

Impact of Introduction of Infant Vaccination with 13-Valent Pneumococcal Conjugate Vaccine (PCV13) on Pneumonia and Invasive Pneumococcal Disease (IPD) in the United States, 2005–2014

Fernanda C. Lessa, Michael (Trey) Spiller, Elizabeth Soda, Daniel Weinberger, Marie R. Griffin, Carlos G. Grijalva, Nong Shang, Susan Petit, Melissa Tobin D'Angelo, Ann Thomas, Kirk Bol, Suzanne McGuire, Wei Xing, Tracy Pondo, Cynthia G. Whitney

Pneumonia and IPD Hospitalizations

- Decreases in US pneumonia and IPD hospitalizations after pediatric 7-valent PCV (PCV7)^{1,2,3}
 - Vaccinated children and non-vaccinated individuals
- Rise in non-PCV7 serotypes (especially 19A) led to pediatric PCV13 introduction in 2010



Did the switch from PCV7 to PCV13 in 2010 result in further declines in Pneumonia and IPD hospitalizations in the US population?

Data Sources



- **Statewide Hospitalization Data, 2005-2014**
 - **Healthcare Cost and Utilization Project (HCUP) (N=17)**
 - **State organizations or directly from Active Bacterial Core surveillance (ABCs) sites (N=6)**

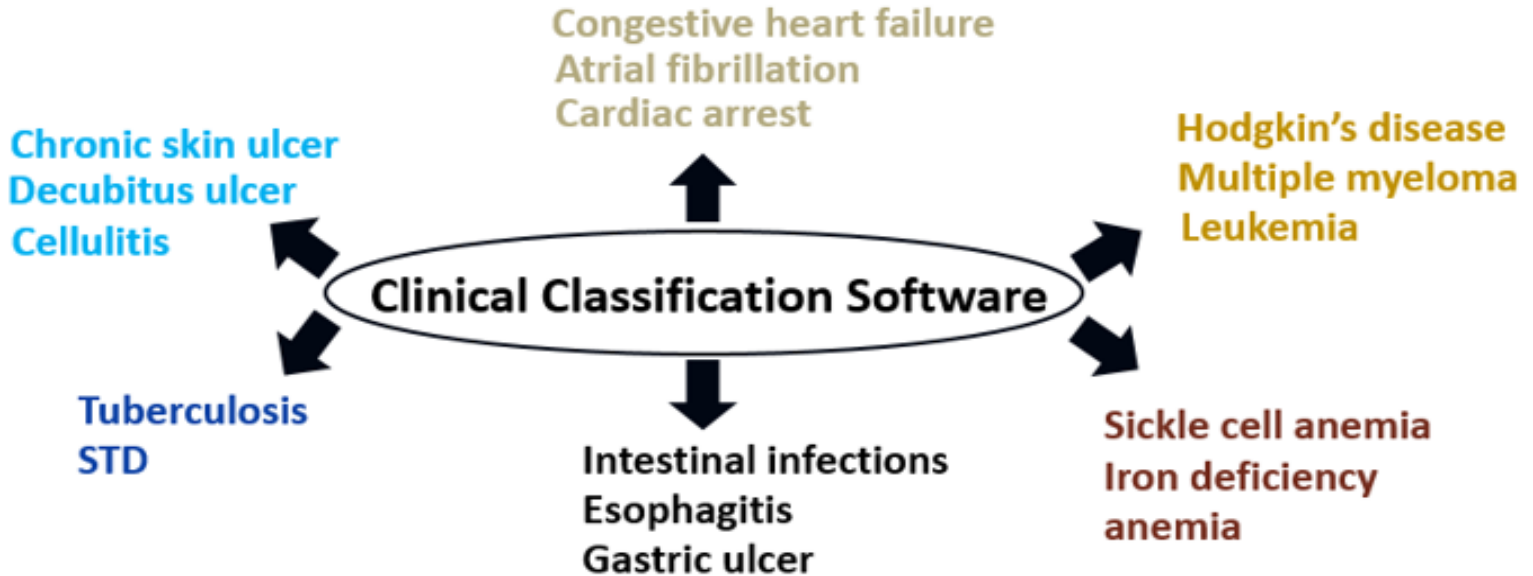


- **Hospitalizations: Pre-PCV13 (Jan 1, 2005-June 30, 2009): 73.4 million**
Post-PCV13(July 1, 2010-December 31, 2014): 69.7 million

