Evaluate the disease and cost impacts of using PCV20 in place of existing conjugate vaccines in six interventions:

Intervention	Comparator	Population
PCV20	PCV13	Healthy
PCV20+PPSV	PCV13+PPSV	CMC
PCV20+PPSV+PPSV	PCV13+PPSV+PPSV	IC
PCV20	PCV15	Healthy
PCV20+PPSV	PCV15+PPSV	CMC
PCV20+PPSV+PPSV	PCV15+PPSV+PPSV	IC

Conjugate doses are given in a 3+1 schedule (3 doses at age 0, 1 dose at age 1),
PPSV doses are given at age 2 for CMC & IC and at age 7 for IC

Policy Question 2

- Should PCV20 without PPSV23 be recommended as an option for pneumococcal vaccination for U.S. children aged 2–18 years with underlying medical conditions that increase the risk of pneumococcal disease?
- Evaluate the disease and cost impacts of using PCV20 in place of existing schedules that include conjugate and polysaccharide in six interventions:

Intervention	Comparator	Population
PCV20	PCV13+PPSV	CMC
PCV20	PCV13+PPSV+PPSV	IC
PCV20	PCV15+PPSV	CMC
PCV20	PCV15+PPSV+PPSV	IC
PCV20+PPSV	PCV20	CMC
PCV20+PPSV+PPSV	PCV20	IC

Conjugate doses are given in a 3+1 schedule (3 doses at age 0, 1 dose at age 1), PPSV doses are given at age 2 for CMC & IC and at age 7 for IC

Methods

- **Cohort model**
  - United States birth cohort 3,939,295
    - 91.1% healthy [a]
    - 8.8% CMC [a]
    - 0.1% IC [a]
    - Background mortality rates from National Center for Health Statistics Vital Statistics
  - Societal perspective
    - Medical &nonmedical (work loss) costs
  - All future outcomes (health &cost) discounted at 3%
  - Costs inflated to 2022$ by CPI or CPI Medical Care
  - Disease incidence followed for 15 years after final PCV20 shot
    - Direct &indirect protection followed over this cohort
    - QALY losses from death and permanent disease states aggregated over the lifetime

[a] Pelton 2014. Tables 1 &2.

Outcomes

- IPD cases (meningitis & other)
- Meningitis sequelae (deafness & other disability)
- Non-invasive pneumonia (inpatient & outpatient)
- Otitis media & tympanostomy tube placement
- Deaths
- QALYs & life years
- Costs
- Cost/QALY

Complete Series PCV Vaccine Effectiveness

	VE	Reference
VT IPD (except ST3, ST19F)	86 (76, 92)	Moore 2016
ST3 IPD	26 (0, 68)	Andrews 2014
ST19F IPD	75 (37, 90)	Andrews 2014
VT NBP (except ST3, ST19F)	51.6 (45.6, 55.2)	b
ST3 NBP	15.6 (0, 40.8)	b
ST19F NBP	45 (22.2, 54)	b
VT AOM (except ST3, ST19F)	54 (41, 64)	Eskola 2001
ST3 AOM	16.3 (12.4, 19.3)	c
ST19F AOM	47.1 (35.8, 55.8)	d

Note: The displayed VE values apply only after receipt of 4th dose. VE during the 1st year (age 0-1) is 75.7% of these numbers. (Adapted from Whitney et al. 2006)

b Applied ratio of VE for NBP to VE for IPD for adults from CAPITA study to pediatric VEs vs IPD above

c Applied ratio of pediatric ST3 IPD to other VT IPD above to Eskola estimate for VT AOM

d Applied ratio of pediatric ST19F IPD to other VT IPD above to Eskola estimate for VT AOM

PPSV Vaccine Effectiveness

	VE	Source
VT IPD	59.7 (47.4, 69.1)	Falkenhorst 2017 & Thorrington 2018
VT NBP	20 (0, 40)	ACIP WG Discussion
VT AOM	0	ACIP WG Discussion

