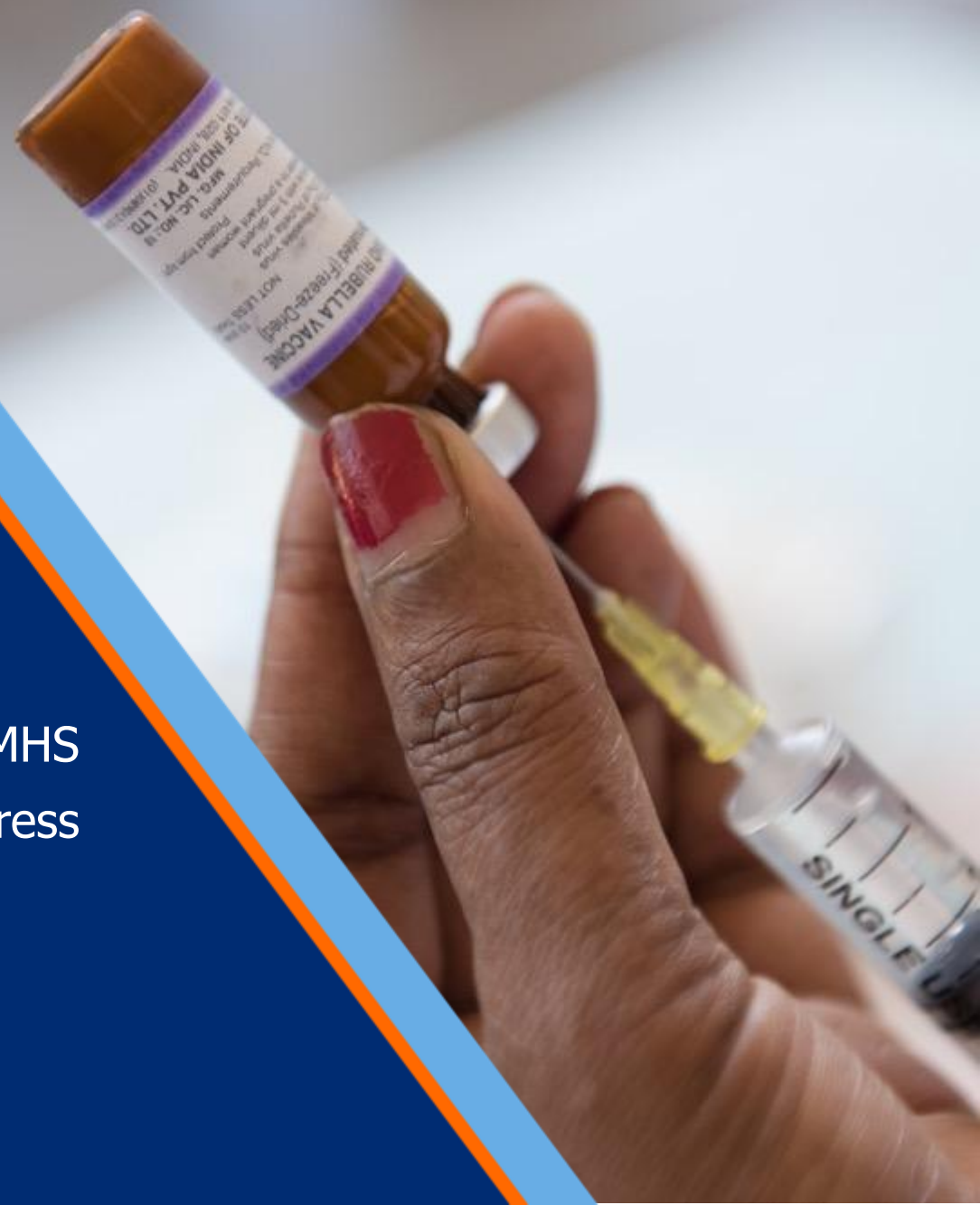


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The R-Shiny tool for immunization program analysis: an interactive web-based approach to estimating benefits, costs, ROI, and funding gaps

Salin Sriudomporn, MHS

2025 Immunization Economics IHEA Pre-Congress



By So Yoon Sim, Elizabeth Watts, Dagna Constenla, Logan Brenzel, and Bryan N. Patenaude

Return On Investment From Immunization Against 10 Pathogens In 94 Low- And Middle-Income Countries, 2011-30