Case Definition: ICD-9-CM Codes

- All-cause pneumonia: 480-487
- Pneumococcal pneumonia: 481
- Invasive pneumococcal disease (IPD)
 - Combination of codes:
 - a) Pneumococcal septicemia, meningitis or peritonitis
 - b) Unspecified bacteremia, sepsis, meningitis, endocarditis, arthritis, pericarditis with a specific pneumococcal code

Control Conditions



Clinical classification software: up to 134 control categories used in each model

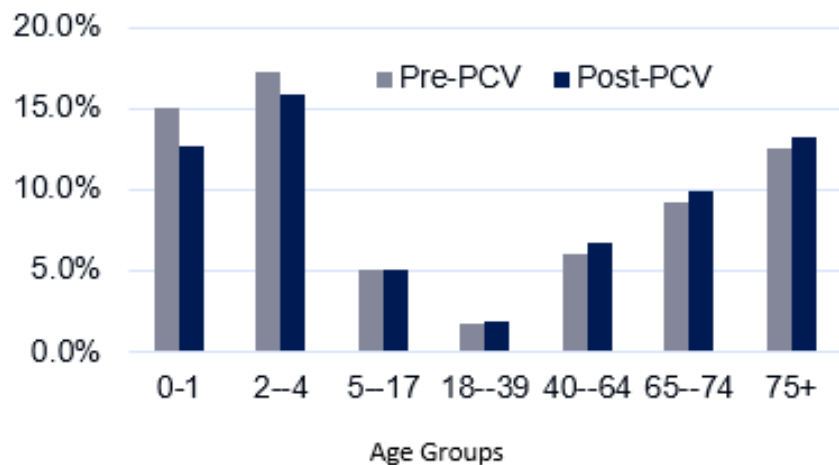
Data Analysis – Synthetic Control Method

- Data stratified by seven age groups
- Null model: model of monthly incidence controlling for seasonality
- Synthetic control model (SCM): time-series model of monthly incidence controlling for seasonality and including several control categories to adjust for confounders
- Rate Ratio (RR) < 1.0 = Vaccine Impact

