

VACCINE DELIVERY RESEARCH DIGEST

UNIVERSITY OF WASHINGTON GLOBAL HEALTH START PROGRAM
REPORT TO THE BILL AND MELINDA GATES FOUNDATION

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TABLE OF CONTENTS

1. Costs and financing of routine immunization: Approach and selected findings of a multi-country study (EPIC).	3
○ A study in six countries to address gaps in facility-level costing data.	
2. One size does not fit all: The impact of primary vaccine container size on vaccine distribution and delivery.	4
○ A simulation model to explore correlations between number of doses contained in a vaccine vial, vaccine availability, and cost per dose administered.	
3. Using the World Health Organization Measles Programmatic Risk Assessment Tool for Monitoring of Supplemental Immunization Activities in the Philippines.	5
○ A discussion of a risk-assessment tool for measles in the Philippines.	
4. Thirty years of vaccination in Vietnam: Impact and cost-effectiveness of the national Expanded Programme on Immunization.	6
○ A country-level assessment of EPI in Vietnam.	
5. Typhoid vaccine introduction: An evidence-based pilot implementation project in Nepal and Pakistan.	7
○ A pilot program to assess the feasibility of a school-based delivery platform conducted by in-country health departments.	
6. Epidemiological and Economic Impact of Monovalent and Pentavalent Rotavirus Vaccines in Low and Middle Income Countries: A Cost-Effectiveness Modeling Analysis.	8
○ A multi-country study assessing the cost-effectiveness of competing rotavirus vaccines.	
7. Costs of vaccine programs across 94 low- and middle-income countries.	9
○ A study to predict the costs of routine and supplemental immunization activities from 2011 to 2020 in 94 countries.	
8. Transport networks and inequities in vaccination: remoteness shapes measles vaccine coverage and prospects for elimination across Africa.	10
○ A spatial analysis of distance to services and vaccination coverage.	
9. Typhoid fever vaccination strategies.	11
○ A literature review of typhoid vaccine disease control and delivery strategies.	
10. Estimated impact and cost-effectiveness of rotavirus vaccination in Senegal: A country-led analysis.	12
○ A cost-effectiveness analysis from Senegal using 20 successive birth cohorts to identify cost per DALY from the health provider and societal perspective.	
 Appendix: PubMed Search Terms	 13



1. COSTS AND FINANCING OF ROUTINE IMMUNIZATION: APPROACH AND SELECTED FINDINGS OF A MULTI-COUNTRY STUDY (EPIC).

Brenzel L, Young D, Walker DG.

Vaccine. 2015 May 7;33 Suppl 1:A13-20.

PMID: 25919153

ABSTRACT

BACKGROUND: Few detailed facility-based costing studies of routine immunization (RI) programs have been conducted in recent years, with planners, managers and donors relying on older information or data from planning tools. To fill gaps and improve quality of information, a multi-country study on costing and financing of routine immunization and new vaccines (EPIC) was conducted in Benin, Ghana, Honduras, Moldova, Uganda and Zambia.

METHODS: This paper provides the rationale for the launch of the EPIC study, as well as outlines methods used in a Common Approach on facility sampling, data collection, cost and financial flow estimation for both the routine program and new vaccine introduction. Costing relied on an ingredients-based approach from a government perspective. Estimating incremental economic costs of new vaccine introduction in contexts with excess capacity are highlighted. The use of more disaggregated System of Health Accounts (SHA) coding to evaluate financial flows is presented.

RESULTS: The EPIC studies resulted in a sample of 319 primary health care facilities, with 65% of facilities in rural areas. The EPIC studies found wide variation in total and unit costs within each country, as well as between countries. Costs increased with level of scale and socio-economic status of the country. Governments are financing an increasing share of total RI financing.

CONCLUSIONS: This study provides a wealth of high quality information on total and unit costs and financing for RI, and demonstrates the value of in-depth facility approaches. The paper discusses the lessons learned from using a standardized approach, as well as proposes further areas of methodology development. The paper discusses how results can be used for resource mobilization and allocation, improved efficiency of services at the country level, and to inform policies at the global level. Efforts at routinizing cost analysis to support sustainability efforts would be beneficial.

