The broader economic benefits of measles supplemental immunization as a delivery platform for other childhood interventions in India

A proposal submitted to the World Health Organization
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Executive Summary

Background

Particularly in low- and middle-income countries (LMICs), immunisation programs have played a catalytic role in shaping health system infrastructure. Since the inception of WHO’s Expanded Programme on Immunization in 1974, implementation of routine vaccination in LMICs has stimulated training of personnel, establishment of a cold chain, enhancement of service delivery capacity, initiation of monitoring practices to ensure quality and safety of vaccines and injections, and improved disease surveillance. This contribution is underappreciated in traditional economic evaluations that generally consider health infrastructure as given. Furthermore, economic evaluations of mass vaccination campaigns (often referred to as supplemental immunisation activities, or “SIAs”) have rarely considered SIAs as a potential health services delivery platform for multiple interventions. Instead, the health system impact of SIAs has been viewed almost exclusively in negative terms, due to their potential to detract from provision of routine services.

Although their primary purpose is delivery of a specific vaccine, SIAs can also be used to strengthen child health services. In response to WHO’s request for proposals, we propose to develop a novel tool to assess the broader economic and health benefits of delivering a combination of interventions integrated onto the same vaccination platform. We will take as a case study current Indian SIAs to deliver a second dose of measles-containing vaccine (MCV2). The Indian SIAs are being rolled out in 14 states with <80% first-dose coverage of measles vaccine (MCV1) between 2010 and 2012 and will target 135 million children age 9 months to 10 years. As currently planned, the Indian states are not making widespread use of the SIA platform to deliver other interventions. Linking SIA campaigns with other interventions could have a very large scope of impact, and especially since the reach of health services in many of these states is poor, could substantially increase reach to the underserved and improve equity of access and health outcomes.

Furthermore, since the causes of childhood death are often multifactorial and clustered in a given population, interventions to reduce multiple causes of death may have effects that are substantially different from the additive effect of each intervention considered in isolation. This may have major implications on the value for money of both the SIA itself as well as the other interventions delivered on the same platform.

Objectives

We propose to work with Indian researchers and policymakers to develop an innovative tool for SIA planning, which gives explicit consideration to the possibility of using measles SIA as a delivery platform for other health interventions. We will take the Indian measles SIAs as a case study.
1. **Development of a decision analysis model.** The model will assess the costs, effects and cost-effectiveness of alternative SIA strategies with a particular emphasis on the synergies in costs and effectiveness associated with a common delivery platform. It will also consider equity across socioeconomic groups (wealth quintiles) and area of residence (urban/ rural).

2. **Refinement of the decision analysis tool to inform policy discussions, in collaboration with stakeholders in India.** We plan to address a wide range of relevant factors such as feasibility and logistics, affordability and budget impact either in the formal analysis, or qualitatively, as most appropriate.

**Methods**

We hypothesise that the value for money offered by the SIA platform depends importantly on the judicious choice of add-on interventions, and that program design can be substantially improved by consideration of intervention synergies in costs and effects. We will evaluate total costs and the specific benefits of delivering several interventions within a single platform in terms of cost savings from sharing resources, as well as total effectiveness and the specific benefits as a result of targeting multiple competing causes of childhood mortality. This approach will allow proper quantification of integrated intervention platforms rarely assessed in cost-effectiveness analyses and analysis of equity impacts.

**Anticipated Outcomes and Deliverables**

1. A peer-reviewed article in an economic journal describing methodological advances related to modelling the broader economic benefits of measles SIAs;
2. A peer-reviewed article in a public health journal describing results and recommendations for measles SIAs in selected Indian states, considering efficiency, equity, and a variety of other factors;
3. A decision analysis tool for SIA planning available for future use in India, and for adaptation and export to other contexts such as Sub-Saharan Africa.
1. Background

Standard cost-effectiveness analyses rarely capture the synergies in costs and effects of interventions commonly delivered together, even though combining several interventions onto the same integrated delivery platform can enable substantial savings. It can also bring benefits which are potentially greater than the additive contribution of each intervention. The cost-effectiveness of a specific immunization platform, such as routine immunization or vaccination catch-up campaigns, can be strongly influenced by the appropriate choice of add-on prevention/treatment interventions which are included onto the platform delivery. This is due both to cost savings from using a common delivery platform, as well as interactions in the effects of each intervention due to competing risks, heterogeneities in the causes of mortality and potentiation/antagonism between their effects. However, such a platform evaluation approach which allows proper quantification of integrated interventions is rarely used in economic evaluations of health interventions.

