



Report on the technical workshop on

The Economics of Vaccination in Low and Middle Income Countries:

29th & 30th October 2003,

The Ambassadors Hotel, Bloomsbury, London

Hosted by Dr Julia Fox-Rushby (LSHTM)

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PURPOSE OF THE MEETING

This technical meeting was intended to draw together several economists and other technical experts working rather independently on questions related to immunization, across a range of academic and policy settings around the world to share work in progress and discuss their current work and thinking. This rare opportunity for constructive debate, in a collegial atmosphere, was designed to explore:

- A range of methodological issues emerging from the growing body of work on the economics of vaccination;
- The potential contribution of current economics research to policy- and program-level decision-making concerning vaccination;
- The gaps in knowledge and potential contributions of future research designed to inform policy-making.

PROCESS OF THE MEETING

Thirty participants from more than 20 organisations participated in the two-day meeting (see Annex 1 for list of participants). A total of 13 papers were divided into the following themes;

- the efficiency of investing in vaccination;
- equity of vaccination and system effects;
- vaccination financing.

The meeting followed the “rules” of the UK Health Economics Study Group. Papers were circulated and read in advance. At the meeting each paper, along with commentary, was presented by a discussant. Authors were permitted to provide clarifications, and the comments and questions were taken from the wider group. The agenda and assignment of discussants is shown in Annex 2.

The sections below briefly highlight the main methodological issues that arose during the rich discussion; indicate the potential links between those issues and policy questions; and identify key gaps in current knowledge. Annex 3 presents summaries of each paper and the corresponding discussion.

THE EFFICIENCY OF INVESTING IN VACCINATION

The paper on efficiency ranged from micro level analysis of programmes that focused on the range of costs to the returns on investment from immunization on improving health and economic well-being over time. Finally, bargaining theory was used to consider the incentives facing national and international agencies given information on the cost-effectiveness of adopting control or eradication policies. Box 1 shows the grouping of papers collected under the theme of efficiency of investing in vaccination.

Box 1: Papers presented on the efficiency of investing in vaccination

The 'cost' in cost-effectiveness analysis

- * "Variation in the costs of delivering routine EPI and treatment of vaccine preventable disease in Peru; implications for cost-effectiveness analysis" Walker et al
- * "Predicting the source of variation in costs associated with pneumococcal disease in Brazil, Chile and Uruguay" Constenla
- * "Immunisation programme costs in relation to coverage" Brenzel

New modeling approaches for cost-effectiveness analysis

- * "The cost-effectiveness of accelerated vaccination activities against neo-natal tetanus in Loralai District, Pakistan" Griffiths et al
- * "The cost-effectiveness of adding HBV, Hib and Rotavirus vaccines and/or expanding existing routine vaccination services in Bangladesh and Peru" Fox-Rushby et al

Economic benefits of disease control and eradication

- * "The economic benefits from investing in child health vaccination" Bloom et al
- * "The Economics of Eradication versus Control of Infectious Diseases" Barrett

The "cost" in cost-effectiveness

To understand whether investment in vaccination is efficient requires understanding both costs and consequences of changing current vaccination practice. The first three papers considered different aspects of cost but all touched on the unifying theme of the need to describe and explain variation in costs both in the provision of vaccines and treatment of vaccine-preventable diseases. In looking at how costs vary by location, over time or by level of production, the papers address the range of issues relevant for interpretation and decision-making based on cost-effectiveness analyses which will impact the resources required to scale-up interventions. It is important to understand whether and how costs vary and encourage researchers to move away from only adopting simplifying assumptions that do not allow cost to vary by location, time, or level of production. Understanding cost variations helps to estimate of the impact of adopting global policies at the national level and national policies at the district level, and in determining whether cost-effectiveness ratios are generalizable. Importantly, what we learn about the sources of cost variations – that is, what drives cost – may be helpful in identifying ways to improve the efficiency of service delivery. The first three papers contributed to this understanding by exploring intra- and inter-country variation, as well as variation over time and by coverage. All also attempted to separate out both price and quantity variables.

The issue of incremental or full costing was also raised in the meeting following differences in both definitions and methods of costing across the papers presented. The value of costing existing services rather than only additional services was considered likely to improve understanding variation both over scales of production and across settings as the resource basis on to which new services are added or expanded is specified. This is most likely to be useful to those considering the relevance of setting or adopting global policy recommendations.