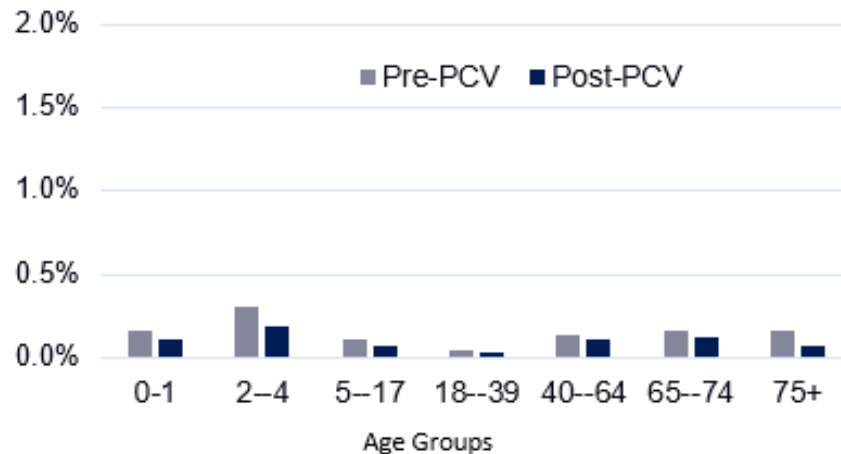
RESULTS

Proportion of Hospitalizations with Outcome of Interest

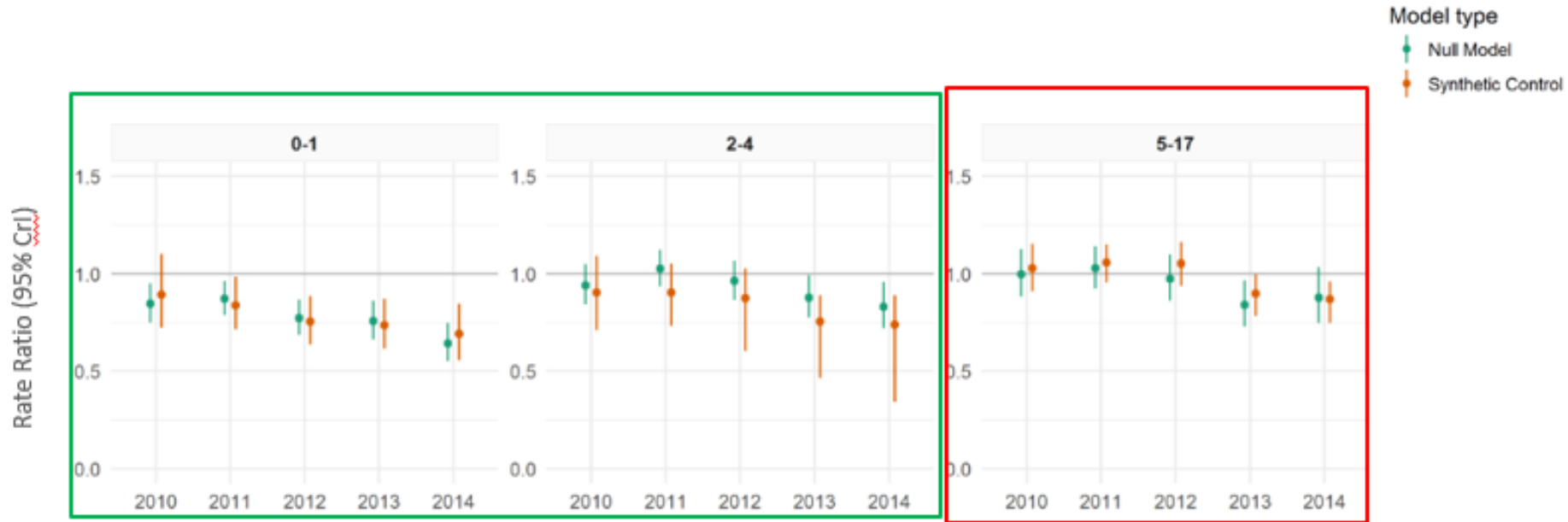
Proportion of Hospitalizations Coded as All-Cause Pneumonia