Furthermore, efficient allocation of resources in the standard economic sense, determined by maximization of the cost-effectiveness in terms of US$ per death averted, does not provide insight into equity, which can limit the utility of cost-effectiveness information to policy makers faced with concerns of fairness, such as the right to a basic level of health and health care. Concerns of equity, understood as fairness in the distribution of coverage (access) and projected impact (outcomes), are rarely addressed in traditional cost-effectiveness analyses.

The Millennium Development Goal 4 (MDG4) aims at reducing under-five mortality by two-thirds between 1990 and 2015 [1]. However, despite progress with a decline from 11.6 million deaths in 1990 to 7.1 million deaths in 2010 [2], mortality of under-five children remains unacceptably high [2]. India counted about 1.6 million deaths for under-fives in 2011 [2]. Measles-related deaths accounted for 1 to 5.2% of under-five children deaths in 2000 [3-6]. The Global Burden of Disease (GBD) study estimated that 556,000 people died from measles in 2001 [3]: the Sub-Saharan Africa and South Asia World Bank regions [7] comprised respectively 63% and 26% of the measles death toll in 2001 [3].

With the momentum arising from the MDG4, the World Heath Assembly adopted in 2003 UNICEF’s resolution to reduce by 50% deaths attributable to measles in 2005 compared to 1999 levels [8]. In May 2005, the World Health Assembly officially endorsed a further goal to reduce measles-related deaths by 90% globally between 2000 and 2010. The Measles Initiative [9], a broad consortium of leading global health agencies launched in 2001, provides support to measles-burdened countries in order to achieve measles-mortality reduction goals. With the experience of both the WHO’s Expanded Programme on Immunization (EPI) launched in 1974 [10] and the UNICEF’s Universal Childhood Immunization by 1990 Initiative (UCI) launched in 1984 [11], and benefiting from the momentum instilled by the creation of the Global Alliance for Vaccines and Immunization
(GAVI) in 1999 [12], the Measles Initiative has been focusing on supplementing routine immunization of children [13,14] by a recommended second dose opportunity for measles vaccine [15,16].

Before a live attenuated measles vaccine was first licensed in 1963, measles was an unavoidable risk of early life with almost every adolescent being infected by the age of adulthood [17]. Recently, researchers at the WHO reported the achievement of the 2005 measles mortality reduction goal, based on results from a natural history model [18], as well as continued successful trends in the decrease of worldwide measles mortality towards the 2010 measles mortality reduction target [19]. The WHO estimated a 78% decrease of measles-related deaths for the period 2000-2008 with a total of 164,000 deaths attributable to measles worldwide in 2008 [20]: the Africa region saw a 92% decline from 371,000 (95% C.I.: 270,000-483,000) to 28,000 (95% C.I.: 19,000-40,000) deaths; the South-East Asia region saw a 46% decline only from 234,000 (95% C.I.: 169,000-309,000) to 126,000 deaths (95% C.I.: 90,000-168,000) [20]. About 25,000 children died from measles in 2008 in Africa [20]. India was the highest burdened country for measles with about 80,000 measles deaths in 2008 [20].

In countries with routine immunization systems that have achieved good population coverage, characterized by WHO as routine coverage of at least 80% for three consecutive years, the second dose of measles vaccine is usually included in the vaccination schedule and administered to children before school entry [16]. Conversely, in countries where routine immunization services have not yet met these targets, an opportunity for a second dose of measles vaccine tends to be offered through supplemental immunization activities (SIAs) [16,21]. During SIAs, children and adolescents of different age ranges who often do not regularly have access to health services are targeted regardless of their previous history of measles vaccination. As implemented by the Pan American Health Organization (PAHO), periodic SIA campaigns occur across different geographical locations with the use of various outreach strategies [21].

SIAs have been vastly and successfully implemented by PAHO since the 1990s, which contributed to the elimination of the endemic transmission of measles in most Latin American countries [22]. The same strategy has been exported and adapted to sub-Saharan Africa and could appear as an explanation for the recently reported drops in measles deaths on the African continent [23-29]. In contrast, as of prior to 2010, India, the country with the highest measles burden globally, was the only high measles mortality country among the high measles mortality countries not to have introduced measles SIAs [30-32].