Indirect Effects

Effects on other children

- Apply to unvaccinated children and children whose vaccination protection is not 100% (i.e., all children)
- Apply to PCV20 unique types only
- Remove 7.8% of disease each year

Effects on adults

- For childhood cohort model, modeled effects on all U.S. adults (258 million)
- Used inputs from our model previously used to analyze PCV20 effects on adults
- Modeled 1 year of impacts on adults for this childhood cohort
  - 2nd year of impacts on adults would be influenced by 2nd childhood cohort, etc.
- Used output from previously used CDC WinBUGS model that shows each childhood cohort responsible for 4.12% decline in previous year's disease on average
  - We modified this 4.17% to account for an anticipated 15 years of use to arrive at an average of 3.12% disease reduction per childhood cohort
- Indirect effects from adults (QALYs and cost savings) were then apportioned to each risk status of children according to their contribution to total QALYs saved.
  - If vaccinating healthy children was responsible for 50% of total QALYs saved among children, then 50% of cost and QALY savings from adults were allocated to the healthy group.

Other Vaccine Assumptions

- **Coverage**
  - 3-dose PCV series (completed by 13 months, applied to 1st year)
    - 94.2% (93.6, 94.8) Hill MMWR 2023
  - 4-dose PCV series
    - 81.9% (80.9, 82.2) Hill MMWR 2023
  - 1st dose PPSV (CMC & IC)
    - 78.1%
  - 2nd dose PPSV (IC)
    - 64.0%
- **Waning**
  - PCV: Years 0-5 get full VE
    - Waning linearly to 0% over next 10 years
  - PPSV: Wane linearly to 50% in first 5 years
    - Wane linearly to 30% in next 5
    - Wane to 0% in last 5 years
- **Adverse events**
  - All vaccines were assumed to have no adverse events

AOM Incidence

Age	0	1	2	3	4
All cause AOM visits, healthy (per 1k) [a]	507 (358,701)	507 (358,701)	319 (229,435)	319 (229,435)	319 (229,435)
All cause AOM visits, CMC/IC (per 1k) [b]	1533 (1083,2117)	1533 (1083,2117)	686 (491,936)	686 (491,936)	686 (491,936)
% of AOM with tympanostomy tube insertion [c]	12% (6-15)	12% (6-15)	8% (4-15)	8% (4-15)	8% (4-15)
% pneumococcal AOM [d]	14.0%	14.0%	16.0%	16.0%	16.0%

Note: No AOM incidence assumed for ages 5+.
a overall numbers from National Ambulatory Medical Survey/National Hospital Ambulatory Medical Care Survey+Market Scan data 2016+2018,
b Market Scan Data 2016-2018
c Pichichero et al. 2013
d Kaur et al. 2022

NBP Incidence

Age	0	1	2	3	4	5	6	7	8	9+
OPT NBP, healthy (per 100k) [a]	640 (594,686)	1291 (1192,1386)	1512 (1368,1658)	785 (715,859)	639 (583,693)	678 (618,733)	575 (524,622)	711 (626,800)	357 (323,391)	319 (294,345)
OPT NBP, CMC/IC (per 100k) [b]	9249 (56388, 65090)	18656 (113162, 131601)	14881 (74090, 89811)	7728 (38714, 46492)	6294 (31556, 37506)	5060 (21862, 25905)	4296 (18546, 21986)	5308 (22121, 28290)	2664 (11413, 13815)	2384 (10384, 12189)
% pneumococcal [c]	6% (1-10)	6% (1-10)	6% (1-10)	6% (1-10)	6% (1-10)	6% (1-10)	6% (1-10)	6% (1-10)	6% (1-10)	6% (1-10)
IPT NBP, healthy (per 100k) [d]	588 (546,630)	417 (385,448)	390 (353,427)	202 (184,221)	165 (150,179)	121 (111,131)	103 (94,112)	127 (112,143)	64 (58,70)	57 (52,61)
IPT NBP, CMC (per 100k) [e]	1642 (1524,1759)	1164 (1075,1250)	1087 (984,1193)	564 (514,617)	461 (420,499)	544 (496,588)	462 (422,500)	568 (500,639)	286 (258,313)	255 (235,275)
IPT NBP, IC (per 100k) [e]	3283 (3048,3518)	2328 (2150,2501)	2174 (1968,2386)	1128 (1027,1234)	922 (840,998)	1328 (1212,1436)	1129 (1029,1220)	1386 (1220,1560)	697 (631,764)	623 (573,672)
% IPT NPB fatality [d]	1.3% (1.02-1.59)	0.53% (0.37-0.70)	0.40% (0.23-0.58)	0.42% (0.21-0.64)	0.61% (0.32-0.91)	0.39% (0.15-0.63)	0.32% (0.06-0.59)	0.78% (0.35-1.20)	0.51% (0.13-0.89)	1.72% (1.42-2.01)
% pneumococcal [c]	12% (2-20)	12% (2-20)	12% (2-20)	12% (2-20)	12% (2-20)	12% (2-20)	12% (2-20)	12% (2-20)	12% (2-20)	12% (2-20)