Proportion of Hospitalizations Coded as Pneumococcal Pneumonia



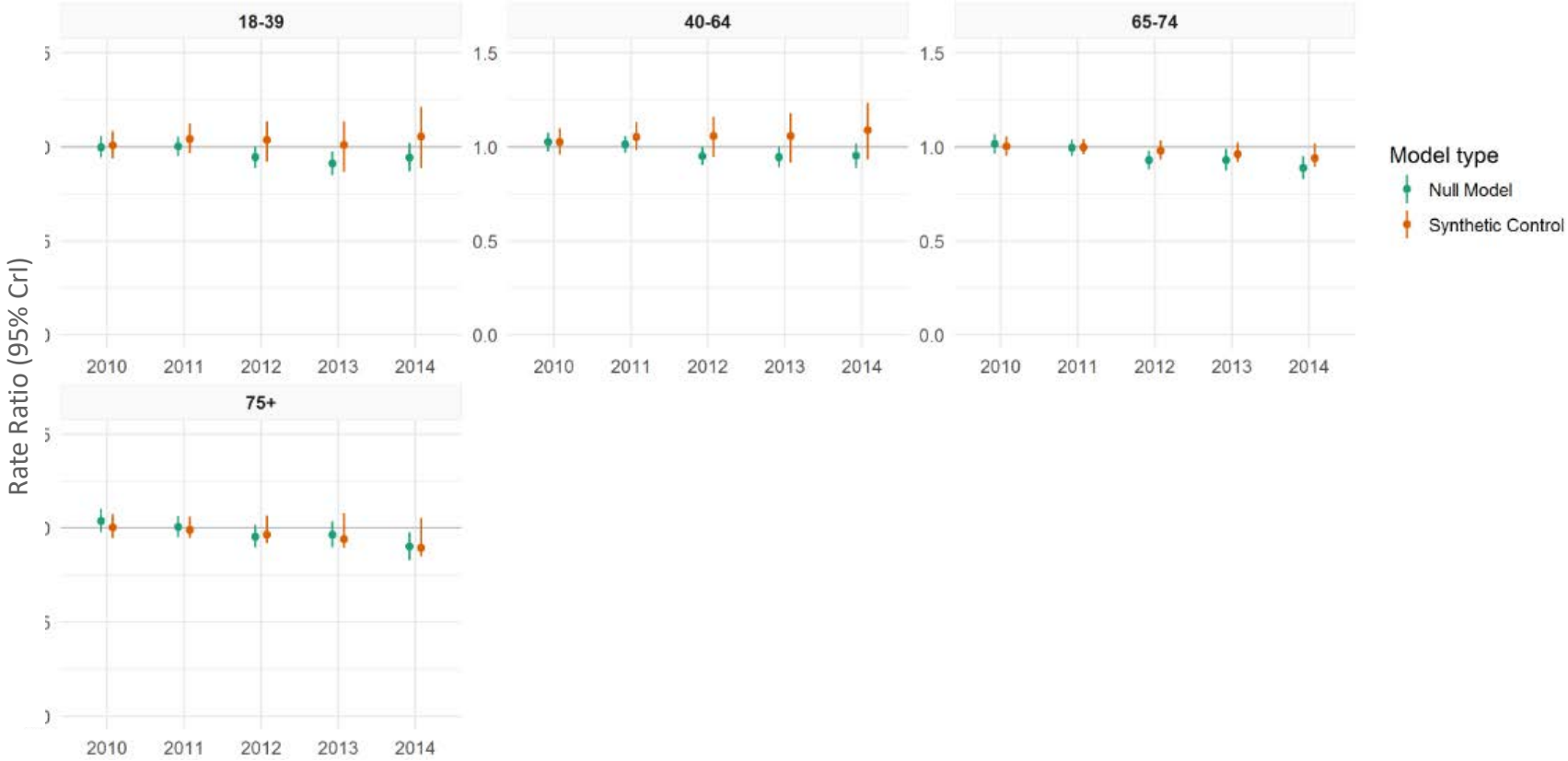
All-Cause Pneumonia among Children



Control categories with highest weights (varied by age group):

