Effects of improving varicella vaccination coverage rates on clinical and economic outcomes in Peru over 10 years

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Background

- Peru introduced a 1-dose universal varicella vaccination (UVV) program in 2018 with a monovalent vaccine administered to children at 12 months of age[1]
- Overall, varicella vaccine coverage rates (VCRs) have remained low (<70% in 2022) and were significantly impacted by the COVID-19 pandemic[2]
- To avoid age shift and increased mortality risk, the World Health Organization (WHO) recommends that countries with medium to high varicella seropositivity (eg, Peru) should maintain a VCR of at least 80%[3]

Objective

- We adapted an existing varicella zoster virus (VZV) dynamic transmission model (DTM) to Peru to evaluate the clinical and economic impact of increasing varicella VCR over a 10-year time period (2023-2032)

Methods

- A previously published age-stratified DTM was adapted to Peru[4] and calibrated to regional varicella seroprevalence and herpes zoster incidence data[5-10]
- The model was parameterized with publicly available demographic, health care resource use (HCRU), cost, and epidemiological data; proxy data were used where country-specific data was unavailable (Table 1)
- All UVV strategies included 1-dose vaccination with VARIVAX® (Merck Sharp & Dohme LLC, Rahway, NJ, USA) over 10 years (2023-2032)
- Our reference strategy was the status quo and assumed a constant VCR of 66%.[2,11] Comparator strategies included increasing VCR to (A) 80%, (B) 85%, and (C) 90% over 1 year and increasing VCR to 85% over (D) 2 years and (E) 5 years (Table 2)
- Outcomes included cumulative varicella cases, inpatient and outpatient cases, payer (ie, direct) and societal (ie, direct and indirect) costs per person per year (PPPY), and cost per averted varicella case (ie, the marginal costs divided by the marginal cases averted)
- All costs and inputs were discounted at 5% annually (2023 USD; $)

Table 1. Country-specific input parameters

Parameter	Value	Source
Resource use parameters		
Proportion of varicella cases that seek outpatient/inpatient care (by age)		
0-1 years	23% / 5%	
1-5 years	15% / 3%	
5-15 years	8% / 2%	12
15-45 years	15% / 3%	
45+ years	23% / 5%	
Economic parameters		
Average daily wage	$16.95	13
Vaccine unit price	$26.72	14
Vaccine administration price	$5.45	15
Cost of outpatient visit	$44.73	16
Workdays lost per outpatient case	2.5 days	16
Cost per inpatient admission	$690.37	16
Workdays lost per inpatient admission	6.8 days	16

Results

- Under the current VCR (reference strategy), we estimated 2,161,267 varicella cases, 211,489 outpatient cases, 46,989 inpatient cases, and 77 deaths over a 10-year time period. Payer and societal costs were $0.39 PPPY and $0.43 PPPY, respectively
- Increasing VCR to 80%, 85%, and 90% over 1 year resulted in reductions in varicella cases, outpatient cases, hospitalizations, and deaths (Figure 1)
- When increasing VCR to 85%, the greatest reduction in clinical burden occurred when 85% VCR was achieved within 1 year compared to the longer time periods of 2 or 5 years (Figure 1)
- From the payer perspective, increased VCR strategies led to a 12% to 21% ($0.05 to $0.08 PPPY) increase in direct costs (Figure 2)
- From the societal perspective, increased VCR strategies led to a 10% to 18% ($0.04 to $0.07 PPPY) increase in total costs
- The cost per varicella case averted was lowest for strategy A ($46.40 payer; $41.79 societal) and highest for strategy E ($65.23 payer; $60.70 societal) (Table 2)
- The cost per additional averted varicella case increased with the target VCR and with the amount of time required to achieve the target VCR