a overall mean from Tong et al. 2018, 5th &95th percentiles calculated using the ratio of 5th &95th to mean in IPT NBP for each age; adjusted by (1-% CMC+IC pop * CMC+IC ratio)/% healthy pop; CMC+IC ratio from MarketScan 2016-2018

b based on Tong et al. 2018, but scaled by age-specific ratios of CMC+IC to healthy calculated from MarketScan 2016-2018

c Adapted from Jain et al. 2015 with expert input.

d Overall numbers from 2018-2019 NIS Data, scaled by (1-(% IC pop * IC ratio + % CMC pop * CMC ratio)) / % healthy pop, ratios for IC and CMC from Pelton et al. 2014

e Overall numbers from 2018-2019 NIS Data, scaled by rate ratios for health: CMC:IC from Pelton et al. 2014

IPD Incidence

Age	0	1	2	3	4	5	6	7	8	9+
IPD Incidence, healthy (per 100k) [a]	14 (11, 16)	10 (7, 12)	5 (3, 6)	5 (3, 6)	3 (2, 4)	5 (3, 6)	3 (1, 4)	2 (1, 3)	1 (0, 2)	1 (1, 1)
IPD Incidence, CMC (per 100k) [a]	24 (20,29)	18 (13,22)	8 (5,11)	9 (5,11)	6 (4,7)	15 (10,20)	9 (3,13)	7 (3,10)	5 (0,7)	3 (3,3)
IPD Incidence, IC (per 100k) [a]	152 (123,179)	112 (78,134)	51 (34,67)	54 (34,67)	34 (22,45)	182 (120,241)	112 (40,160)	81 (40,120)	56 (0,80)	40 (40,40)
% meningitis [a]	15.87 (14.45,17.43)	15.87 (14.45,17.43)	15.87 (14.45,17.43)	15.87 (14.45,17.43)	15.87 (14.45,17.43)	20.05 (18,22.33)	20.05 (18,22.33)	20.05 (18,22.33)	20.05 (18,22.33)	20.05 (18,22.33)
% meningitis resulting in fatality [a]	10.48 (7.85,13.99)	10.48 (7.85,13.99)	10.48 (7.85,13.99)	10.48 (7.85,13.99)	10.48 (7.85,13.99)	0.00%	0.00%	0.00%	0.00%	0.00%
% other IPD resulting in fatality [a]	3.61 (2.92,4.47)	3.61 (2.92,4.47)	3.61 (2.92,4.47)	3.61 (2.92,4.47)	3.61 (2.92,4.47)	3.83 (2.93,5.02)	3.83 (2.93,5.02)	3.83 (2.93,5.02)	3.83 (2.93,5.02)	3.83 (2.93,5.02)