WEB: <http://dx.doi.org/10.1016/j.vaccine.2014.12.066>

IMPACT FACTOR: 3.49

CITED HALF-LIFE: 4.90

UW EDITORIAL COMMENT: This study addresses gaps in information for current vaccine costs, in order to inform future financing goals. Figure 3 breaks down costs in each country by labor, vaccine, and other costs. Table 5 shows the facility-based routine immunization economic costs and national-level financing. Further information on costs in each country included in this study may be found in the special issue of *Vaccine* published in May 2015, titled *Expanding the Evidence Base to Inform Vaccine Introduction: Program Costing and Cost-effectiveness Analyses*.



2. ONE SIZE DOES NOT FIT ALL: THE IMPACT OF PRIMARY VACCINE CONTAINER SIZE ON VACCINE DISTRIBUTION AND DELIVERY.

Haidari LA, Wahl B, Brown ST, Privor-Dumm L, Wallman-Stokes C, Gorham K et al.

Vaccine. 2015 Apr 15. pii: S0264-410X(15)00471-5. [Epub ahead of print].

PMID: 25889160

ABSTRACT

BACKGROUND: While the size and type of a vaccine container (i.e., primary container) can have many implications on the safety and convenience of a vaccination session, another important but potentially overlooked consideration is how the design of the primary container may affect the distribution of the vaccine, its resulting cost, and whether the vial is ultimately opened.

METHODS: Using our HERMES software platform, we developed a simulation model of the World Health Organization Expanded Program on Immunization supply chain for the Republic of Benin and used the model to explore the effects of different primary containers for various vaccine antigens.

RESULTS: Replacing vaccines with presentations containing fewer doses per vial reduced vaccine availability (proportion of people arriving for vaccines who are successfully immunized) by as much as 13% (from 73% at baseline) and raised logistics costs by up to \$0.06 per dose administered (from \$0.25 at baseline) due to increased bottlenecks, while reducing total costs by as much as \$0.15 per dose administered (from \$2.52 at baseline) due to lower open vial wastage. Primary containers with a greater number of doses per vial each improved vaccine availability by 19% and reduced logistics costs by \$0.05 per dose administered, while reducing the total costs by up to \$0.25 per dose administered. Changes in supply chain performance were more extreme in departments with greater constraints. Implementing a vial opening threshold reversed the direction of many of these effects.

CONCLUSIONS: Our results show that one size may not fit all when choosing a primary vaccine container. Rather, the choice depends on characteristics of the vaccine, the vaccine supply chain, immunization session size, and goals of decision makers. In fact, the optimal vial size may vary among locations within a country. Simulation modeling can help identify tailored approaches to improve availability and efficiency.

WEB: <http://dx.doi.org/10.1016/j.vaccine.2015.04.018>

IMPACT FACTOR: 3.49

CITED HALF-LIFE: 4.90

UW EDITORIAL COMMENT: Table 1 shows the vaccine characteristics in the supply chain model used in this study, while Figure 2 shows the supply chain performance metrics under each vaccine presentation scenario. Limitations to this study include the following: it did not address safety, including user errors associated with greater dose vials and inappropriate vaccine administration, and did not factor in the costs of waste disposal. Both are important considerations when considering new vaccine delivery strategies in low-resource settings.



3. USING THE WORLD HEALTH ORGANIZATION MEASLES PROGRAMMATIC RISK ASSESSMENT TOOL FOR MONITORING OF SUPPLEMENTAL IMMUNIZATION ACTIVITIES IN THE PHILIPPINES.

Ducusin MJ, de Quiroz-Castro M, Roesel S, Garcia LC, Cecilio-Elfa D, Schluter WW et al.

Risk Anal. 2015 May 7. [Epub ahead of print].