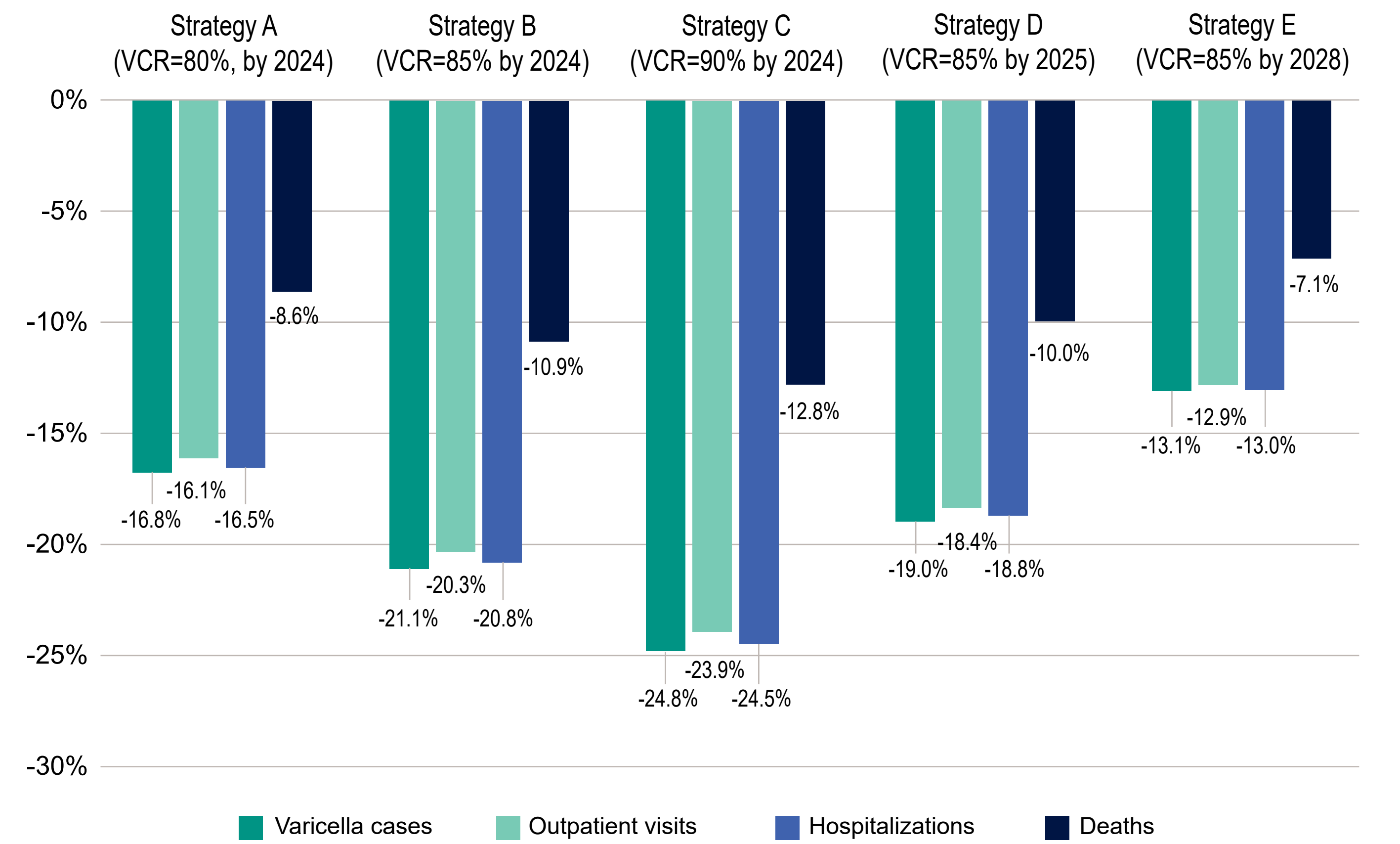### Figure 1. Change in clinical outcomes relative to reference strategy