SIA mass campaigns can last a few days to a few weeks. Capitalizing on the experience gained in the Americas, notably in Mexico with the “diagonal” provision of a basic package of health services through the National Health Weeks [33], SIAs can also incorporate the delivery of other child interventions such as vitamin A supplementation, the distribution of
deworming medicines, oral polio vaccines, and/or insecticide-treated bed nets (ITNs) etc, most notably in Sub-Saharan Africa [34]. Often, these campaigns are integrated within the periodic Child Health Days [35]. In many Sub-Saharan African countries such as Ethiopia, ITNs have been distributed through the channel of these SIA campaigns [36,37], which has enabled an impressive scale-up of ITNs in some countries [38]. Most research to date has focused on the cost-effectiveness of the whole SIA delivery platform [42-50], with little attention to the broader economic and health benefits of delivering a combination of interventions integrated onto the same SIA platform [39-41].

The National Technical Advisory Group on Immunization in India recommended in 2008 that a second dose of measles-containing vaccine (MCV2) should be delivered through routine immunization programmes in states with ≥80% coverage of the first dose of measles-containing vaccine (MCV1) or through mass vaccination campaigns in states with <80% coverage of MCV1 [51]. Fourteen states with routine MCV1 coverage of less than 80% have been selected for campaign-based provision of a second dose of measles vaccine: Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Rajasthan, Tripura and Uttar Pradesh. The SIAs are set to be rolled out between 2010 and 2012 and will target 135 million children aged 9 months to 10 years. As currently planned, states are not making widespread use of the SIA platform to deliver other interventions for child health or maternal health. In this context, linking campaigns with other interventions has a very large scope of impact. Since the reach of health services in many of these states is poor, an improved SIA platform design has the potential to increase reach to the underserved and improve equity of access and health outcomes. Results from this project would be used to develop insights related to the design of future Indian measles SIAs. The tools will be adaptable to aid in SIA planning in other contexts.

In the proposed work, we will analyze the prospective cost-effectiveness of the SIA campaign delivery platform in India from the perspective of the health budget of selected Indian states. We will assess the cost-effectiveness of the SIA platform while looking at effectiveness and costs for a cluster of interventions added on to measles vaccine. This will involve evaluating the benefits of delivering several interventions within a single platform in terms of cost savings from sharing resources, as well as benefit multipliers as a result of targeting multiple competing causes of childhood mortality. This approach is novel as it departs from the traditional approach of assessing the cost-effectiveness of a single health intervention, such as measles vaccine only. As with pioneering work on the cost-effectiveness of surgery by Debas and colleagues [52], which presented estimates for costs for different levels of surgical care including community clinic, district hospital, etc., our analysis emphasizes the health delivery platform as the unit of analysis, and therefore has more relevance to the decision maker. Finally, we will assess the equity impact associated with the implementation of the SIA platform by determining the distribution of the health benefits across the wealth strata of the population.
Our team proposes to capitalize on their expertise in economic evaluation of immunisation programmes to develop the previously described line of work. The results of the analysis will have important practical implications for India’s decision makers in terms of how to optimize the current SIA platform with adequate child interventions, in order to achieve greater health outcomes at lower costs, and to target those most in need. Further, along with our methods, our approach will be easily exported to other countries in order to inform policy makers, most notably in Sub-Saharan Africa.

Our approach aims to quantify the efficiency and equity gains in combining several interventions, and hence has potential applications far beyond measles SIAs, and may encourage the development of more cost-effective and equitable means of integrated health care delivery.

2. Objective

We will develop an economic evaluation tool to aid decision makers in considering the broader economic and health benefits of modifying an SIA platform to deliver an expanded set of child health interventions, taking the Indian measles SIA as a case study. In particular, our aim is to engage with policymakers in India to develop an innovative tool to measure and present the broader economic benefits associated with using vaccination, in this case a measles SIA, as a delivery platform for other childhood interventions. Specifically, we have two main aims:

- **Aim 1**: the development of a decision analysis model. The model will incorporate costs, health benefits and broader outcomes or “spillovers”. In particular, it will assess the cost-effectiveness of alternative SIA strategies with a particular emphasis on the synergies in costs and effectiveness associated with a common delivery platform, and equity understood as fairness in the distribution of coverage (access) and projected impact (outcomes). Comparison, when possible, with distribution coverage of routine services will be assessed.

- **Aim 2**: to work collaboratively with decision makers in India to further refine the decision analysis tool so that it is useful in informing policy discussions, considering measles SIAs as a case study. Factors such as feasibility and logistics, affordability and budget impact will be discussed through the formal analysis and qualitatively.
3. Methods

3.1. Review of the literature and surveys

We will review both existing peer-reviewed articles, the grey literature and household surveys most relevant to the proposed work. The review will encompass 4 themes.

