EPH177

Advancing Health Economics: Incorporating AMR Impact into Pneumococcal Vaccine Assessment

Mark H. Rozenbaum[1], Maria J. Tort[1], Ruth Chapman[2], Katherine K. Perez[1], Benjamin M Althouse[1,3,4], Raymond Farkouh[1]

[1]Pfizer Inc., Collegeville, PA, USA; [2]Thermo Fisher Scientific, London, UK; [3]Information School, University of Washington Seattle, WA, USA; [4]Department of Biology, New Mexico State University, Las Cruces, NM, USA

BACKGROUND

- Antimicrobial resistance (AMR) is a critical global health issue, causing 4.95 million deaths annually and projected to increase healthcare costs by US$ 1 trillion by 2050.[1,2]
- Vaccination is a key strategy against AMR, reducing infection rates, antibiotic use, and the emergence of resistant strains.[3-6]
- Pneumococcal conjugate vaccines (PCVs), such as PCV7 and PCV13, have significantly reduced antibiotic-resistant pneumococcal infections,[7-12] while PCV15 and PCV20 are expected to provide further reductions.
- Cost-effectiveness analyses[13-20] show that PCVs reduce disease incidence, mortality, and healthcare costs, but often overlook the full socioeconomic benefits of vaccination.

OBJECTIVE

- **This study aimed to develop a conceptual framework for modeling and quantifying the effects of vaccination on AMR, utilizing PCVs as an illustrative example.**

METHODS

Model Structure

- A simplified framework was used due to lack of data required to fully parameterize the proposed pathways. This framework leveraged all available PCV data.
- A multi-cohort, population-based decision-analytic Markov model[17] was used to compare routine vaccination with PCV20 against PCV13 and PCV15.
- The model assumed a 3+1 dosing schedule for PCV20 and considered a 25-year time period.
- The model assumptions are described in Rozenbaum et al.[17]

Model Inputs

Antibiotic Prescriptions

- 100% of individuals with invasive pneumococcal disease (IPD) and hospitalized pneumonia receive antibiotics.
- The antibiotic prescription rates for non-hospitalized pneumonia and otitis media (OM) were 78% and 85% for children, respectively.[21]
- Prescription rates were assumed to remain constant over the time horizon.

Antibiotic Resistance

- The proportion of antibiotic-resistant S. *pneumoniae* cases was based on data from 2018–2021[22] (**Table 1**).
- Resistance rates were assumed to remain constant.

Table 1. Proportion of Cases Resistant to Antibiotics by Age and Disease Outcome

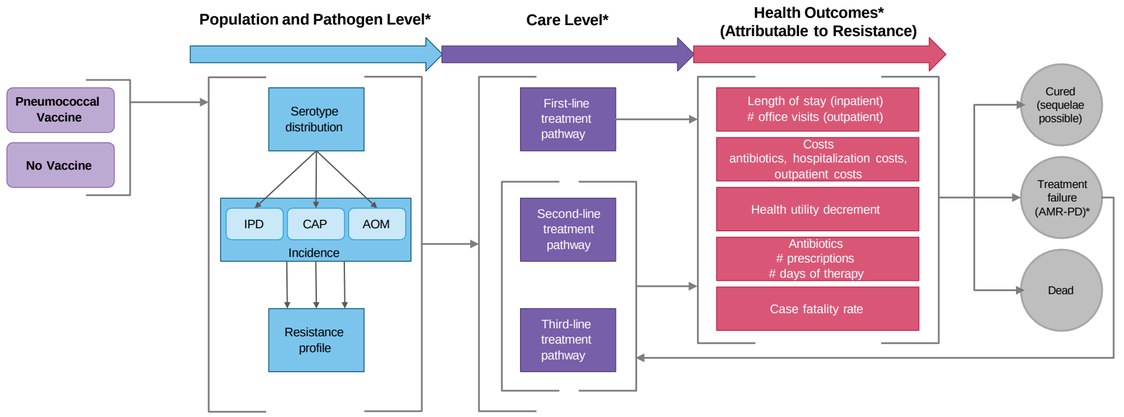
Age	IPD	Non-invasive Hospitalized Pneumonia	Non-hospitalized Pneumonia	Complex OM	Simple OM
All Ages	38%	56%	56%	30%	30%
<18 Years	39%	49%	49%	30%	30%
≥18 Years	38%	57%	57%	30%	30%