Figure 2. Change in cost outcomes relative to reference strategy
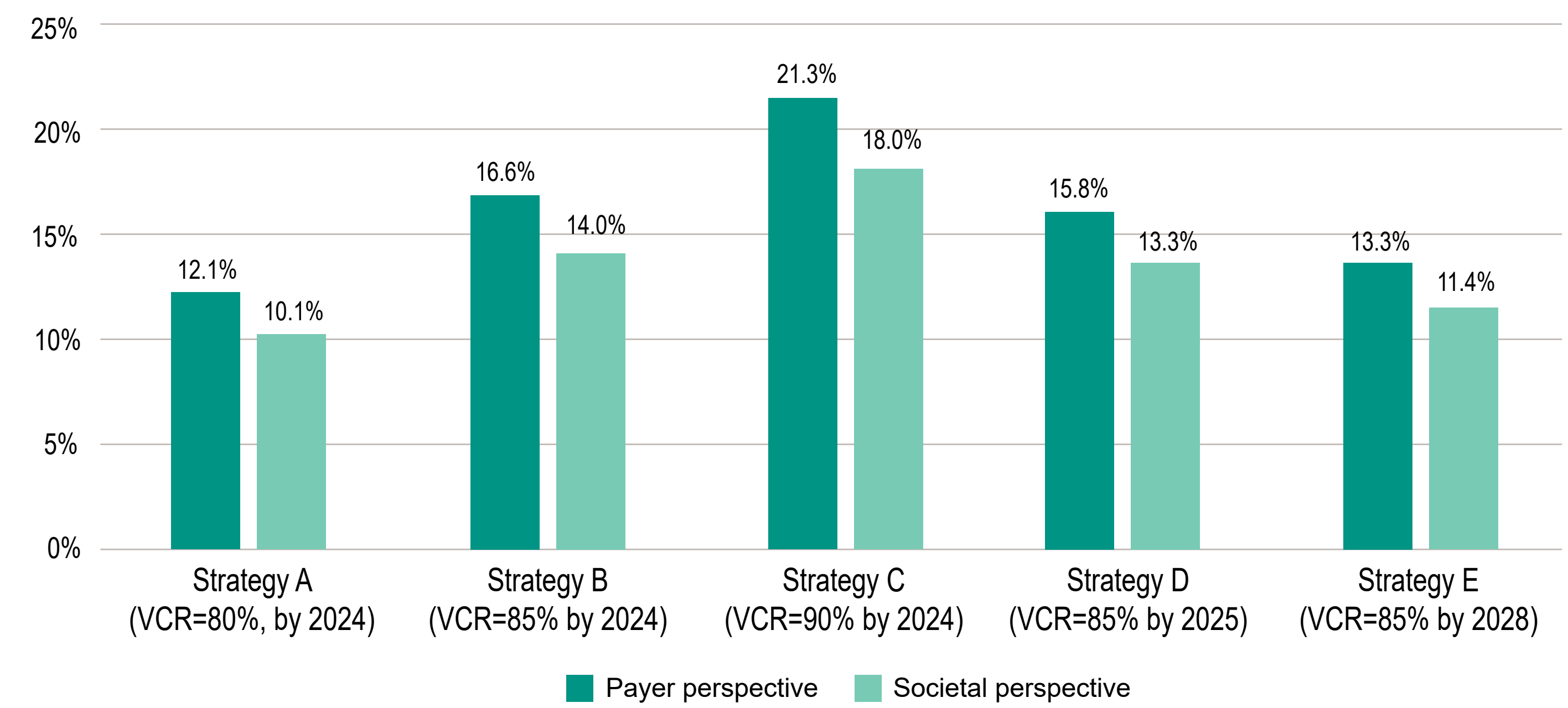

Table 2. VCR and cost per case averted for the different UVV strategies

Strategy	Target VCR	Year by which target VCR is achieved	Cost per averted case	
			Payer	Societal
Reference/ Status quo	66%	2023	N/A	N/A
A	80%	2024	$46.40	$41.79
B	85%	2024	$50.66	$46.04
C	90%	2024	$55.10	$50.47
D	85%	2025	$53.46	$48.87
E	85%	2028	$65.23	$60.70

Limitations

- Regional varicella seroprevalence and herpes zoster incidence data were used for model calibration, as country-specific calibration data were not available
- Our model did not include costs associated with the rapid expansion of the UVV program to increase first-dose VCR, eg, costs incurred to expand the vaccine cold chain, hire additional medical staff, organize public awareness campaigns, or to evaluate whether the existing system for measles, mumps, and rubella (MMR) vaccination could be leveraged. These costs may be disproportionately higher for countries aiming for higher VCRs

Discussion and Conclusions

- Our model provides different scenarios for policymakers to evaluate the benefits and costs of improving varicella VCRs
- Increasing varicella VCR compared to reference strategy (status quo) resulted in better clinical outcomes including lower varicella cases, hospitalizations, and deaths, with a small per-capita increase in costs
- All strategies improved clinical outcomes; attaining higher VCR and faster leads to better clinical outcomes.
- The most-efficient strategy (ie, the strategy with the lowest cost per additional averted varicella case) was strategy A (VCR = 80% achieved by 2024). Thus, strategy A may be an effective strategy to implement for policymakers with limited resources
- Our study findings are consistent with the WHO recommendation of maintaining varicella VCR>80% to lower varicella morbidity and mortality

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