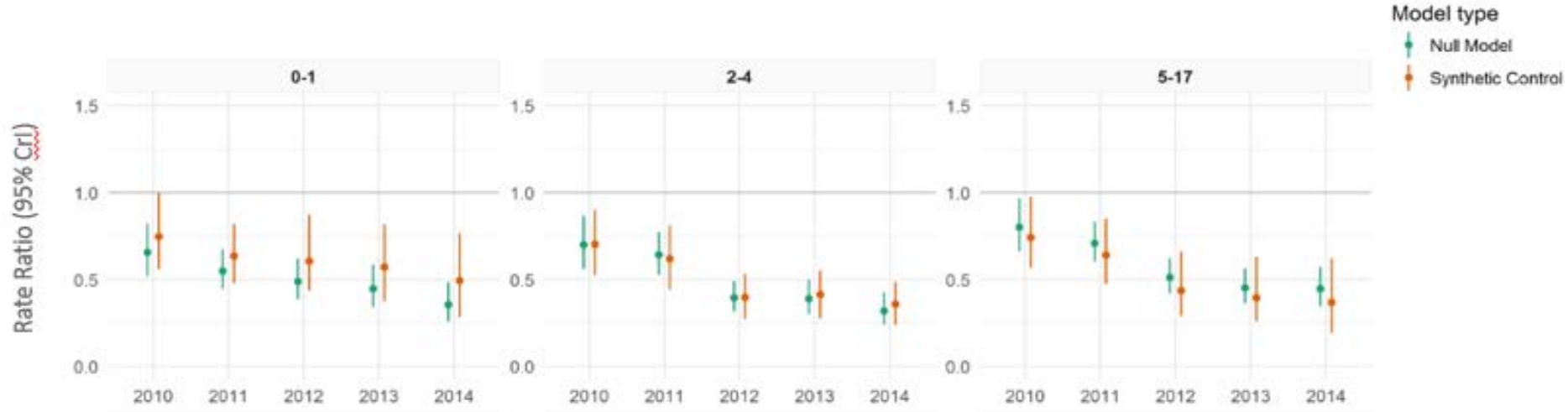
- 1) Respiratory Infections (excluding pneumonia codes, and other codes related to pneumococcal disease)
- 2) Viral infection
- 3) Skin and subcutaneous tissue infections

All-Cause Pneumonia among Adults



Pneumococcal Pneumonia

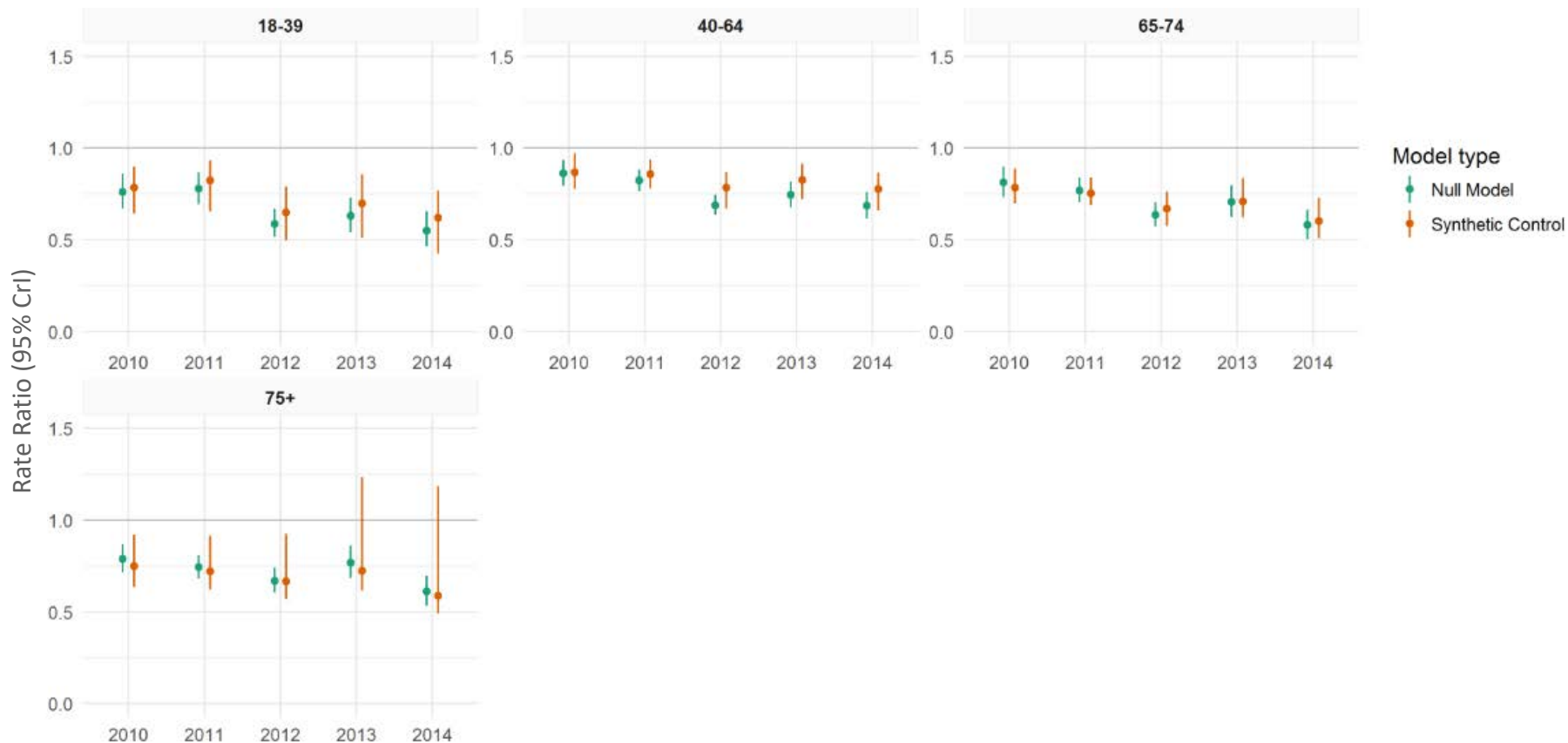
Pneumococcal Pneumonia among Children (ICD-9: 481)