IPD = invasive pneumococcal disease; OM = otitis media

CONCEPTUAL FRAMEWORK

- The conceptual framework includes three pathways (**Figure 1**):
  - ***Population and pathogen***: disease epidemiology (i.e., serotype distribution, disease incidence, and resistance profiles)
  - ***Care pathway***: clinical management (i.e., antibiotic access, diagnostic and treatment protocols, and the impact of treatment failures due to resistance)
  - ***Health outcomes***: AMR outcomes (i.e., hospital stays, costs, mortality rates, additional antibiotic prescriptions, and the spread of resistant strains)

Figure 1. Conceptual Framework



*All data points can be age and disease specific

OM = otitis media; CAP = community-acquired pneumonia; IPD = invasive pneumococcal disease; SoC = standard of care

RESULTS (cont.)

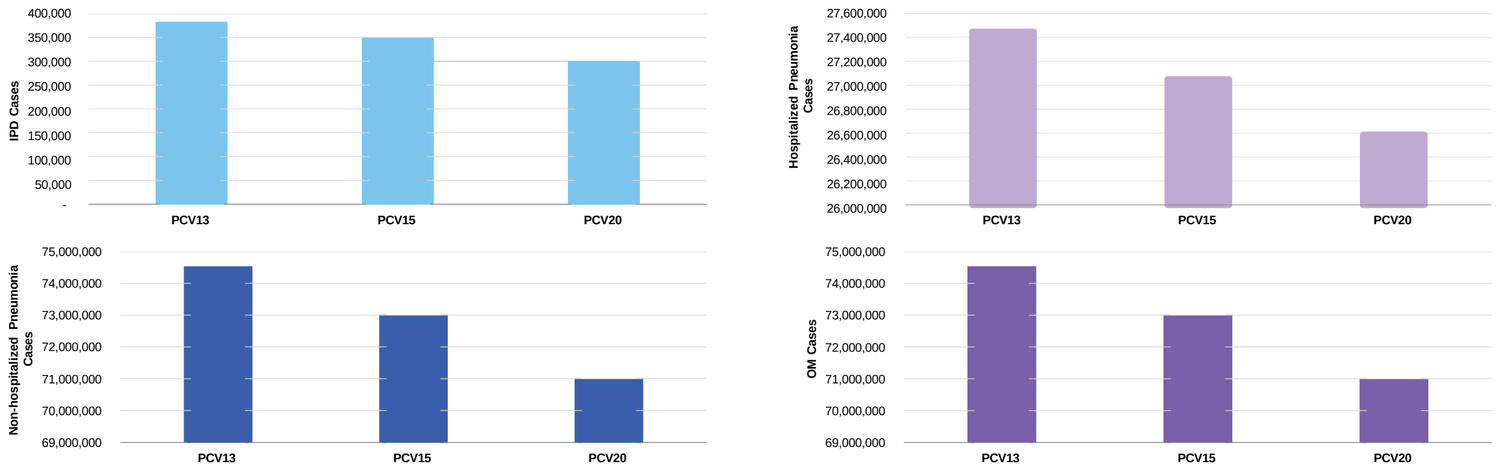
- Over 25 years, PCV20 could prevent 14 million additional antibiotic-resistant infections compared to PCV13 and 7.2 million compared to PCV15 (**Table 2**; **Figure 2**).
- PCV20 could prevent 23.5 million antibiotic prescriptions compared to PCV13 and 12 million compared to PCV15 (**Table 2**).
  - Of the total antibiotic prescriptions prevented compared to PCV13, 0.7% were for IPD, 5.6% for hospitalized pneumonia, 23.9% for non-hospitalized pneumonia, and 69.7% for OM.
  - Compared to PCV20, 0.7% were for IPD, 5.9% for hospitalized pneumonia, 25.8% for non-hospitalized pneumonia, and 67.6% for OM.
- Most averted antibiotic-resistant infections and antibiotic prescriptions were due to prevented OM cases among those aged 0–17 years.

