Incremental Cost-Effectiveness of Modifying PPSV and PCV Recommendations for Adults Age 50 and Over

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June 25, 2014

Conflicts of Interest

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

Methods: Study Question

- **Evaluate cost effectiveness of**
  - Adding PCV for older adults
  - Removing the risk-based recommendation of PPSV
- **Evaluate**
  - Program cost/savings
  - Changes in disease, medical costs, and nonmedical costs
    - Societal perspective
  - Population
    - Adults age 50+ or age 65+ as appropriate
    - Exclude immunocompromised

Methods: Interventions

1. PCV13 at 50
2. PCV13 at 65
3. PCV13 and PPSV23 at 50
4. PCV13 and PPSV23 at 65
5. Adding PCV13 at 50
6. Adding PCV13 at 65
7. Replacing PPSV23 at 65 with PCV13 at 65

Comparison Strategy:

Current (PPSV23 for high risk 50-64, PPSV23 at 65)

Methods: Time Frame

- Track today's 50 (or 65) year olds through life expectancy (or until age 100)
- Look at disease rates now
- Project herd impacts from child immunization program ahead 6 years
- All outcomes and costs discounted by 3%
- All costs in 2013$

Methods: Economic Model

- **Cohort Model**
  - Cost per quality adjusted life year gained
  - Cost per life year gained
  - Use cohort of 50 year olds for strategies that change vaccinations for 50 year olds
  - Use cohort of 65 year olds for strategies that do not deviate from current recommendation until age 65
- **Compare each recommendation to status quo and calculate incremental cost effectiveness ratio**
  - Divide change in costs by change in Quality Adjusted Life Years (QALYs)

Methods: Health Outcomes

- Cases of Invasive Pneumococcal Disease (IPD)
- Cases of hospitalized Nonbacteremic Pneumonia (NBP)
- Cases of outpatient NBP
- Deaths due to IPD
- Deaths due to NBP
- QALYs
- Life Years

Methods: Inputs
IPD Disease Burden

Variable	Healthy 50-64	Healthy 65+	High Risk 50-64	High Risk 65+
IPD Rate (per 100,000)	8.62	15.06	33.71	47.63
% IPD Cases Resulting in Fatality	6.74	11.85	11.62	15.05
%PCV13 Serotypes	26.75	24.7	24.8	21.32
%PPSV23 (not in PCV13) Serotypes	48.09	38.06	44.39	38.37
% Nonvaccine Serotypes	25.16	37.25	30.81	40.31

Source: ABCs 2012

Methods: Inputs
NBP Disease Burden

Variable	50-64	65+	Source
Inpatient NBP Rate (per 100,000)	258.2	1375.2	Simonsen et al Lancet Respir Med 2014
% NBP Cases Resulting in Fatality	3.2	6.7	Huang et al Vaccine 2011 (National Inpatient Survey 2004 data)
Outpatient NBP Rate (per 100,000)	600	2010	Nelson et al Vaccine 2008
% PCV13 Serotypes	10	10	CAPITA, EPIC study, Pfizer supported US study

Methods: Inputs
Vaccine Effectiveness

Variable	Base	Source
PCV vs VT IPD	75.00	CAPITA
PCV vs VT NBP	45.00	CAPITA
PPSV vs VT IPD	74.00	Moberley 2008 Cochrane Review
PPSV vs VT NBP	0	Fry et al. 2002 Vaccine

Methods: Inputs
Herd Effects from PCV7 in Children

Age	Serotypes	2003 Rate (ABCs)	2009 Rate (ABCs)	% Change
50-64	NVT	3.61	5.01	38.9
50-64	PCV7	6.26	1.34	-78.6
50-64	PPSV23 not in PCV7	8.35	14.85	77.9
65+	NVT	7.67	12.62	64.5
65+	PCV7	13.62	1.82	-86.6
65+	PPSV23 not in PCV7	20.83	24.38	17.0

These changes are then projected forward on "PCV6" and "PPSV23 not in PCV13" types