Control categories with highest weights (varied by age group):

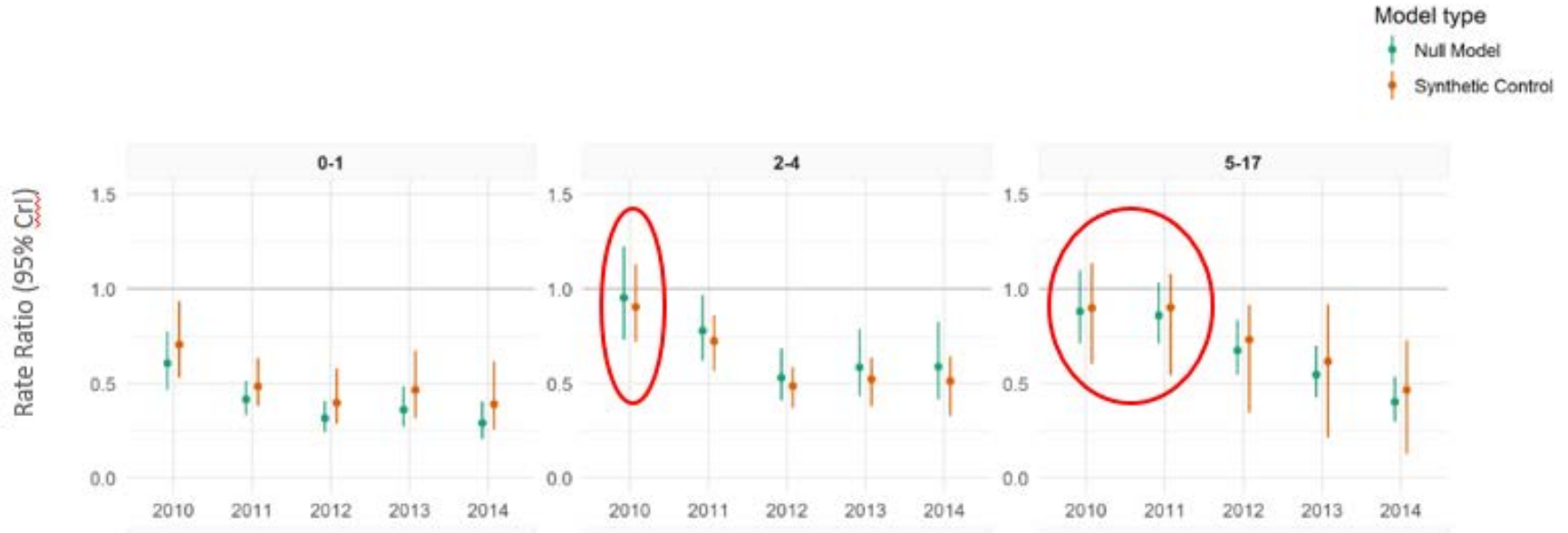
- 1) Respiratory infections
- 2) Other gastrointestinal disorders
- 3) Anemia