PMID: 25950923

ABSTRACT

In 2012, the World Health Organization Regional Committee for the Western Pacific Region (WPR) reaffirmed its commitment to eliminate measles and urged WPR member states to interrupt endemic measles virus transmission as rapidly as possible. In 2013, a large measles outbreak occurred in the Philippines despite implementation of measles elimination strategies including a nationwide supplemental immunization activity (SIA) in 2011 using measles- and rubella-containing vaccine and targeting children aged nine months to seven years. To prevent future measles outbreaks a new tool was developed to assess district-level risk for measles outbreaks, based on the WPR polio risk assessment tool previously applied in the Philippines. Risk was assessed as a function of combined indicator scores from four data input categories: population immunity, surveillance quality, program performance, and threat assessment. On the basis of the overall score, the tool assigned each district a risk category of low, medium, high, or very high. Of the 122 districts and highly urbanized cities in the Philippines, 58 (48%) were classified as high risk or very high risk, including the district of the Metro Manila area and Region 4A where the outbreak began in 2013. Risk assessment results were used to guide the monitoring and supervision during the nationwide SIA conducted in 2014. The initial tool drafted in the Philippines served as a template for development of the global risk assessment tool. Regular annual measles programmatic risk assessments can be used to help plan risk mitigation activities and measure progress toward measles elimination.

WEB: <http://dx.doi.org/10.1111/risa.12404>

IMPACT FACTOR: 1.97

CITED HALF-LIFE: 8.50

UW EDITORIAL COMMENT: Figure 2 shows the overall risk score breakdowns of very high-risk districts by category (population immunity, surveillance quality, program delivery performance, and threat/probability assessment) in the Philippines. Appendix B shows the distribution of Wilcoxon rank scores for districts' confirmed annual measles incidence by measles risk categories in the Philippines in 2013. While this tool gives a risk score, it is important to note that the drivers of measles are not homogeneous, and different regions with the same risk score may have different drivers of risk which must be considered for effective programs and policies.



4. THIRTY YEARS OF VACCINATION IN VIETNAM: IMPACT AND COST-EFFECTIVENESS OF THE NATIONAL EXPANDED PROGRAMME ON IMMUNIZATION.

Jit M, Huyen DT, Friberg I, Van Minh H, Kiet PH, Walker N et al.

Vaccine. 2015 May 7;33 Suppl 1:A233-9.

PMID: 25919167

ABSTRACT

INTRODUCTION: Countries like Vietnam transitioning to middle-income status increasingly bear the cost of both existing and new vaccines. However, the impact and cost-effectiveness of the Expanded Programme on Immunization (EPI) as a whole has never been assessed on a country level.

METHODS: Data on vaccine-preventable disease incidence and mortality from Vietnam's national surveillance was analysed to estimate the likely impact that vaccination in 1980-2010 may have had. Adjustment for under-reporting was made by examining trends in reported mumps incidence and in case-fatality risks for each disease. The same data were separately analysed using the Lives Saved Tool (LiST) to give an alternative estimate of impact. The financial cost of EPI in 1996-2010 was also estimated from the perspective of service provider.

RESULTS: National surveillance data suggests that up to 5.7 million diseases cases and 26,000 deaths may have been prevented by EPI. Analysis using LiST suggests that even more deaths (370,000) may have been prevented by measles and pertussis vaccination alone. The cost-effectiveness of EPI is estimated to be around \$1000-\$27,000 per death prevented.

CONCLUSION: Two separate approaches to assessing EPI impact in Vietnam give different quantitative results but a common conclusion: that EPI has made a substantial impact on mortality and represents good value for money.

WEB: <http://dx.doi.org/10.1016/j.vaccine.2014.12.017>

IMPACT FACTOR: 3.49

CITED HALF-LIFE: 4.90

UW EDITORIAL COMMENT: While the Expanded Programme on Immunization (EPI) has had clear positive results on mortality in Vietnam, different approaches show different magnitudes of effects. Table 2 shows both low and high figures (the lowest and highest results from the twelve linear regression models used) for the estimated EPI impact on cases and deaths due to measles, pertussis, diphtheria, and polio. Figure 2 shows the highest and lowest numbers of disease cases and deaths prevented by EPI from 1980 to 2010 based on national surveillance data. Finally, Table 3 outlines characteristics, strengths, and limitations of the two approaches used to retrospectively estimate program impact.



5. TYPHOID VACCINE INTRODUCTION: AN EVIDENCE-BASED PILOT IMPLEMENTATION PROJECT IN NEPAL AND PAKISTAN.

Khan MI, Pach A 3rd, Khan GM, Bajracharya D, Sahastrabuddhe S, Bhutta W et al.