Methods: Inputs
Coverage Rate

Group	Coverage	Source
High Risk 50-64	20%	NHIS 2012 (MMWR Feb 7, 2014)
Healthy 50-64	37.1%	Adapted from office visit ratios NHIS 2012
65+	59.9%	NHIS 2012 (MMWR Feb 7, 2014)

Coverage rate for healthy 50-64 year olds is found by averaging 1) the high risk 50-64 coverage rate (20%) and 2) the ratio of the percent of 45-64 year olds that had seen a doctor in the last year (84%) to the percent of 65-75 year olds that had seen a doctor in the last year (92.5%) and multiplying that by the coverage rate for 65+ (59.9%)

Methods: Inputs
Vaccine Cost ($)

Variable	Age 50-64	Age 65+	Source
PCV13	128	85	CDC Price List July 2013
PPSV23	63	23	CDC Price List July 2013
Vaccine Administration	17	17	Maciosek et al 2006 Am J Prev Med
Travel+ time cost	29	29	Maciosek et al 2006 Am J Prev Med

Methods: Inputs
Disease Cost ($)

Variable	Base	Source
50-64, IPD	42,906	MarketScan, 2010
50-64, IPT NBP	37,336	MarketScan, 2010
50-64, OPT NBP	136	MarketScan, 2010
65+, IPD	28,949	MarketScan, 2010
65+, IPT NBP	24,888	MarketScan, 2010
65+, OPT NBP	271	MarketScan, 2010

Methods: Inputs
Utility Decrements

Variable	QALYs	Healthy Life Lost (Days)	Implied Average Duration of Illness (Days)	Source
IPD	0.008665	3.2	21	Melagaro & Edmunds 2004 Vaccine
IPT NBP	0.006	2.2	15	Melagaro & Edmunds 2004 Vaccine
OPT NBP	0.004	1.5	15	Melagaro & Edmunds 2004 Vaccine

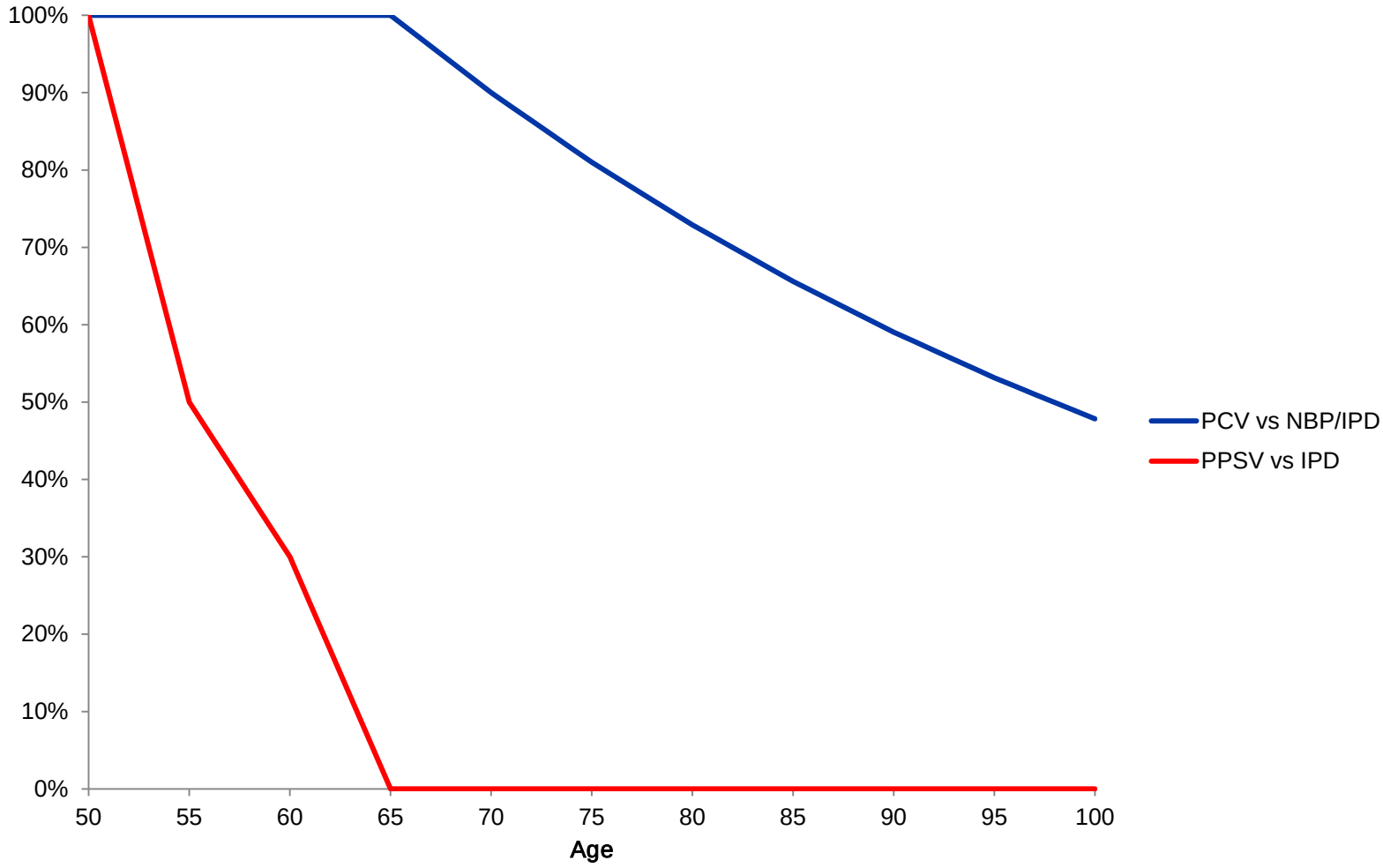
Implied duration of illness based off of an IPD or IPT NBP day being 85% of a healthy day, and an OPT NBP day being 90% of a healthy day (Vold et al 2000 Clin Infect Dis)