Table 2. Incremental Cases Averted: PCV20 versus PCV13 and PCV15

	Cases		Antibiotic-resistant cases		Antibiotic prescriptions	
	PCV13	PCV15	PCV13	PCV15	PCV13	PCV15
IPD	-194,750	-102,579	-74,189	-39,071	-194,750	-102,579
Non-invasive hospitalized pneumonia	-1,573,765	-846,116	-862,579	-465,208	-1,573,765	-846,116
Non-hospitalized pneumonia	-6,675,939	-3,703,531	-3,568,680	-1,985,932	-5,207,233	-2,888,754
Complex OM	-19,451,363	-9,705,505	-9,544,668	-4,755,697	-16,533,659	-8,249,679
Total	-27,895,818	-14,357,730	-14,050,115	-7,245,908	-23,509,406	-12,087,128

IPD = invasive pneumococcal disease; OM = otitis media; PCV = pneumococcal conjugate vaccine

Figure 2. Predicted Antibiotic-resistant Cases



IPD = invasive pneumococcal disease; OM = otitis media; PCV = pneumococcal conjugate vaccine

CONCLUSION

- **The proposed conceptual framework includes critical AMR parameters for vaccine evaluation but highlights data gaps.**
- **The pragmatic modeling approach shows that PCV infant immunization can reduce antibiotic prescriptions and resistance.**
  - **These findings support including AMR considerations in cost-effectiveness models.**

References

1. Murray CJL, et al. *The Lancet*. 2022;399(10325):629-55.
2. Poudel SK, et al. *PLoS One*. 2023;18(4):e0283021.
3. Althouse BM, et al. *Proc Natl Acad Sci U S A*. 2010;107 Suppl 1(Suppl 1):1696-701.
4. Lipsitch M, Siber GR. *mBio*. 2016;7(3).
5. Smith AM, Huber VC. *Viral Immunol*. 2018;31(2):159-73.
6. World Health Organization (WHO). Estimating the impact of vaccines in reducing antimicrobial resistance and antibiotic use: technical report. 2024. https://www.who.int/publications/i/item/9789240098787
7. Buchy P, et al. *Int J Infect Dis*. 2020;90:188-96.
8. Frost I, et al. *Lancet Microbe*. 2023;4(2):e113-e25.
9. Ganaie F, et al. *mBio*. 2020;11(3).
10. Kyaw MH, et al. *N Engl J Med*. 2006;354(14):1455-63.
11. Suaya JA, et al. *Vaccine*. 2018;36(49):7479-86.
12. Yildirim I, et al. *Pediatrics*. 2024;153(1).
13. Chen C, et al. *Lancet Glob Health*. 2019;7(1):e58-e67.
14. Kuhlmann A, von der Schulenburg JG. *Eur J Health Econ*. 2017;18(3):273-92.
15. Lytle D, et al. *Hum Vaccin Immunother*. 2023;19(2):2257426.
16. Malene BM, et al. *Cost Eff Resour Alloc*. 2023;21(1):52.
17. Rozenbaum MH, et al. *J Med Econ*. 2024;27(1):644-52.
18. Shen K, et al. *PLoS One*. 2018;13(7):e0201245.
19. Tasslimi A, et al. *Int Health*. 2011;3(4):259-69.
20. Zakiyah N, et al. *Vaccines (Basel)*. 2020;8(3).
21. King L. Pediatric outpatient ARI visits and antibiotic use attributable to serotypes in higher valency PCVs. Advisory Committee on Immunization Practices (ACIP). Atlanta, GA, USA2023. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2023-02/slides-02-22/Pneumococcal-03-King-508.pdf
22. Andrejko KL, et al. ntimicrobial Non-susceptibility Among Invasive and Non-invasive Streptococcus pneumoniae Infections in the United States, 2018–2021. 13th Meeting of the International Society of Pneumonia & Pneumococcal Diseases; 2024.

Disclosures

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For more information please contact:
MH Rozenbaum, PhD, MBA
Phone: +31 10 4064494
Email: mark.rozenbaum@Pfizer.com
www.pfizer.com