Meningitis Sequelae

Age	0-4	5+
Disability % [b]	7 (4, 11)	11 (8, 18)
Deafness % [b]	9 (7, 13)	14 (11, 22)

a ABC's data 2018-2019.
b Olarte et al. 2015; Edmond et al. 2010

IPD/NBP Serotype Distributions

Age	0	1	2 to 5	6+
% PCV13 (+6C-3-19F)	3.68%	1.23%	9.76%	10.64%
% ST3	11.90%	3.68%	10.93%	14.22%
% ST19F	7.35%	7.37%	5.65%	9.17%
% PCV15 only (ST 22F, 33F)	17.41%	21.01%	14.97%	14.14%
% PCV20 only	12.86%	19.78%	11.45%	13.52%
% PPSV23 only	1.84%	1.23%	0.73%	5.83%

AOM Serotype Distributions

% PCV13 (+6C-3-19F)	3.06%
% ST3	3.06%
% ST19F	3.06%
% PCV15 only (ST 22F, 33F)	8.16%
% PCV20 only (ST 8, 10A, 11A, 12F, 15B)	23.47%

IPD serotype distributions from ABCs data 2018-2019. Applied to NBP by assumption.
AOM serotype distributions from Kaur et al. 2022 modified by expert input.

Vaccine Prices

PCV13 Private	$226.43	CDC Price List[b]
PCV13 Public	$158.18	CDC Price List
PCV15 Private	$216.086	CDC Price List[b]
PCV15 Public	$162.27	CDC Price List
PCV20 Private	$253.96	a
PCV20 Public	$187.27	a
PPSV23 Private	$117.08	CDC Price List[b]
PPSV23 Public	$65.80	CDC Price List
Vaccine Admin	$30.13	Tsai Prev Med Reports 2019
Travel/Caregiver Time	$35.96	Maciosek Am J Prev Med 2006

a Ratio of PCV20:PCV15 cost in adults separately for public and private from CDC Price list and applied to PCV15 costs in children. Estimation procedure discussed with manufacturer.

b Private list price inflated 7.1% to account for differences between CDC private list price and average reimbursement (Leidner et al. 2021)

Disease Cost ($)

	Medical cost [a]	Non-medical cost [b, c]
Disability	$258,084 ($206,467, $309,701)	$1,413,847
Deafness	$48,354 ($38,683, $58,025)	$583,399
AOM	$83 ($67, $100)	$253
Tymp tube	$3,610 ($2,888, $4,332)	$253
IPD	$19,196 ($15,357, $23,035)	$624
IPD-mening	$25,691 ($20,553, $30,829)	$3,273
IPT NBP	$10,965 ($8,772, $13,158)	$624
OPT NBP	$351 ($281, $421)	$467

a Medical costs are from MarketScan 2004-2006 data inflated to 2022$ using Medical component of CPI. Ranges +/- 20%.
b Disability & deafness: MMWR 53(03);57-59 and Errata. E.g.: assistive devices, home modifications, special education costs, productivity losses, etc.
c Other conditions: Ray et al. 2006 PIDJ

QALY Decrements

AOM	0.0016 (0, 0.0155)
Tymp tube	0.0016 (0, 0.0155)
OPT NBP	0.0004 (0.0001, 0.0329)
IPT disease (not mening)	0.0105 (0.0001, 0.0155)
IPD mening no sequelae	0.0165 (0.0001, 0.0166)
Deafness	0.2137 (0.07, 0.72)
Disability	0.2456 (0.16, 0.49)

QALY decrement are low, median, and high estimates from the survey by Tang et al. 2021. The upper bound of AOM is capped at the upper bound of inpatient disease. Tympanostomy tube placement which follows Delgleize et al. 2016 in setting equal to AOM. QALY decrements are scaled by background QALY values which range from 0.94 for age 0 to 0.92 for age 15 (Erickson et al. Statistical Notes 1995)