- **Theme 1**: the economic evaluation of vaccination programs and campaigns in India, with a focus on measles immunization. We will collect primary information on costs, health outcomes and cost-effectiveness of measles vaccination. We will also collect information on the costs of mass vaccination campaigns, such as the polio campaigns, with a particular attention to the human and technical resources involved, and the savings realized as several combined interventions are integrated onto the delivery platform.

- **Theme 2**: the burden of disease and risk factors for children under age 10 in India. We will review on the burden of measles, the status of current measles mortality reduction and elimination goals. We will collect information on the burden of other important childhood diseases including pneumonia, diarrhea, malaria, and worm infections; and on the burden and distribution of risk factors including malnutrition and nutrient deficiencies. The team will capitalize on academic ties with the teams of the ongoing GBD study conducted at the University of Washington, and the Million Deaths Study in India conducted at the University of Toronto.

- **Theme 3**: the effectiveness of the child health interventions to be included onto the SIA platform. A starting point will be the work produced by the Child Health Epidemiology Reference Group (CHERG) and the Lives Saved Tool (LiST), which will enable identifying which add-on interventions should be added onto the SIA platform.

- **Theme 4**: the distribution in the Indian population (in specific different states, among wealth quintiles or urban versus rural location) of the coverage of different childhood interventions. The Indian DLHS household survey [53] and the 2010 UNICEF coverage survey [54] will guide a substantial part of our thinking.

The review will identify the gaps in our existing knowledge and highlight where data collection will be necessary to pursue the proposed work.
3.2. Stakeholder involvement

We will build strong relationships with local stakeholders, from a few selected Indian states where the work and the analysis will be conducted. We will engage substantially with technical and operational groups of the Ministries of Health. We will also consult with the technical advisory groups, the Expanded Programme on Immunization (EPI) managers of WHO and UNICEF, and other programs relevant to child and maternal health outside of EPI.

Due to the short time period between launch and submission of WHO’s RFP, we have not yet identified all project partners. We are presently seeking to expand the group to include further collaborators.

Interviews will be conducted to determine the stakeholders’ opinions on the appropriate add-on interventions to be integrated onto a common SIA delivery platform. We will also ask about the range of technical and operational criteria relevant to delivery of these interventions through a common SIA platform and not considered in standard cost-effectiveness analyses. The interviews will be conducted via telephone or meetings in India. We will develop a survey instrument tailored specifically to the interviewees.

We will also consult stakeholders to determine what types of outcomes (e.g. cost savings, cost-effectiveness, equity, productivity changes) are most useful for decision making, as well as the most helpful ways of presenting them.

3.3. Data collection

We will assess whether sufficient data is available for analysis on the four themes outlined in part 3.1. Missing gaps will be filled through collaborative data collection with the local stakeholders. Where no primary data are available or can be collected, we will elicit subjective distributions on the relevant parameters from local experts.

4. Analysis

4.1. Stakeholder Support

Interviews will be analyzed, both qualitatively and quantitatively, to assess stakeholder support of the interventions to be included onto the SIA delivery platform, in complement to the formal evidence-based analysis.
4.2. Cost effectiveness model

We will develop a cost effectiveness (CE) model for the analysis, inspired by previous work realized by some team participants. The CE model will include two components: a costs component and a health benefits component. The CE model will consider two scenarios:

- **Strategy 1**: the SIA platform delivers measles vaccine (MCV) only, to children under 10 years.

- **Strategy 2**: the SIA platform delivers MCV + other child interventions, to children under 10 years.

The selection of the other child interventions will depend on the stakeholders’ opinions and on the potential health benefits and cost savings their addition brings to the SIA platform. Candidate interventions are: vitamin A supplementation, deworming medicines (Albendazole and Mebendazole), insecticide-treated bed nets, zinc supplementation, nutritional supplements, active promotion of oral rehydration therapy, BCG, rubella, and OPV vaccination, and catch up and booster strategies for DTP vaccination. Maternal interventions such as iron supplements have also been distributed in some SIAs.

**Costs component.** This will involve incremental costing, in other words we will estimate the additional societal resources required for implementing the SIA platform, Strategy 1 or Strategy 2, as compared to status quo. In particular, the model will incorporate the potential savings that can be made while using a common platform for the delivery of multiple interventions. Furthermore, all possible combinations of interventions will be compared against each other, so that the most cost-effective combinations for any given threshold can be determined with reference to the cost-effectiveness frontier (i.e. all options that remain after dominated options are eliminated).