ABSTRACT Estimating the value of global investment in immunization programs is critical to helping decision makers plan and mobilize immunization programs and allocate resources required to realize their full benefits. We estimated economic benefits using cost-of-illness and value-of-a-statistical-life approaches and combined this estimation with immunization program costs to derive the return on investment from immunization programs against ten pathogens for ninety-four low- and middle-income countries for the period 2011-30. Using the cost-of-illness approach, return on investment for one dollar invested in immunization against our ten pathogens was 26.1 for the ninety-four countries from 2011 to 2020 and 19.8 from 2021 to 2030. Using the value-of-a-statistical-life approach, return on investment was 51.0 from 2011 to 2020 and 52.2 from 2021 to 2030. The results demonstrate continued high return on investment from immunization programs. The return-on-investment estimates from this study will inform country policy makers and decision makers in funding agencies and will contribute to efforts to mobilize resources for immunization. Realization of the full benefits of

orn, So Yoon Sim, Joshua Mak, Logan Brenzel, and Bryan N. Patenaude

ing And Funding Gap For 16 es Across 94 Low- And e-Income Countries, 2011-30

e estimated immunization program costs, financing, and s for sixteen vaccines among ninety-four low- and me countries during the period 2011-30. Inputs were om the Institute for Health Metrics and Evaluation, the 2020accine Economics costing analysis, the World Health n, Gavi, and the United Nations Children's Fund. We found a g gap of \$38.4 billion between 2011 and 2030, with the cost ation delivery being the main driver (86 percent) of the . On average, government financing of vaccination programs s throughout the period. However, the decline in both Gavi ment assistance for health (DAH) financing anticipated 1 and 2030 outpaces the forecasted increases in domestic immunization spending. Probabilistic sensitivity analysis was oth the costing and the scenario analyses to address in the financing of vaccines and vaccine delivery. The results narrowing gap for vaccine acquisition but a growing gap for very, which emphasizes the critical need for resource

By Joshua Mak, Salin Sriudomporn, William J. Moss, and Bryan N. Patenaude

An Estimate Of The Return On Investment Of A Malaria Vaccine In 20 Sub-Saharan African Countries, 2021-30

ABSTRACT Malaria is a leading global health problem that was responsible for an estimated 619,000 deaths worldwide in 2021. We modeled the return on investment (ROI) for the introduction and continuation of a four-dose malaria vaccine, RTS,S/AS01, from 2021 to 2030 in twenty sub-Saharan African countries supported by Gavi, the Vaccine Alliance. We used the Decade of Vaccine Economics benefits and costing outputs to calculate an ROI using health impact data modeled by the Swiss Tropical and Public Health Institute (hereafter "Swiss") and Imperial College London (hereafter "Imperial"). The Swiss estimates with a base vaccine price of US\$7.00 resulted in an ROI of 0.42, and the Imperial impact estimates with the same base vaccine price resulted in an ROI of 2.30. Inclusion of the fifth seasonal dose for ten countries exhibiting high seasonal disease burden increased the Swiss ROI by 143 percent, to 1.02, and the Imperial ROI by 23.5 percent, to 2.84. To improve ROI, decision makers should continue to improve delivery platforms, decrease vaccine



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Themed Section: Vaccines

Economic Benefits of Immunization for 10 Pathogens in 94 Low- and Middle-Income Countries From 2011 to 2030 Using Cost-of-Illness and Value-of-Statistical-Life Approaches

Elizabeth Watts, MHS, So Yoon Sim, MA, MSPH, Dagna Constenla, PhD, Salin Sriudomporn, MHS, Logan Brenzel, PhD, Bryan Patenaude, ScD

Achieving immunization agenda 2030 coverage targets for 14 pathogens: Projected product and immunization delivery costs for 194 Countries, 2021-2030

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PCV ROI analysis in Ecuador supported the decision to retain PCV10 in their immunization program



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Economic Evaluation

Return on Investment of 10-Valent Pneumococcal Conjugate Vaccine in Ecuador From 2010 to 2030

Ruth Jimbo-Sotomayor, PhD, Elizabeth Watts, MHS, Luciana Armijos, MD, MPH, Salin Sriudomporn, MHS, Xavier Sánchez, PhD, Adriana Echeverría, MD, Alvaro Whittenbury, MD, Bryan Patenaude, ScD

ABSTRACT

Objectives: Ecuador introduced the pneumococcal conjugate vaccine in 2010. A recent time series analysis has demonstrated the impact of 10-valent pneumococcal conjugate vaccine (PCV10) on hospitalized pneumococcal disease in children. We leveraged these estimates to calculate the return on investment (ROI) of PCV10 in Ecuador from 2010 to 2030 at the national and regional levels.

Methods: We used 2 approaches to estimate the economic benefits: (1) cost of illness, which includes treatment, transportation, and productivity loss averted, (2) and the value of statistical life, which reflects society's average willingness to pay to save one life. Costs of the immunization program include vaccine costs (doses, syringes, injection supplies) and immunization delivery costs (personnel, cold chain equipment and maintenance, transportation, distribution services, and other recurrent costs). We estimated the ROI by dividing the net benefits by costs.