Methods: Inputs
Alternate Larger Utility Decrements

Variable	QALYs	Healthy Life Lost (Days)	Implied Average Duration of Illness (Days)	Source
IPD	.075	27.2	181	Sisk et al 2003 Ann Intern Med
IPT NBP	.075	27.2	181	Smith et al 2012 JAMA
OPT NBP	.050	18.1	181	Taking ratio of OPT to IPT in Melagaro and applying to Smith

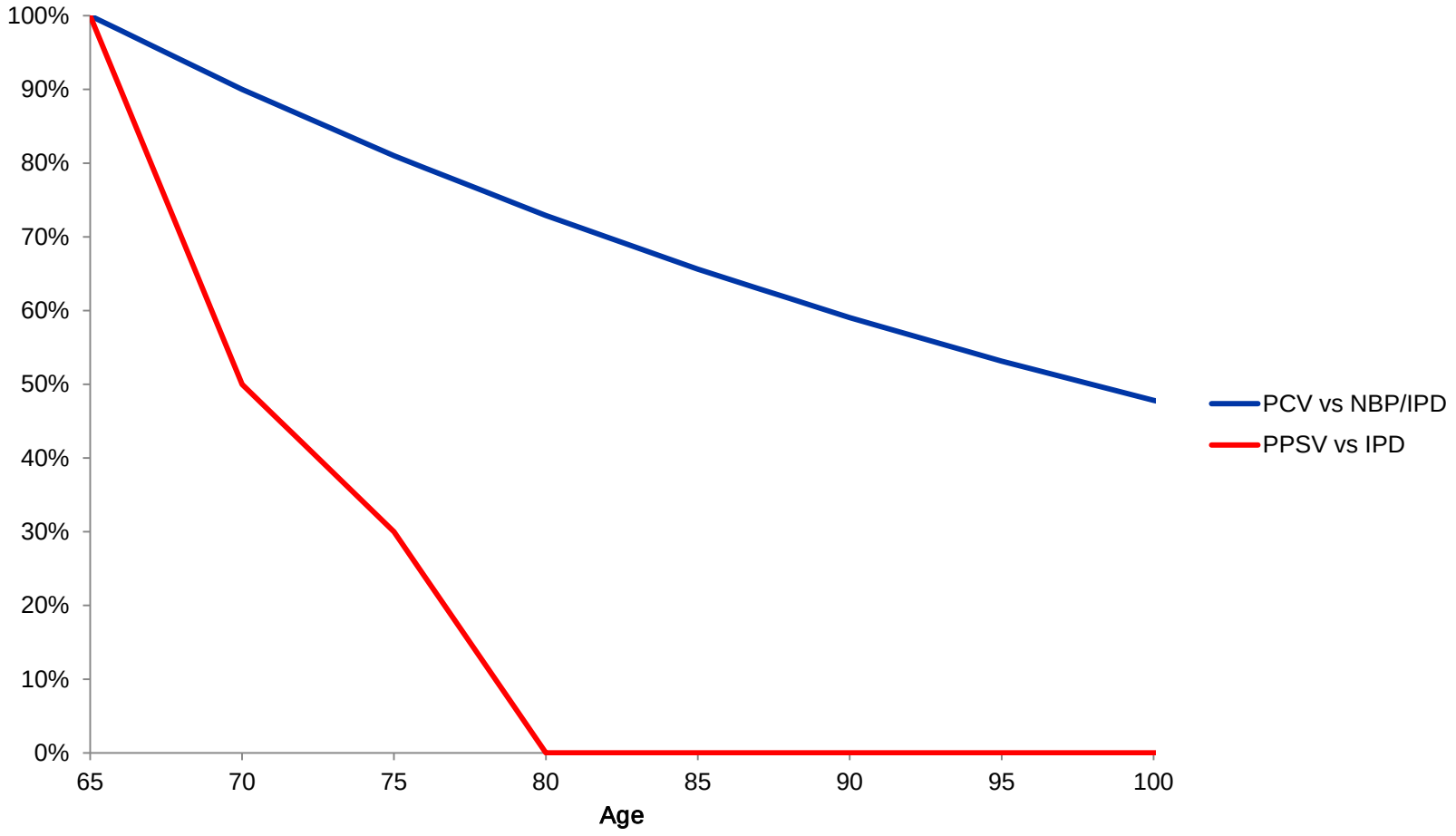
Implied duration of illness based off of an IPD or IPT NBP day being 85% of a healthy day, and an OPT NBP day being 90% of a healthy day (Vold et al 2000 Clin Infect Dis)

Methods: Inputs
Waning Immunity Vaccination at 50



PPSV duration adapted from Fry et al. Vaccine 2002
PCV duration adapted from CAPITA results

Methods: Inputs
Waning Immunity Vaccination at 65



PPSV duration adapted from Fry et al. Vaccine 2002
PCV duration adapted from CAPITA results

Results Preview

- **Dominated Strategies**
  - Remove risk-based PPSV recommendations
  - Increase in IPD
  - Decrease in NBP (usually)
  - Overall decrease in QALYs and Life Years
  - Increased cost
- **Health Improving Strategies**
  - Preserve risk-based PPSV recommendation
  - Increases in QALYs and Life Years
  - Increased cost

Results
Dominated Strategies

1. PCV13 at 50
2. PCV13 at 65
3. PCV13 and PPSV23 at 50
4. PCV13 and PPSV23 at 65

Generally decreased QALYs for increased cost

Results
Health Improving Strategies

5. Adding PCV13 at 50
6. Adding PCV13 at 65
7. Replacing PPSV23 at 65 with PCV13 at 65

Results: Change in Health Outcomes Health Improving Strategy

	Adding PCV13 at 50	Adding PCV13 at 65	Replacing PPSV23 at 65 with PCV13 at 65
IPD	-277	-226	1,298
IPT NBP	-2,596	-4,961	-4,961
OPT NBP	-4,431	-7,252	-7,252
Deaths (IPD)	-33	-33	184
Deaths (NBP)	-148	-332	-332
QALYs	1,489	3,053	1,383
Life-years	2,197	4,627	1,883

Output shows change in each outcome when compared to existing recommendation.