Pneumococcal Pneumonia among Adults



Invasive Pneumococcal Disease (IPD)

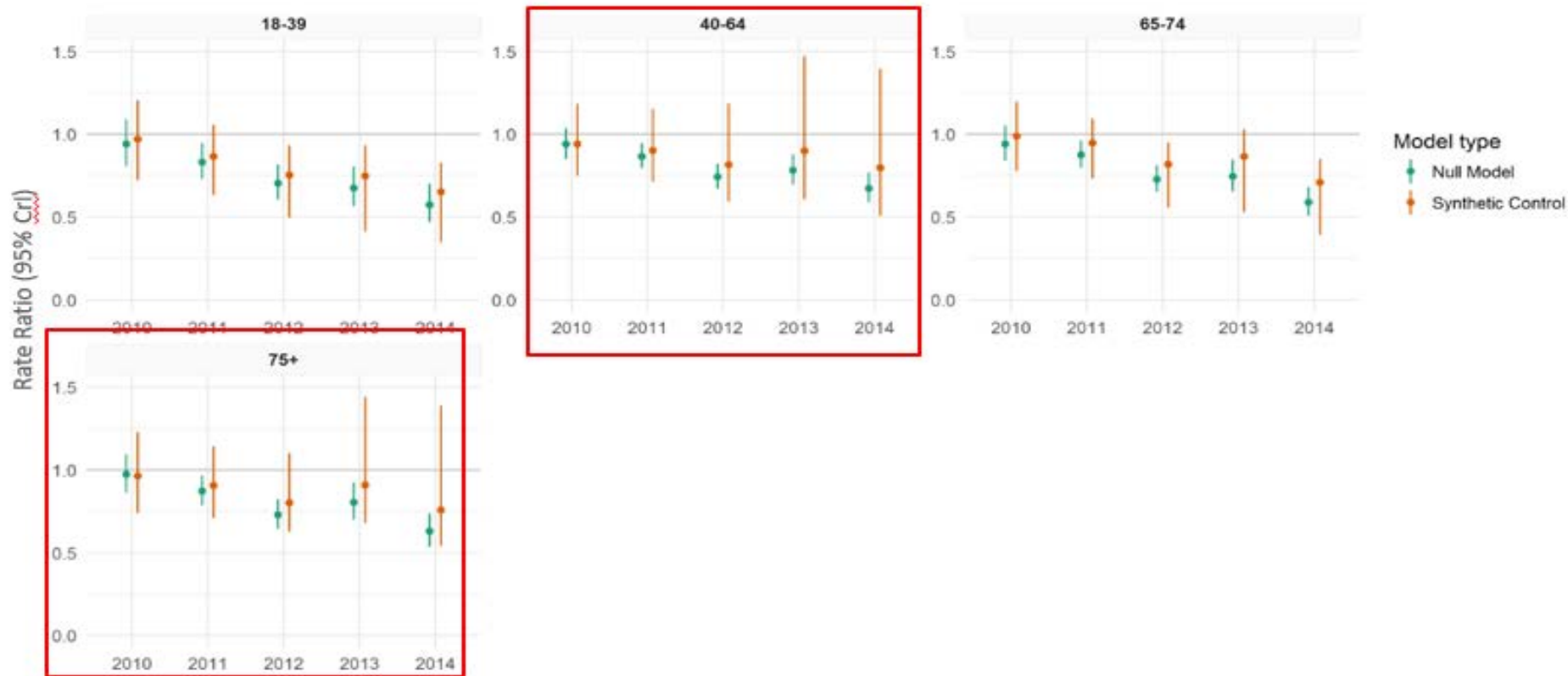
IPD among Children



Control categories with highest weights (varied by age group):

- 1) Chronic ulcer of skin
- 2) Other upper respiratory disease (e.g. polyp of nasal cavity, nasal septum deviation, unspecified disease of larynx)
- 3) Biliary tract disease