Results: The ROI using the cost-of-illness approach was slightly negative in the introduction year. From 2011 to 2020, we estimated the ROI to be 0.45 (0.15-0.73). For the future decade, the ROI is estimated at 0.37 (-0.03 to 1.03). Using the value-of-statistical-life approach, the ROI was 1.46 (0.82-2.17) in the introduction year. In the first decade, the ROI was 1.01 (0.49-1.60); in the second decade, the ROI fell to 0.83 (0.23-1.78).

Conclusions: The results of this study demonstrate the total economic benefits of PCV10 in Ecuador exceed immunization program costs after the introduction year. Estimates from this study will inform country policy makers and will contribute to efforts to mobilize resources for immunization.

Keywords: 10-valent pneumococcal conjugate vaccine, Ecuador, pneumococcal diseases, return of investment.

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Introduction

Pneumococcal diseases are responsible for a significant burden of disease worldwide, especially in those younger than 5 years and adults older than 65 years.¹ One of the most cost-effective strategies to reduce pneumococcal-related morbidity and mortality globally is to introduce pneumococcal conjugate vaccines (PCVs) into routine immunization programs.²

Ecuador is a country located in South America that occupies an area of 283 561 km². In 2021, the total population is approximately 17 million people.³ In the year 2020, there were 265 437 live births nationwide, with a life expectancy of 71.01 years and an infant mortality rate of 9.5 per 1000 live births. In 2020, the gross domestic product (GDP) per capita was \$5600.⁴ The Ecuadorian health system is divided into a public system that covers approximately 85% of the population and a private health system.⁵ More than 90% of immunization activities are performed at the primary level.

In Ecuador, 10-valent pneumococcal conjugate vaccine (PCV10) was introduced into the national immunization scheme in 2010. Currently, the country administers 3 doses according to the 3 + 0 schedule (2, 4, and 6 months of age).⁶ A study of Jimbo et al⁷ demonstrated that PCV10 vaccine reduced hospitalized cases of pneumonia by 27% among children younger than 1 year and 33% in children younger than 5 years. Using data from 5-year periods before and after vaccine introduction, the estimated impact of PCV on pneumonia-related mortality was 14% in children younger than 1 year and 10% in children younger than 5 years. A 22% reduction in pneumonia mortality among adults at the age of 50 to 64 years was also observed as an indirect effect.

In addition to the direct and indirect clinical benefits of the PCV vaccine in the population, there are also economic benefits arising from the introduction of PCV vaccine into the routine vaccination program.^{8,9} One method to assess the economic impact of immunization is return on investment (ROI), which compares net benefits of an intervention with costs.¹⁰ Ozawa et al¹¹ evaluated

Objective

“To provide a publicly available web-based, and easy-to-use tool that enables countries to lead their immunization investment planning, supported by collaborative guidance.”

Comprehensive

Convenient

Collaborative

Country-led

Methodology

- **R-Shiny based** application
- Based on immunization program analysis models created by the Decade of Vaccine Economics (DOVE)/ Vaccine Economics Research for Sustainability and Equity (VERSE) team at the International Vaccine Access Center, the Johns Hopkins Bloomberg School of Public Health.
 - **Economic benefit – Cost-of-Illness (COI) approach**
 - Vaccine-specific immunization program costing and the funding gap are calculated based on the current level of financing - **Costing, Financing and Funding Gap (CFF) model.**
- Model key components of immunization program analysis, including
 - Economic benefits, Costing, ROI, Financing and Funding Gaps
- At **both national and subnational** level.

Methodology – DOVE/ VERSE Model Review



Health impact estimates

Demographic & coverage data

Immunization Delivery Cost Catalogue

Immunization expenditure data

Economic Benefits (COI, VSL)