Indirect Effects from Adult Program

	Base (indirect rate = 3.17%)	10% less effective (indirect rate = 2.853%)	Same effect as on kids (indirect rate = 7.8%)
Health Outcomes			
IPD cases	-182	-164	-447
IPT pneumonia cases	-3,210	-2,889	-7,899
OPT pneumonia Cases	-7,335	-6,601	-18,048
Deaths due to IPD	-24	-21	-59
Deaths due to pneumonia	-127	-115	-314
QALYs	1,262	1,136	3,105
Life-years	1,849	1,664	4,549
Costs (million $)			
Total cost	-$80	-$72	-$197
Medical costs	-$80	-$72	-$197
Vaccine costs	$0	$0	$0

Policy Questions

1. PCV20 in place of existing conjugate vaccines among all risk groups.

2. PCV20 in place of existing schedules that include conjugate and polysaccharide among CMC & IC populations

Direct Swap PCV20 for PCV13

	PCV20 vs PCV13 Healthy	PCV20+PPSV vs PCV13+PPSV CMC	PCV20+PPSV+PPSV vs PCV13+PPSV+PPSV IC
IPD meningitis cases	-55	-8	-1
IPD non-meningitis cases	-276	-40	-3
Deafness	-4	-1	0
Disability	-6	-1	0
IPT pneumonia cases	-1,106	-277	-7
OPT pneumonia cases	-1,798	-1,552	-18
AOM cases	-145,371	-36,645	-444
Tymp tubes	-14,647	-3,815	-46
Deaths due to IPD	-14	-2	0
Deaths due to pneumonia	-8	-2	0
Childhood QALYs	917	190	7
Adult QALYs (indirect)	1,039	215	8
Life-years	685	128	7
Costs (million $)			
Total cost	$153	-$17	-$0.92
Medical costs	-$108	-$27	-$0.56
Non-medical costs	-$52	-$13	-$0.27
Adult costs (indirect)	-$66	-$14	-$0.53
Vaccine costs	$379	$37	$0.44
Cost ratios ($)			
Cost/QALY	78,115	**Cost-saving**	**Cost-saving**
Cost/life-year	223,192	**Cost-saving**	**Cost-saving**

Direct Swap PCV20 for PCV15

	PCV20 vs PCV15 Healthy	PCV20+PPSV vs PCV15+PPSV CMC	PCV20+PPSV+PPSV vs PCV15+PPSV+PPSV IC
IPD menigitis cases	-25	-4	0
IPD non-meningitis cases	-125	-18	-2
Deafness	-2	0	0
Disability	-3	0	0
IPT pneumonia cases	-500	-126	-3
OPT pneumonia cases	-824	-716	-8
AOM cases	-107,856	-27,188	-329
Tymp tubes	-10,867	-2,830	-34
Deaths due to IPD	-7	-1	0
Deaths due to pneumonia	-4	-1	0
Childhood QALYs	488	104	4
Adult QALYs (indirect)	1,033	221	8
Life-years	308	58	3
Costs (million $)			
Total cost	$234	-$1	-$0.48
Medical costs	-$68	-$17	-$0.32
Non-medical costs	-$35	-$9	-$0.16
Adult costs (indirect)	-$65	-$14	-$0.48
Vaccine costs	$402	$39	$0.47
Cost ratios ($)			
Cost/QALY	153,715	Cost-saving	Cost-saving
Cost/life-year	757,901	Cost-saving	Cost-saving

Direct Swap PCV20 for PCV15 Sensitivity Analysis: PCV20 VE 10% Lower

	PCV20 vs PCV15 Healthy	PCV20+PPSV vs PCV15+PPSV CMC	PCV20+PPSV+PPSV vs PCV15+PPSV+PPSV IC
IPD meningitis cases	-16	-2	0
IPD non-meningitis cases	-82	-10	-1
Deafness	-1	0	0
Disability	-2	0	0
IPT pneumonia cases	-392	-95	-2
OPT pneumonia cases	-651	-542	-6
AOM cases	-85,628	-21,597	-262
Tymp tubes	-8,633	-2,250	-27
Deaths due to IPD	-4	-1	0
Deaths due to pneumonia	-3	-1	0
Childhood QALYs	360	76	2
Adult QALYs (indirect)	933	197	6
Life-years	216	39	2
Costs (million $)			
Total cost	$263	$6	-$0.22
Medical costs	-$53	-$13	-$0.22
Non-medical costs	-$27	-$7	-$0.11
Adult costs (indirect)	-$59	-$12	-$0.36
Vaccine costs	$402	$39	$0.47
Cost ratios ($)			
Cost/QALY	203,365	23,832	**Cost-saving**
Cost/life-year	1,216,977	168,181	**Cost-saving**