IPD among Adults



Cumulative Number of Hospitalizations Averted since PCV13 Introduction, 2010–2014

Age Group	All-Cause Pneumonia n (95% CrI)
0-1	38,418 (18383–66824)
2-4	17,026 (6736–73763)
5-17	3,059 (-5283, 15922)
18-39	-10,385 (-38697, 30111)
40-64	-86,470 (-202457, 80953)
65-74	30185 (-20021,67478)
75+	107167(-113643,176998)

Cumulative Number of Hospitalizations Averted since PCV13 Introduction, 2010–2014

Age Group	All-Cause Pneumonia n (95% CrI)	Pneumococcal Pneumonia n (95% CrI)
0-1	38,418 (18383–66824)	743 (316– 1443)
2-4	17,026 (6736–73763)	1257 (756–2214)
5-17	3,059 (-5283, 15922)	1929 (796 – 3767)
18-39	-10,385 (-38697, 30111)	2032 (1134 – 4492)
40-64	-86,470 (-202457, 80953)	5660 (3641 – 9446)
65-74	30185 (-20021,67478)	5796 (3534 – 7876)
75+	107167(-113643,176998)	9067 (-194 –12273)

6,370 (206–
8765) cases
averted by 2013

Cumulative Number of Hospitalizations Averted since PCV13 Introduction, 2010–2014

Age Group	All-Cause Pneumonia n (95% CrI)	Pneumococcal Pneumonia n (95% CrI)	IPD n (95% CrI)
0-1	38,418 (18383–66824)	743 (316– 1443)	874 (469 –1497)
2-4	17,026 (6736–73763)	1257 (756–2214)	368 (254 –700)
5-17	<i>3,059 (-5283, 15922)</i>	1929 (796 – 3767)	335 (95 –2027)
18-39	<i>-10,385 (-38697, 30111)</i>	2032 (1134 –4492)	948 (320 –3608)
40-64	<i>-86,470 (-202457, 80953)</i>	5660 (3641 – 9446)	2983 (-3418 –10328)
65-74	<i>30185 (-20021,67478)</i>	5796 (3534 – 7876)	1277 (433–5847)
75+	<i>107167(-113643,176998)</i>	9067 (-194 –12273)	1724 (-1736 – 4981)

Summary

- Declines in all-cause pneumonia only observed in children < 5 years old after PCV13 introduction
- Pneumococcal pneumonia hospitalizations declined in all age groups, but for adults ≥ 75 years no significant declines observed in 2013 and 2014
- No decline in IPD hospitalizations for age group 40-64 years and ≥ 75 years old

Limitations

- Changes in hospital coding practices during analysis period may affect trends over time
- All-cause pneumonia includes healthcare-associated pneumonia
- Administrative data likely underestimate specific outcomes related to pneumococcal disease
 - Underreporting observed when comparing CT ABCs data and State inpatient data especially for adults

Conclusion

- Lack of measurable impact on all-cause pneumonia in persons ≥ 5 years likely related to:
 - Use of nonspecific outcome (only small fraction of all-cause pneumonia is vaccine-type pneumococcal pneumonia)
 - Small expected benefit given PCV7 effects already in place at baseline
- Direct and indirect effect observed for pneumococcal pneumonia and IPD hospitalizations after switching to PCV13
- No decline in IPD hospitalizations among age groups 40-64 years and ≥ 75 years when adjusting for confounders
 - Wide credible intervals
 - Under reporting/coding of IPD on hospitalization data

Acknowledgments

Respiratory Diseases Branch

Trey Spiller

Elizabeth Soda

Tracy Pondo

Nong Shang

Cynthia Whitney

Yale University

Dan Weinberger

Josh Warren

Vanderbilt University

Marie Griffin

Carlos Grijalva

Emerging Infections Program

Susan Petit (CT)

Melissa Tobin-D'Angelo (GA)

Suzanne McGuire (NY)

THANK YOU!

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