Issues related to data constraints were prominent in the research. All three research efforts went to extraordinary lengths to access basic data on cost; each involved new and detailed studies in individual institutions. The problems with data availability brought to light several issues: the need for more data, and more accessible data; and the high cost of gaining representative samples of provider units to cost single treatments or delivery mechanisms (i.e., immunization, separated from the delivery of other health services). Discussion of the data problems stimulated consideration of efficient research strategies, which included more secondary analysis of existing data sets and the addition of targeted questions to other surveys. Both of these strategies require some centralized communication system about future research plans.

Research on production and cost functions for delivery of immunization services would generate knowledge to inform decisions about whether to expand existing vaccination programmes. The first three papers also highlighted the potential for, and paucity of, such research. Brenzel highlighted that assumptions of constant returns to scale are unlikely to hold, so multiplying costs up or down in a linear way may drastically over- or underestimate costs. (Equally, the assumption that the impact on disease is proportional to the number of children vaccinated is also likely not to hold.) There is need for additional work in this area.

New modeling approaches for cost-effectiveness analysis

Taking a somewhat more dynamic approach to cost-effectiveness analysis than has traditionally been the case, the following two papers presented two new models: one for neo-natal tetanus in a district of Pakistan (Griffiths et al) and another to examine options of expanding routine vaccination and/or adding new vaccines to the existing schedule in three districts in Peru and Bangladesh (Fox-Rushby et al). Both papers provided innovative models. However, the latter model was particularly unusual because it incorporated several vaccine preventable diseases and therefore allows competing and complementary vaccination policies to be considered for the same population. The challenges for the future are to improve both the complexity of models (which means they are more able to reflect reality) as well as to use empirical evidence and help interpret results and methods for policy-makers.

Economic benefits of disease control and eradication

The next two papers considered the potential relationship between vaccination with height/weight gain (a proxy for health) and future earnings; and the desirability and incentives facing national and international policy makers with respect to the goal of eradication vs. control of vaccine preventable disease.

The timeframe of analysis - both time horizons adopted and value of successive years - becomes critical in affecting the desirability of present investment and potential futures of populations. Adopting a longer time frame increases the possibility that vaccination can be viewed as an economic investment with economic returns, as opposed to “merely” consumption benefits of saving life-years or, as with the case of eradication, saving future costs of control programmes to an indefinite future (subject to the rate of discounting). However, levels of uncertainty also increase with time and this may itself impact on decision-making in the short run. The role of using existing, and investing in new, longitudinal studies was highlighted as a potential research tool to aid further analysis.

A game theoretic approach was presented by Barrett to highlight the conflicting incentives facing different agencies at national and international levels in deciding to adopt eradication strategies. A future direction for the research would be to link it to bargaining theory as well as to empirical examples of the cost-effectiveness of control versus eradication that account for uncertainty of eradication.

EQUITY OF IMMUNISATION AND SYSTEM EFFECTS

Three papers were selected on equity of immunization and system effects to reflect innovations in evaluative approaches: assessing the relationship between equity and immunization coverage over time; and evaluation of health reforms and health financing strategies on immunization outcomes.

Box 2: Papers presented on equity of immunization and system effects

- * “Equality and Sustainability” Delamonica et al
- * “Improving Vaccination Coverage for the Poor: Public-Private Partnership in Cambodia” Schwartz & Bushan
- * “Decentralisation and Public Services: The case of immunisation” Khaleghian

Equity issues

A long standing concern in the evaluation of vaccination programmes has been the over-reliance on indicators of coverage and numbers of vaccinations delivered, at the expense of indicators that shed light on the distribution of benefits. Whilst there have been calls for consideration of who receives vaccination, there has been little guidance about how best this could be assessed. Delamonica et al’s paper developed approaches and worked through examples to show how equity effects might be modeled over time (rather than just looking at one point in time to assess impact on equity). In the future, alternative approaches could move to accounting for differences in the equity of distributions as well as considering absolute levels of poverty.

The meeting debated the case for evaluating equity in immunization as an absolute or relative gap in coverage. Concentrating on changes in gaps only could suggest gaps are changing in the same way when the levels can be very different. However, working with both gaps and levels can introduce the possibility of there being a trade-off and that we might be willing to give up some level of immunization to close the ‘gap’ e.g. stopping immunizing one rich child and nothing else is an improvement because of the impact it has on reducing the ‘gap’ but this is counterintuitive (in addition to not accounting for any impact on herd immunity). A focus on the absolute level of immunisation for poor children is therefore still of interest. The suggestion to at least consider levels of vaccination has some resonance with the renewed attention of GAVI and the Vaccine Fund’s to looking at the absolute number of missing children and identifying where those children are and what the characteristics of such children.