Cost of NIPs

Financing of NIPs

Return on Investment

Funding Gap

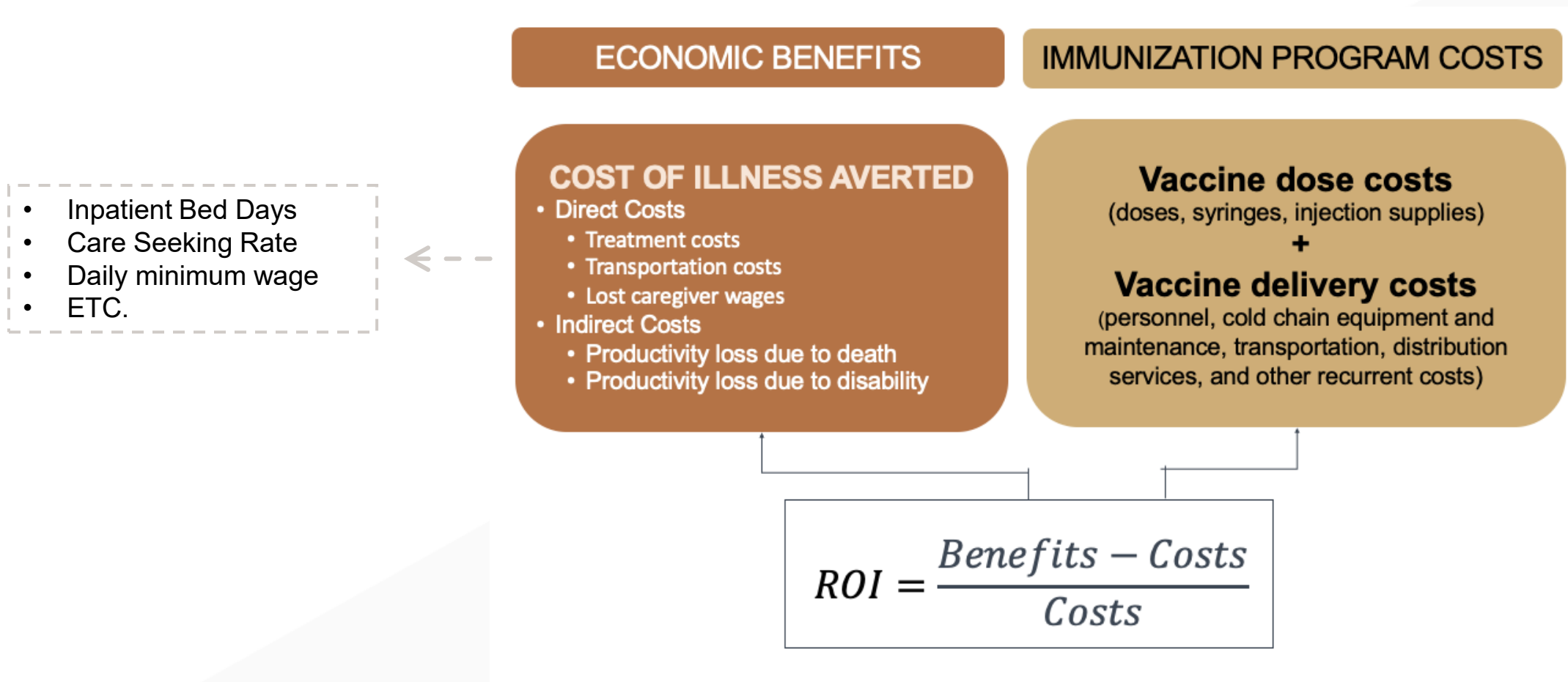
ROI Model

CFF Model



Funded by Gates Foundation

Return on Investment (ROI) Model



Immunization Program Costing

$$\text{Vaccine costs}_{ijk} = \sum_{k=2021}^{2030} \sum_{j=1}^{117} \sum_{i=1}^{18} (\text{number of doses}_{ijk} \times \text{price per dose}_{ijk})$$

+

$$\text{Immunization delivery costs}_{ijk} = \sum_{k=2021}^{2030} \sum_{j=1}^{117} \sum_{i=1}^{18} (\text{number of doses}_{ijk} \times \text{delivery cost per dose}_{ij})$$

$$\begin{aligned} \text{Number of doses}_{ijk} &= \text{Target population}_{ijk} \times \text{Coverage rate}_{ijk} \\ &\times \text{Number of recommended doses}_{ij} \\ &\times (1/(1 - \text{Wastage rate}_{ij})) \times (\text{Buffer}_{ijk}) \end{aligned}$$

Where i = vaccine, j = country and k = year

* the buffer stock rate for routine immunization is calculated incrementally

ROI Shiny Application – LIVE DEMO



Introducing the Return-on-Investment Tool

Under the VERSE grant, the Return-on-Investment tool was developed to enable researchers and decisionmakers to calculate the estimated return on investment (ROI) of financing specific vaccines programs. To make this estimate, the application draws upon two economic models developed by [IVAC's](#) Economics and Finance Team.

Economic Benefits

This tool computes the economic benefits of a vaccination program using a [cost-of-illness](#) (COI) approach. COI considers both the direct and indirect costs associated with the illness. Economic impact is discounted to the year of vaccination so that benefits are attributed to vaccines delivered - as traditionally done within health economics, this discount rate is 3% per year. Benefits are attributed to costs averted due to preventing an illness from occurring. These are disaggregated into averted costs from treatment, transportation to clinic, caregiver wages, and long-term costs due to disability and to death. Our COI model builds on estimates of the cases and deaths averted by vaccines from [the Vaccine Impact Modeling Consortium \(VIMC\)](#). The current version of this tool is based on the default touchstone [touchstone2019](#).

Costs

What's next?

- Integrating additional metrics:
 - **Cost per dose**
 - **Cost per death averted**
 - **Cost per DALY averted**
- Enhancing customization to better reflect country-specific data:
 - Adjustable **coverage targets**
 - Editable **financing inputs**
 - Scenario analysis for **policy and investment planning**

THANK YOU!



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