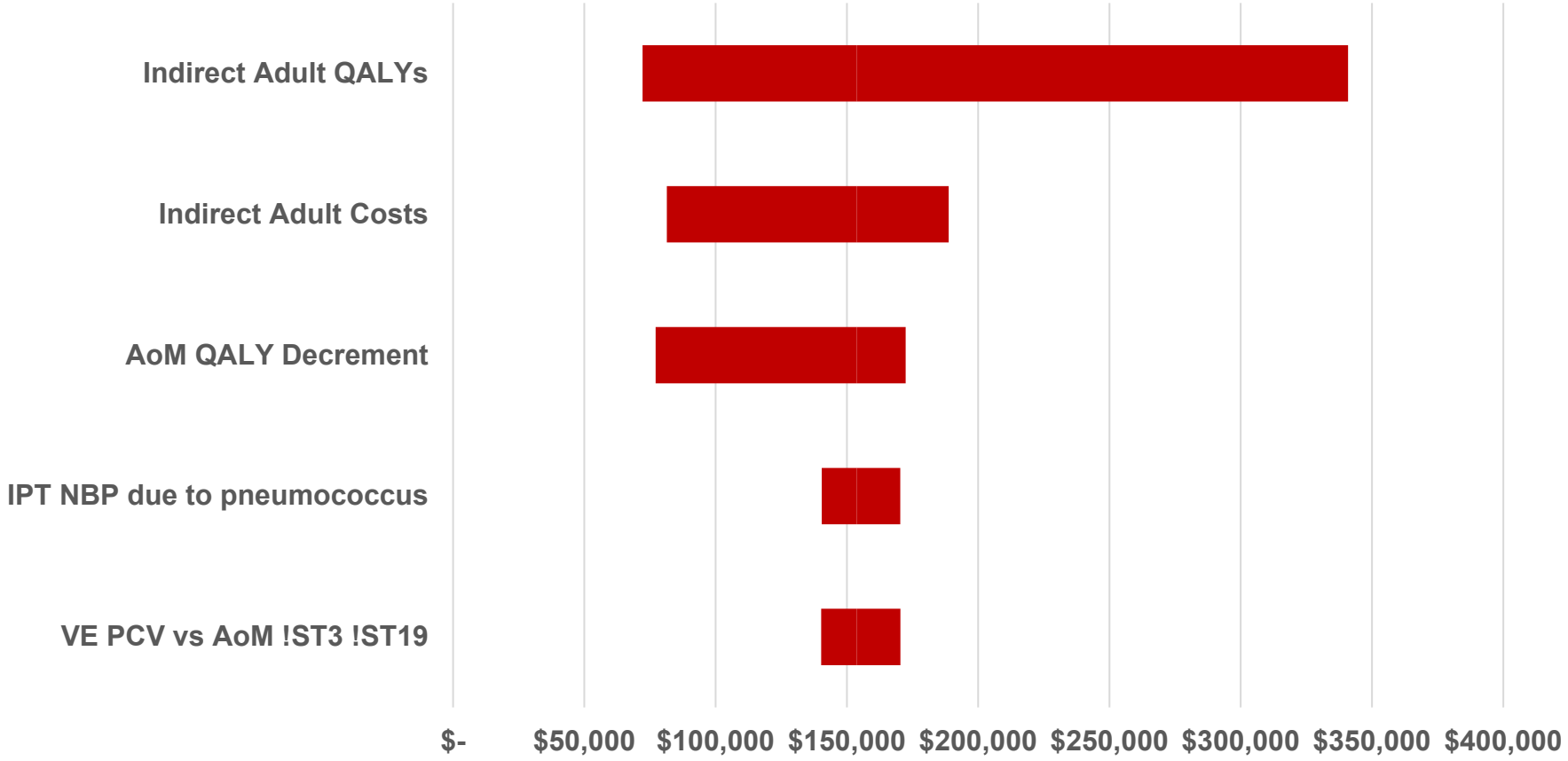
Direct Swap PCV20 for PCV15
Sensitivity Analysis: Adult Indirect Effects 7.8%