The cost estimates will rely on costing data from WHO’s Accelerated Disease Control Team, located in the Department of Immunization, Vaccines & Biologicals (IVB), who will share programme budget data and general SIA costing data, and SIA coverage data. These data will be complemented by programme data coming from Indian colleagues.

Within the costs component, the costs will be calculated using WHO’s ingredients approach and be categorized by the resources needed used to produce the different interventions delivered by the platform. The costs component will also estimate the health care savings made in avoiding hospitalization days due to specific diseases and conditions. Finally, we will quantify the productivity gains and economic community externalities associated with the disease burden reduction.
Health benefits component. It will assess the health benefits conferred by the implementation of the SIA platform, per age group (0-4 and 5-9 age groups) and gender, at the state level. The review of part 3.1 will provide inputs into the health benefits component in terms of the burden of disease and risk factors, and the effect sizes of the different interventions considered. As mentioned, the LiST approach will be considered as well as recent important reviews and analyses on the effect sizes of interventions including measles vaccination [55], vitamin A supplementation [55,56], zinc supplementation [57], oral rehydration therapy [58], deworming medications [59], insecticide-treated bed nets [60], which will be adjusted to the Indian context. We will also model the value of incorporating relevant vaccination strategies as described above.

A novel feature of our approach is that we will consider interactions between the effects of different interventions on mortality. This approach will allow proper quantification of integrated intervention platforms which are rarely assessed in cost-effectiveness analyses. In particular, we will seek to capture three kinds of interactions:

1. Competing risks: our model will capture the reality that mortality reduction from a particular cause may increase the mortality rate due to other causes, since a child prevented from dying of one cause may still die in childhood from any other cause. The benefits of combining several interventions can bring benefits that are greater than the additive contribution of each intervention separately.

2. Heterogeneities in the distribution of causes of mortality: we will consider the distribution of competing causes of childhood mortality, rather than assuming that the risk of mortality is uniformly distributed. For instance, if the risk of death due to measles and diarrhea are associated, then the benefit of reducing both risks in the same person may be greater than the sum of the independent benefit of reducing each risk.

3. Potentiation and antagonism in the effect of interventions: we will consider the possibility that the effect of two interventions on a single cause of death (for example, measles vaccination and vitamin A supplementation on diarrhea mortality) may be greater or less than the additive effect of each separate cause due to interactions in the causal chain of events leading to mortality.

Health benefits will be assessed in natural units (cases and deaths averted) and monetary units. Traditional metrics including Years of Life Saved (YLS) and disability-adjusted-life-years (DALY) averted [61] will also be used. We will also assess the impact of the interventions on the government health care budget. Most importantly, we will seek stakeholder advice regarding which kind of outcome measures are most useful.
Finally, special attention will be paid to quantify the fuller spectrum of morbidity and disability potentially averted by the SIA platform, which, for example, in the case of soil-transmitted-helminth infections, includes developmental and behavioral aspects especially in young children [62] and cognition [63].

The cost-effectiveness model will be used to provide estimates of the total costs and health benefits for Strategy 1 and Strategy 2 (with different clusters of interventions). It will produce aggregate estimates for Strategies 1 and 2 (and its different combinations) with metrics judged suitable by Indian decision makers as well as the two usual metrics of US$ per Year of Life Saved and US$ per DALY.

4.3. Equity

Efficient allocation of resources in the economic sense, or maximizing the cost-effectiveness in terms of US$ per YLS or DALY averted, is insufficient to policy makers faced with concerns for fairness, such as the right to a basic level of health care [64].

The analysis will therefore also consider equity, understood as fairness in the distribution of coverage (access) and projected impact (outcomes). Equity of coverage, will be examined using DLHS-3 data [53] and UNICEF coverage survey data [54]. The DLHS-3 data is available at district level, while the UNICEF coverage survey is available at state level. Both sources give us state-specific estimates of current coverage for vaccines and the other interventions considered in the analysis, separable by wealth quintile, urban-rural status, sex of child, and other social group markers. From this, we can calculate to whom the “additional” SIA coverage accrues, making it possible for decision makers to weight these gains in different ways. Equity of projected impact will be based on an understanding of the distribution of the burden of disease by wealth quintile as described in the discussion of competing mortality above. This will enable us to quantify the benefits of the intervention across quintiles, to consider the impact of synergies in intervention delivery, and to model quintile-specific cost-effectiveness.

