

Assessing the Consequences of Suboptimal Infant Vaccination Rates on Pertussis Costs in Brazil: A Prospective Modeling Analysis

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INTRODUCTION

Pertussis, or whooping cough, is an acute respiratory infectious disease caused by the bacterium *Bordetella pertussis*.¹ Secondary attack rates reach approximately 70%–80% among non-immune individuals in households and school/work environments.¹ Outbreaks can expand rapidly.² WHO recommends a $\geq 90\%$ VCR to control pertussis.³

OBJECTIVE

Assess the impact of persistent low VCRs (vaccination coverage rates) on pertussis epidemiology over 8 years and the economical impacts in direct medical and societal perspectives

METHODS

A dynamic transmission model previously developed⁴ was adapted to capture the main characteristics of pertussis vaccination in Brazil (Figure 1), as well as the main clinical features of pertussis infections. The population was stratified in five age categories: <1, 1-4, 5-9, 10-19 and ≥ 20 years old. Costs parameters were extracted from published data⁵ (Table 1). The model was calibrated on reported pertussis incidence for the period 2010-2015, adjusted for under-reporting based on surveillance to diagnosis claims database comparisons in Canada, and a 100-sample probabilistic sensitivity analysis for the 2022-2029 period was conducted. The upper bound of the 95% CI of the mean annual incidence over the study period across the 100 iterations of the model was used as a quantitative indicator of the magnitude of a potential outbreak. Additionally, two scenarios were developed, the **scenario A where VCR is restored to 2010 level** (VCRs for doses 1, 2 and 3=99%) and **Scenario B if the VCRs remain at the 2019 level** (VCRs for doses 1, 2 and 3=79%, 74.5% and 70%, respectively).

Figure 1: Dynamic Transmission Model*⁴

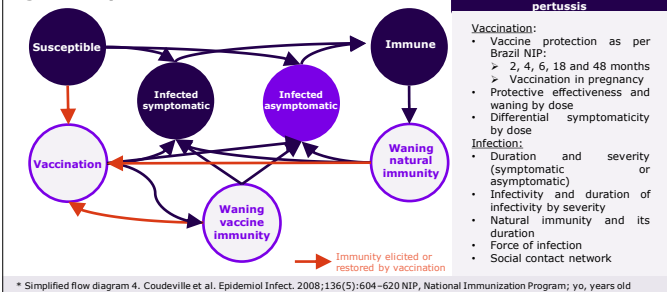


Table 1: Health economic parameters

	Hospitalization rate symptomatic cases	Fatality rate symptomatic cases	Outpatient cost/case (US\$)	Hospitalization cost/case (US\$)
>1 yo	37.4% ^a	0.5% ^a	11.4 ^b	220.7 ^b
1–4 yo	37.4% ^a	0.1% ^a	15.2 ^b	186.1 ^b
5–9 yo	0.8% ^b	0% ^b	14.4 ^b	166.0 ^b
10–19 yo	0.8% ^b	0% ^b	18.6 ^b	182.0 ^b
20+ yo	3.0% ^b	0% ^b	14.0 ^b	235.2 ^b

a) Replicated from Luz et al. 5 b) Adapted from Luz et al.5 Hospitalization rates reduced by vaccination in pregnancy as per Winter et al.6 2018–19 fatality rates

RESULTS

When comparing Scenario A with B, the model predicts an increased pertussis incidence driven by unvaccinated cohorts, with twice as many cases in infants under 1 year of age (356,000 vs 175,000 cases) and 3-fold increase cases in children aged 1-4 years (158,000 vs. 56,000 cases) (Figure 2).

Figure 2: Model-forecasted impact of lower VCRs - Epidemiologic trends

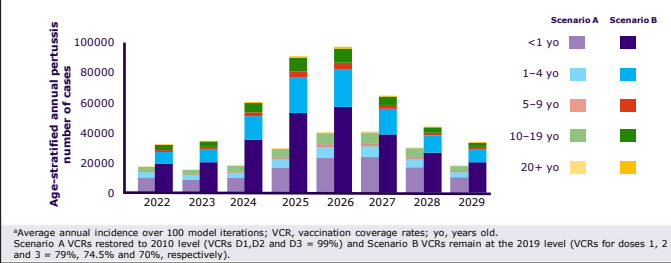


Figure 3: Average annual Medical Costs

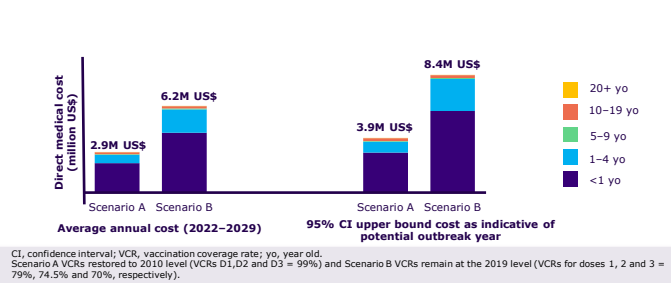
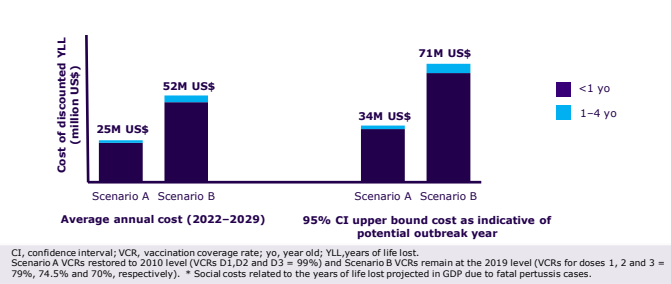


Figure 4: Average annual Societal Costs



Annual direct public healthcare costs for a possible pertussis outbreak could rise from US\$3.9M in the scenario A to US\$8.4M in scenario B (Figure 3) and annual societal costs due to years of life lost could be US\$34M to US\$71M, in scenario A and B, respectively (Figure 4).

DISCUSSION

Suboptimal VCRs lead to divergent trend in incidence compared to scenario with recovery of VCRs at 2010 level:

- With more than twice as many cases in epidemic peak years reflected in outpatients, hospitalized numbers and fatalities.
- Increasing by more than twice direct medical costs and societal burden associated with years of life lost due to pertussis fatalities.
- Resulting in annual incremental costs in a potential outbreak.

CONCLUSIONS

Low VCRs could result in an annual incremental cost of US\$ 23.3M, rising to US\$ 41.5M in a potential outbreak. Mitigating the risks of low VCRs requires maintaining vaccine acceptability in the population.

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DISCLOSURES

The authors are Sanofi's employees and may hold shares and/or stock options in the company.

FUNDING

This study was funded by Sanofi.