Results: Cost and Cost Effectiveness
Health Improving Strategy

	Adding PCV13 at 50	Adding PCV13 at 65	Replacing PPSV23 at 65 with PCV13 at 65
Total Cost (Millions)	$687	$189	$64
Medical (Millions)	-$84	-$132	-$88
Vaccine total cost (Millions)	$771	$321	$152
Cost/QALY gained	$461,229	$62,065	$46,396
Cost/Life-year gained	$312,690	$40,949	$34,076

Output shows change in each outcome when compared to existing recommendation.

Methods: Sensitivity Analyses

- **Uncertainty surrounding QALY**
  - Use alternate source of QALYs
  - Much higher emphasis on non-fatal disease
  - Sisk et al. value an episode of IPD at 0.2 QALYs
    - ~ 20x larger than Rubin et al.
    - If a day of IPD is worth 0.85 of a day in perfect health this is about 487 days average duration
- **Vaccine price**
  - Large increase for PCV13 orders
  - Assume PCV13 price would fall to PPSV23 price ($23.31)
- **PCV13 for adults is less efficient in later years**
  - Look after 6 years when herd immunity is phased in
- **Sensitivity analysis focused on age 65 strategy changes**

Results: Sensitivity Analyses
Adding PCV13 to Existing Recommendation

	Base	Higher QALY Decrements	Low Price	Higher QALY + Low Price	Cohort in 2019
Cost/QALY gained	$62,065	$54,183	$12,270	$10,711	$272,621
Cost/Life-year gained	$40,949	$40,949	$8,095	$8,095	$169,974

Results: Sensitivity Analyses
Replacing PPSV23 at 65 with PCV13 at 65

	Base	Higher QALY Decrements	Low Price	Higher QALY + Low Price	Cohort in 2019
Cost/QALY gained	$46,396	$36,333	Cost Saving	Cost Saving	Dominated*
Cost/Life-year gained	$34,076	$34,076	Cost Saving	Cost Saving	Dominated*

* Strategy results in additional cases of IPD which result in more QALYs lost than are gained from decreased NBP.

Context
Cost / QALY of Selected Other Interventions

Intervention	2013 Cost/QALY	Source
Childhood HiB	cost saving	Zhou et al 2002 Pediatrics
AHCPR Smoking Cessation Guidelines	$4,000	Cromwell et al 1997 JAMA
Sigmoidoscopy followed by colonoscopy if high-risk polyp diagnosed every 10 years	$28,000	Frazier et al. 2000 JAMA
Herpes Zoster Vaccination at 60	$80,000	Ortega-Sanchez, 2013 ACIP
Mammography Screening (biennially) for Women 50-74 years	$87,000	Stout et al 2014 J Natl Cancer Inst
Mammography Screening for Women 40-49	$202,000	Salzmann et al 1997 Arch Intern Med
Lyme Disease vaccine with attack rate of 0.5%	$255,000	Shadick et al 2001 Arch Intern Med
Value of a Statistical Life Year	$492,000	Aldy and Viscusi 2006 ReStat
Pap Smears for Low Risk Women	$1,779,000	Eddy 1990 Arch Intern Med

Limitations

- Uncertainty surrounding QALYs
- Uncertainty surrounding vaccine waning
- Full PCV7 herd effects are projected forward on PCV6 types

Summary

- Cost/QALY is ~$50,000 - $60,000/QALY under base-case assumptions
- PCV13 for adults is comparable to other interventions accepted as cost-effective when
  - Added at age 65 to the current PPSV23 schedule
  - Replacing PPSV23 at age 65 years
- Simplified strategies that consider only age-based recommendations are generally dominated
- Health benefits vary between PPSV23 and PCV
  - PCV13 strategies decrease NBP compared to PPSV23
  - More IPD when exchanging PPSV23 dose for PCV13
- After herd effects from child program are fully realized, PCV13 in adults is much less cost effective
  - Estimates ranging from dominated to $270,000/QALY

Thank you!

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