Vaccine. 2015 Apr 30. pii: S0264-410X(15)00417-X. [Epub ahead of print]

PMID: 25937612

ABSTRACT

The World Health Organization (WHO) in 2008 recommended the use of currently licensed typhoid vaccines using a high risk or targeted approach. The epidemiology of disease and the vaccine characteristics make school-based vaccination most feasible in reducing typhoid disease burden in many settings. To assess feasibility of school-based typhoid vaccination, two districts in Kathmandu, Nepal and two towns in Karachi, Pakistan were selected for pilot program. Vaccination campaigns were conducted through the departments of health and in partnerships with not-for-profit organizations. In total 257,015 doses of Vi polysaccharide vaccine were given to students in grades 1-10 of participating schools. The vaccination coverage ranged from 39 percent (38,389/99,503) in Gulshan town in Karachi, to 81 percent (62,615/77,341) in Bhaktapur in Kathmandu valley. No serious adverse event was reported post vaccination. The coverage increased for vaccination of the second district in Pakistan as well as in Nepal. There was an initial concern of vaccine safety. However, as the campaign progressed, parents were more comfortable with vaccinating their children in schools. Supported and conducted by departments of health in Pakistan and Nepal, a school-based typhoid vaccination was found to be safe and feasible.

WEB: <http://dx.doi.org/10.1016/j.vaccine.2015.03.087>

IMPACT FACTOR: 3.49

CITED HALF-LIFE: 4.90

UW EDITORIAL COMMENT: Table 1 shows the social mobilization and communication plan for school-based typhoid vaccination in Nepal and Pakistan, which included awareness programs, print media, mass media, and social mobilization data collection. Partnerships and communication were two key elements of this project. This study emphasized the importance of a flexible communication strategy that could be adjusted in real time to respond to the needs and concerns of parents and other stakeholders. It was also noted that public schools (more common in Nepal) were easier to access for vaccine programs than private schools (more common in Pakistan), and suggested that requiring signed parental consent forms, while important, was associated with lower vaccination coverage.



6. EPIDEMIOLOGICAL AND ECONOMIC IMPACT OF MONOVALENT AND PENTAVALENT ROTAVIRUS VACCINES IN LOW AND MIDDLE INCOME COUNTRIES: A COST-EFFECTIVENESS MODELING ANALYSIS.

Paternina-Caicedo A, De la Hoz-Restrepo F, Alvis-Guzmán N.

Pediatr Infect Dis J. 2015 Apr 28. [Epub ahead of print]

PMID: 25923424

ABSTRACT

BACKGROUND: Competing choices of rotavirus vaccines make the selection of either vaccine difficult for health decision-makers. The objective of this study is to assess cost effectiveness of the monovalent and pentavalent rotavirus vaccines and impact on children deaths, inpatient, and outpatient visits in 116 low and middle income countries that represent ~99% of rotavirus mortality.

METHODS: A decision tree model followed hypothetical cohorts of children from birth up to 5 years of age for each country in 2010. Inputs were gathered from international databases, and previous research on incidence and effectiveness of monovalent and pentavalent vaccines. Costs were expressed in 2010 international dollars. Outcomes were reported in terms of cost per disability-adjusted life-year (DALY) averted, comparing no vaccination with either monovalent or pentavalent mass introduction. Vaccine price was assumed fixed for all world low and middle-income countries.

RESULTS: Around 292 thousand deaths, 3.34 million inpatient cases, and 23.09 million outpatient cases would occur with no vaccination. In the base-case scenario, monovalent vaccination would prevent 54.7% of inpatient cases and 45.4% of deaths. Pentavalent vaccination would prevent 51.4% of inpatient cases and 41.1% of deaths. The vaccine was cost-effectiveness in all world countries in the base case scenario for both vaccines. Cost per DALY averted in all selected countries was I\$372 for monovalent, and I\$453 for pentavalent vaccination.

CONCLUSION: Rotavirus vaccine is cost-effective in most analyzed countries. Despite cost effectiveness analysis is a useful tool for decision making in middle-income countries, for low-income countries health-decision makers should also assess the impact of introducing either vaccine on local resources, and budget impact analysis of vaccination.