	PCV20 vs PCV15 Healthy	PCV20+PPSV vs PCV15+PPSV CMC	PCV20+PPSV+PPSV vs PCV15+PPSV+PPSV IC
IPD meningitis cases	-25	-4	0
IPD non-meningitis cases	-125	-18	-2
Deafness	-2	0	0
Disability	-3	0	0
IPT pneumonia cases	-500	-126	-3
OPT pneumonia cases	-824	-716	-8
AOM cases	-107,856	-27,188	-329
Tymp tubes	-10,867	-2,830	-34
Deaths due to IPD	-7	-1	0
Deaths due to pneumonia	-4	-1	0
Childhood QALYs	488	104	4
Adult QALYs (indirect)	2,542	545	19
Life-years	308	58	3
Costs (million $)			
Total cost	$138	-$21	-$1.18
Medical costs	-$68	-$17	-$0.32
Non-medical costs	-$35	-$9	-$0.16
Adult costs (indirect)	-$161	-$35	-$1.17
Vaccine costs	$402	$39	$0.47
Cost ratios ($)			
Cost/QALY	45,551	Cost-saving	Cost-saving
Cost/life-year	447,389	Cost-saving	Cost-saving

Direct Swap PCV20 for PCV15, Healthy Multivariate Sensitivity, 90% Confidence Interval

	PCV20 vs PCV15 Healthy	5th Healthy	95th Healthy
IPD meningitis cases	-25	-28	-21
IPD non-meningitis cases	-125	-135	-104
Deafness	-2	-3	-1
Disability	-3	-4	-2
IPT pneumonia cases	-500	-829	-82
OPT pneumonia cases	-824	-1,363	-136
AOM cases	-107,856	-130,202	-87,612
Tymp tubes	-10,867	-14,286	-7,866
Deaths due to IPD	-7	-8	-5
Deaths due to pneumonia	-4	-6	-1
Childhood QALYs	488	362	1,263
Adult QALYs (indirect)	1,033	402	2,541
Life-years	308	206	388
Costs (million $)			
Total cost	$234	$135	$279
Medical costs	-$68	-$85	-$49
Non-medical costs	-$35	-$42	-$30
Adult costs (indirect)	-$65	-$162	-$24
Vaccine costs	$402	$401	$404
Cost ratios ($)			
Cost/QALY	153,715	51,105	210,518
Cost/life-year	757,901	409,958	1,144,176

Direct Swap PCV20 for PCV15, Healthy
One-way Sensitivity
Influential Inputs on Cost/QALY



All inputs were included in multivariate sensitivity analysis. The top 5 according to size of change in cost per QALY are charted here. Ends of bars represent the cost/QALY when the particular input is set to the min/max (or 5th &95th) of the input distribution.

PCV20 without PPSV23, PCV13 Context

	PCV20 vs PCV13+PPSV CMC	PCV20 vs PCV13+PPSV+PPSV IC
IPD meningitis cases	-7	-1
IPD non-meningitis cases	-35	-3
Deafness	-1	0
Disability	-1	0
IPT pneumonia cases	-267	-6
OPT pneumonia cases	-1,497	-17
AOM cases	-36,645	-444
Tymp tubes	-3,815	-46
Deaths due to IPD	-2	0
Deaths due to pneumonia	-2	0
Childhood QALYs	180	6
Adult QALYs (indirect)	204	7
Life-years	118	6
Costs (million $)		
Total cost	-$55	-$1.57
Medical costs	-$27	-$0.51
Non-medical costs	-$12	-$0.24
Adult costs (indirect)	-$13	-$0.45
Vaccine costs	-$3	-$0.38
Cost ratios ($)		
Cost/QALY	**Cost-saving**	**Cost-saving**
Cost/life-year	**Cost-saving**	**Cost-saving**