5. Deliverables

- Publish two manuscripts: (i) one in a methodological journal describing our approach to assessing the broader economic benefit of using vaccination as a platform for other childhood interventions, and (ii) one in a public health journal on the specific results and policy recommendations of this analysis in India. The papers will be written with our collaborators.
• Design a SIA platform decision analysis tool available to Indian decision makers.

In future work, we hope to explore how to apply our methodology to other settings and platforms, notably in Sub-Saharan Africa. As part of this, we plan to make the tool more accessible to a wide range of users, so that it can be exported to a variety of settings.

6. Timeline

Phase 1: November – December 2011

- Finalize administrative details
- Review of the literature and surveys
- Engage stakeholders

Phase 2: January – April 2012

- Interview stakeholders
- Data collection

Phase 3: May – October 2012

- Data analysis
- Write two papers, as described in part 5.
- Presentation of the results to stakeholders and at international conferences.
Annex I: references


**Annex II: team profiles**

Stéphane Verguet
Stéphane Verguet is a senior fellow in the Department of Global Health, at the University of Washington, after completing a postdoctoral fellowship at the university’s Institute for Health Metrics and Evaluation (IHME). Since joining the University of Washington in 2009, he has been involved in several areas of work within the Disease Control Priorities Network (DCPN) project. He works on the economic evaluation of integrated child health and immunization campaign delivery platforms, including supplementary immunization activities in sub-Saharan Africa and South Africa, and their impact on health systems. In addition, he contributes to the Global Burden of Disease (GBD) study, focusing on estimating the burden of vaccine-preventable diseases, specifically measles. He graduated from the Ecole Polytechnique in France, and holds a PhD in Mechanical Engineering and a Master in Public Policy from the Goldman School of Public Policy, both from the University of California, Berkeley.

Mira Johri
Mira Johri is Associate Professor in the Department of Health Administration and Researcher in the International Health Unit, University of Montreal. Her research aims to contribute to global health and development by strengthening the capacity to evaluate, prioritise and improve the efficiency of health-related strategies and interventions. It makes use of quantitative economic evaluation methods and aims to better integrate concerns for equity and fairness—in addition to more commonly studied criteria such as those related to efficiency—into the formation of health policies. Mira is particularly interested in interventions to improve maternal and child health in low- and middle-income countries,
particularly India. In 2009-2010, she was a visiting researcher at the World Health Organisation, Geneva, where she initiated an analysis of the “Generalised cost-effectiveness of existing, underused and new childhood vaccines.” The analysis is currently underway and conducted jointly by the unit for Cost-effectiveness and Priority Setting, Department of Health Systems Financing, and the Department of Immunisation, Vaccines and Biologicals.

Mark Jit
Mark Jit is a senior modeller and health economist working in the Health Protection Agency of the United Kingdom. His role is to assess the impact and cost-effectiveness of a range of infectious disease interventions, particularly immunisation programmes, in order to inform policy making. He has also been commissioned to undertake a number of modelling projects for the World Health Organisation (both in Geneva and for regional offices), including reviewing the literature on the broader economic impact of immunisation, assessing the cost-effectiveness of rotavirus vaccination in Armenia, comparing models of human papillomavirus vaccination used in low and middle income countries, as well as estimating the costs of scaling up hepatitis B birth dose immunization globally.

Dean Jamison
Dean Jamison is Professor in the Department of Global Health at the University of Washington. In 2006-2008 he served as the T. & G. Angelopoulos Visiting Professor of Public Health and International Development in the Harvard Kennedy School and the Harvard School of Public Health. He concurrently served as a Professor in Global Health Sciences at the University of California, San Francisco. Before joining the UCSF and Harvard faculties, Jamison had been at University of California, Los Angeles (1988-2006) and previously at the World Bank (1976-1988). While at the World Bank he served as a senior economist in the research department, division chief for education policy, and division chief for population, health and nutrition. In 1992-93 he temporarily rejoined the World Bank to serve as Director of the World Development Report Office and as lead author for the Bank’s 1993 World Development Report, *Investing in Health*. His publications are in the areas of economic theory, public health and education. Jamison recently led the Disease Control Priorities Project, for which he was senior editor of *Disease Control Priorities in Developing Countries*, 2nd edition, and an editor of *Global Burden of Disease and Risk Factors*, both published by Oxford University Press in 2006. Jamison studied