WEB: <http://dx.doi.org/10.1097/INF.0000000000000727>

IMPACT FACTOR: 3.14

CITED HALF-LIFE: 6.90

UW EDITORIAL COMMENT: This study addresses a gap in the literature in that it is the first study to assess multiple, competing rotavirus vaccines. Table 3 shows the cost-effectiveness of monovalent and pentavalent vaccination programs in the 116 countries included in the study. In their discussion, the authors point out that while cost-effectiveness information is important for decision-makers, many countries do not have the expertise in their vaccine advisory committees to properly interpret the results of these studies and therefore struggle to use the information effectively to shape policy.



7. COSTS OF VACCINE PROGRAMS ACROSS 94 LOW- AND MIDDLE-INCOME COUNTRIES.

Portnoy A, Ozawa S, Grewal S, Norman BA, Rajgopal J, Gorham KM et al.

Vaccine. 2015 May 7;33 Suppl 1:A99-A108.

PMID: 25919184

ABSTRACT

While new mechanisms such as advance market commitments and co-financing policies of the GAVI Alliance are allowing low- and middle-income countries to gain access to vaccines faster than ever, understanding the full scope of vaccine program costs is essential to ensure adequate resource mobilization. This costing analysis examines the vaccine costs, supply chain costs, and service delivery costs of immunization programs for routine immunization and for supplemental immunization activities (SIAs) for vaccines related to 18 antigens in 94 countries across the decade, 2011-2020. Vaccine costs were calculated using GAVI price forecasts for GAVI-eligible countries, and assumptions from the PAHO Revolving Fund and UNICEF for middle-income countries not supported by the GAVI Alliance. Vaccine introductions and coverage levels were projected primarily based on GAVI's Adjusted Demand Forecast. Supply chain costs including costs of transportation, storage, and labor were estimated by developing a mechanistic model using data generated by the HERMES discrete event simulation models. Service delivery costs were abstracted from comprehensive multi-year plans for the majority of GAVI-eligible countries and regression analysis was conducted to extrapolate costs to additional countries. The analysis shows that the delivery of the full vaccination program across 94 countries would cost a total of \$62 billion (95% uncertainty range: \$43-\$87 billion) over the decade, including \$51 billion (\$34-\$73 billion) for routine immunization and \$11 billion (\$7-\$17 billion) for SIAs. More than half of these costs stem from service delivery at \$34 billion (\$21-\$51 billion)-with an additional \$24 billion (\$13-\$41 billion) in vaccine costs and \$4 billion (\$3-\$5 billion) in supply chain costs. The findings present the global costs to attain the goals envisioned during the Decade of Vaccines to prevent millions of deaths by 2020 through more equitable access to existing vaccines for people in all communities. By projecting the full costs of immunization programs, our findings may aid to garner greater country and donor commitments toward adequate resource mobilization and efficient allocation. As service delivery costs have increasingly become the main driver of vaccination program costs, it is essential to pay additional consideration to health systems strengthening.

WEB: <http://dx.doi.org/10.1016/j.vaccine.2014.12.037>

IMPACT FACTOR: 3.49

CITED HALF-LIFE: 4.90

UW EDITORIAL COMMENT: Figure 2 shows the total immunization program costs by component and by routine versus SIAs. Figure 3 shows routine vaccine costs by type of vaccine and GAVI eligibility status. Figure 4 shows the percentage of total SIA costs by vaccine for the 94 countries included in this analysis.



8. TRANSPORT NETWORKS AND INEQUITIES IN VACCINATION: REMOTENESS SHAPES MEASLES VACCINE COVERAGE AND PROSPECTS FOR ELIMINATION ACROSS AFRICA.

Metcalf CJ, Tatem A, Bjornstad ON, Lessler J, O'Reilly K, Takahashi S et al.

Epidemiol Infect. 2015 May;143(7):1457-66. Epub 2014 Aug 14.