PCV20 without PPSV23, PCV15 Context

	PCV20 vs PCV15+PPSV CMC	PCV20 vs PCV15+PPSV+PPSV IC	PCV20 vs PCV15+PPSV, Half PPSV Coverage CMC	PCV20 vs PCV15+PPSV+PPSV, Half PPSV Coverage IC
IPD meningitis cases	-3	0	-4	0
IPD non-meningitis cases	-13	-1	-21	-2
Deafness	0	0	0	0
Disability	0	0	0	0
IPT pneumonia cases	-116	-2	-138	-3
OPT pneumonia Cases	-661	-7	-786	-9
AOM cases	-27,188	-329	-27,188	-329
Tymp tubes	-2,830	-34	-2,830	-34
Deaths due to IPD	-1	0	-1	0
Deaths due to pneumonia	-1	0	-1	0
Childhood QALYs	95	3	111	4
Adult QALYs (indirect)	108	3	125	5
Life-years	48	2	64	4
Costs (million $)				
Total cost	-$33	-$0.91	$4	-$0.66
Medical costs	-$17	-$0.26	-$18	-$0.34
Non-medical costs	-$8	-$0.12	-$9	-$0.18
Adult costs (indirect)	-$7	-$0.18	-$8	-$0.29
Vaccine costs	-$1	-$0.35	$39	$0.15
Cost ratios ($)				
Cost/QALY	**Cost-saving**	**Cost-saving**	18,722	**Cost-saving**
Cost/life-year	**Cost-saving**	**Cost-saving**	68,612	**Cost-saving**

Adding PPSV23 to a PCV20 Primary Series

	PCV20+PPSV vs PCV20 CMC	PCV20+PPSV+PPSV vs PCV20 IC
IPD meningitis cases	-1	0
IPD non-meningitis cases	-5	-1
Deafness	0	0
Disability	0	0
IPT pneumonia cases	-10	-1
OPT pneumonia cases	-55	-1
AOM cases	0	0
Tymp tubes	0	0
Deaths due to IPD	0	0
Deaths due to pneumonia	0	0
QALYs	9	1
Life-years	10	1
Costs (million $)		
Total cost	39	$0.73
Medical costs	-1	-$0.06
Non-medical costs	0	-$0.04
Vaccine costs	40	$0.82
Cost ratios ($)		
Savings/QALY	4,086,881	690,388
Savings/life-year	3,923,758	658,925

Limitations

- Uncertainty around indirect effects on adults
- Uncertainty around QALY decrements
  - AOM
- PCV20 VE based on immunogenicity trials
  - Same VE for all PCV valencies
- ST3 VE limited data

Conclusion
Policy Question 1

- **Replacing PCV13 with PCV20 costs:**
  - $57k/QALY (aggregate)
    - $78k/QALY (healthy)
    - Cost-saving (CMC)
    - Cost-Saving (IC)
- **Replacing PCV15 with PCV20 costs:**
  - $125k/QALY (aggregate)
    - $154k/QALY (healthy)
    - Cost-saving (CMC)
    - Cost-saving (IC)

Conclusion
Policy Question 2

- Replacing PCV13+PPSV23 (or PCV15+PPSV23) with PCV20 by itself in CMC/IC is cost saving
- Adding PPSV23 to PCV20 for CMC/IC costs:
  - $3.9 million/QALY (aggregate)
    - $4.1 million/QALY (CMC)
    - $0.7 million/QALY (IC)

Thank you!

Please send comments to:
cfstoecker@tulane.edu

Contributors:

Miwako Kobayashi
Dipreye Ayabina
Namrata Prasad
Andrew Leidner