PMID: 25119237

ABSTRACT

Measles vaccination is estimated to have averted 13.8 million deaths between 2000 and 2012. Persisting heterogeneity in coverage is a major contributor to continued measles mortality, and a barrier to measles elimination and introduction of rubella-containing vaccine. Our objective is to identify determinants of inequities in coverage, and how vaccine delivery must change to achieve elimination goals, which is a focus of the WHO Decade of Vaccines. We combined estimates of travel time to the nearest urban centre ($\geq 50\,000$ people) with vaccination data from Demographic Health Surveys to assess how remoteness affects coverage in 26 African countries. Building on a statistical mapping of coverage against age and geographical isolation, we quantified how modifying the rate and age range of vaccine delivery affects national coverage. Our scenario analysis considers increasing the rate of delivery of routine vaccination, increasing the target age range of routine vaccination, and enhanced delivery to remote areas. Geographical isolation plays a key role in defining vaccine inequity, with greater inequity in countries with lower measles vaccine coverage. Eliminating geographical inequities alone will not achieve thresholds for herd immunity, indicating that changes in delivery rate or age range of routine vaccination will be required. Measles vaccine coverage remains far below targets for herd immunity in many countries on the African continent and is likely to be inadequate for achieving rubella elimination. The impact of strategies such as increasing the upper age range eligible for routine vaccination should be considered.

WEB: <http://dx.doi.org/10.1017/S0950268814001988>

IMPACT FACTOR: 2.49

CITED HALF-LIFE: 6.50

UW EDITORIAL COMMENT: Figure 1 shows the effects of travel time on vaccination coverage, by age as a function of travel time and by hours traveled. A limitation of this study is that it does not distinguish between routine and supplementary immunization activities; SIAs are often implemented specifically to target rural populations. There are also suggestions for further research on whether transmission rates decrease with lower population density, and build-up of susceptibility.



9. TYPHOID FEVER VACCINATION STRATEGIES.

Date KA, Bentsi-Enchill A, Marks F, Fox K et al.

Vaccine. 2015 Apr 19. pii: S0264-410X(15)00481-8. [Epub ahead of print].

PMID: 25902360

ABSTRACT

Typhoid vaccination is an important component of typhoid fever prevention and control, and is recommended for public health programmatic use in both endemic and outbreak settings. We reviewed experiences with various vaccination strategies using the currently available typhoid vaccines (injectable Vi polysaccharide vaccine [ViPS], oral Ty21a vaccine, and injectable typhoid conjugate vaccine [TCV]). We assessed the rationale, acceptability, effectiveness, impact and implementation lessons of these strategies to inform effective typhoid vaccination strategies for the future. Vaccination strategies were categorized by vaccine disease control strategy (preemptive use for endemic disease or to prevent an outbreak, and reactive use for outbreak control) and vaccine delivery strategy (community-based routine, community-based campaign and school-based). Almost all public health typhoid vaccination programs used ViPS vaccine and have been in countries of Asia, with one example in the Pacific and one experience using the Ty21a vaccine in South America. All vaccination strategies were found to be acceptable, feasible and effective in the settings evaluated; evidence of impact, where available, was strongest in endemic settings and in the short- to medium-term. Vaccination was cost-effective in high-incidence but not low-incidence settings. Experience in disaster and outbreak settings remains limited. TCVs have recently become available and none are WHO-prequalified yet; no program experience with TCVs was found in published literature. Despite the demonstrated success of several typhoid vaccination strategies, typhoid vaccines remain underused. Implementation lessons should be applied to design optimal vaccination strategies using TCVs which have several anticipated advantages, such as potential for use in infant immunization programs and longer duration of protection, over the ViPS and Ty21a vaccines for typhoid prevention and control.

WEB: <http://dx.doi.org/10.1016/j.vaccine.2015.04.028>

IMPACT FACTOR: 3.49

CITED HALF-LIFE: 4.90

UW EDITORIAL COMMENT: Table 1 outlines the selected characteristics of currently available typhoid vaccines, while Table 2 summarizes the reported experiences with typhoid vaccination strategies. Community and school-based programs have been popular, as they offer the additional opportunity to offer an integrated package of services beyond typhoid vaccination. The authors also emphasize the importance of water and sanitation improvements as a long-term measure for decreasing the transmission of typhoid and other food- and water-borne diseases.



10. ESTIMATED IMPACT AND COST-EFFECTIVENESS OF ROTAVIRUS VACCINATION IN SENEGAL: A COUNTRY-LED ANALYSIS.

Diop A, Atherly D, Faye A, Lamine Sall F, Clark AD, Nadiel L et al.

Vaccine. 2015 May 7;33 Suppl 1:A119-25.

PMID: 25919151

ABSTRACT

INTRODUCTION: Rotavirus is the leading cause of acute severe diarrhea among children under 5 globally and one of the leading causes of death attributable to diarrhea. Among African children hospitalized with diarrhea, 38% of the cases are due to rotavirus. In Senegal, rotavirus deaths are estimated to represent 5.4% of all deaths among children under 5. Along with the substantial disease burden, there is a growing awareness of the economic burden created by diarrheal disease. This analysis aims to provide policymakers with more consistent and reliable economic evidence to support the decision-making process about the introduction and maintenance of a rotavirus vaccine program.

METHODS: The study was conducted using the processes and tools first established by the Pan American Health Organization's ProVac Initiative in the Latin American region. TRIVAC version 2.0, an Excel-based model, was used to perform the analysis. The costs and health outcomes were calculated for 20 successive birth cohorts (2014-2033). Model inputs were gathered from local, national, and international sources with the guidance of a Senegalese group of experts including local pediatricians, personnel from the Ministry of Health and the World Health Organization, as well as disease-surveillance and laboratory specialists.

RESULTS: The cost per disability-adjusted life-year (DALY) averted, discounted at 3%, is US\$ 92 from the health care provider perspective and US\$ 73 from the societal perspective. For the 20 cohorts, the vaccine is projected to prevent more than 2 million cases of rotavirus and to avert more than 8500 deaths. The proportion of rotavirus deaths averted is estimated to be 42%. For 20 cohorts, the discounted net costs of the program were estimated to be US\$ 17.6 million from the healthcare provider perspective and US\$ 13.8 million from the societal perspective.

CONCLUSION: From both perspectives, introducing the rotavirus vaccine is highly cost-effective compared to no vaccination. The results are consistent with those found in many African countries. The ProVac process and tools contributed to a collaborative, country-led process in Senegal that provides a platform for gathering and reporting evidence for vaccine decision-making.

WEB: <http://dx.doi.org/10.1016/j.vaccine.2014.12.065>

IMPACT FACTOR: 3.49

CITED HALF-LIFE: 4.90

UW EDITORIAL COMMENT: Table 6 shows the health benefits for 20 cohorts vaccinated over the period 2014-2033, while Table 7 shows the economic benefits for the same cohort in the same period. This study highlights the fact that data collection and analysis were done with local researchers, which increases the likelihood of uptake by local and national policy-makers.



APPENDIX: PUBMED SEARCH TERMS

(((((vaccine[tiab] OR vaccines[tiab] OR vaccination[tiab] OR immunization[tiab] OR immunisation[tiab] OR vaccine[mesh] OR immunization[mesh]) AND (logistics[tiab] OR supply[tiab] OR "supply chain"[tiab] OR implementation[tiab] OR expenditures[tiab] OR financing[tiab] OR economics[tiab] OR "Cost effectiveness"[tiab] OR coverage[tiab] OR attitudes[tiab] OR belief[tiab] OR beliefs[tiab] OR refusal[tiab] OR "Procurement"[tiab] OR timeliness[tiab] OR systems[tiab])) OR ("vaccine delivery"[tiab])) NOT ("in vitro"[tiab] OR "immune response"[tiab] OR gene[tiab] OR chemistry[tiab] OR genotox*[tiab] OR sequencing[tiab] OR nanoparticle*[tiab] OR bacteriophage[tiab] OR exome[tiab] OR exogenous[tiab] OR electropor*[tiab] OR "systems biology"[tiab] OR "animal model"[tiab] OR cattle[tiab] OR sheep[tiab] OR goat[tiab] OR rat[tiab] OR pig[tiab] OR mice[tiab] OR mouse[tiab] OR murine[tiab] OR porcine[tiab] OR ovine[tiab] OR rodent[tiab] OR fish[tiab])) AND (English[LA]) AND ("2015/04/15"[PDAT] : "2015/05/14"[PDAT]))

*On May 25, 2015, this search of English language articles published between April 15, 2015 and May 14, 2015 and indexed by the US National Library of Medicine resulted in 211 unique manuscripts.