Links between equity and health outcomes, as with the focus of cost analysis, could also consider equity in reduction of disease incidence or improvements in quality of life as immunization coverage changes. Developing research that combines this type of approach with cost-effectiveness analysis could help determine whether trade-offs between efficiency and equity exist and, if so, at what level of coverage (for example, does the introduction of new vaccines exacerbate inequity at coverage levels of 50 or 80 percent?). It could also help determine whether it is more efficient to vaccinate the poorest population groups or poorest geographical areas first. If such analysis were also considered over time, it could help identify whether the disease burden is shifted to a different time in individual's lives (when the disease could be more severe, as in the case of rubella).

Health and political systems

Results of cost-effectiveness analysis often are presented as if immunization services exist outside of a health system. This is reflected, for example, in the lack of accounting for shared costs or in applying incremental cost-effectiveness ratios from one system to another (which suggests that underlying services have no impact on the delivery of a new vaccine). There is little research considering the relative value of alternative methods of organizing systems, and therefore the two papers presented by Schwartz and Bushan, and Khaleghian on how the private sector and decentralization of government services might impact on vaccination delivery reflect new contributions to knowledge.

Contracting out, as a major organizational change, was considered by Schwartz and Bushan. They presented an unusual case of a program evaluated using an experimental design, which may be a useful reference point for future evaluations that examine system-wide managerial, organizational or other changes. The evaluation revealed differences between the performance of districts where government-only services were provided, and the districts in which contracted NGO services were provided. Future research can help to discern the causes for such differences; discussion about the future agenda emphasized the importance of describing and understanding the differences between contracting or changing organizations; the need to select a large enough sample to detect change; the difficulties in controlling non-experimental situations and therefore in being able to attribute change to a specific intervention; the fact that studying organization change can itself induce change so that control areas are no longer comparable to usual practice; the fact that focusing the benefits of a new service on impact on vaccination (or even health more generally) may underestimate the benefits of the particular re-organisation. In addition to considering the impact on vaccination, the impact on resource use and costs also could be considered.

The impact of decentralization on essential public services is an increasingly important field for study. Khaleghian considered its impact on immunization coverage, which is particularly relevant given both decentralizing health services and integration of immunization services into broader primary health care provision. Using a variety of databases for 140 countries over time, the paper considered the relationship between immunization rates for DTP3 and measles with impact of decentralization. The mixed evidence - that decentralization was associated with higher coverage in low income countries but lower coverage in middle income ones - was used to question why some countries manage the transition more successfully than others (in terms of immunization

coverage) and which mechanisms might be appropriate for improve the performance of local authorities less inclined to maintain or increase immunization coverage rates.

IMMUNISATION FINANCING

The question of how much individual countries and donors should pay for vaccination is one of the big questions at present and there is much debate about the principles for such decision-making. Should payment by donors, for example, be based on a countries own ability to pay, performance criteria, notions of fairness or a mix of these ideas? If we select one or more of these ideas, then how reliably can countries be differentiated? Asking such questions, seeking to provide evidence, and questioning the basis of which benchmarks to use to help such decisions was the focus of papers in this session.

Box 3: Papers presented on immunization financing

- * “A critical review of financial sustainability” Kaddar et al
- * “Developing benchmarks for financing vaccination” Swanson et al
- * “Indicators of financial sustainability of vaccination finance” Makinen

GAVI and financial sustainability

The creation of the Global Alliance for Vaccines and Immunization (GAVI), and its sister entity, the Vaccine Fund, has had a major impact on current thinking about financing for vaccination, and the need to develop financing mechanisms corresponding to the introduction of newer (and more costly) vaccines and the expansion of coverage. All papers in this session drew on GAVI’s definition of financial sustainability:

“Although self-sufficiency is the ultimate goal, in the nearer term sustainable financing is the ability of a country to mobilize and efficiently use domestic and supplementary external resources on a reliable basis to achieve target levels of immunization performance.”

One of the principal concerns of countries and GAVI/Vaccine Fund partners is the extent to which new or recently introduced vaccines, or expansion of routine immunization, will be financed in the future. In partial response to this, two related exercises have been undertaken: First, financial sustainability plans (FSPs) are being prepared by recipients of Vaccine Fund grants; and new thinking is underway to provide guidance about the optimal mix of financing between donor organizations and recipient governments.

Financial Sustainability Plans undertaken by national governments have helped understand the future recurrent cost burden, and identify ways to raise public expenditure levels for immunization programs. However, the FSPs do not compare the relative costs and health impact of immunization vs. other uses of public funds, and therefore provide little information in themselves about whether spending on immunization constitutes a “good buy” for a given country. FSPs are also limited because they focus on budget impact and do not consider shared resources or cost borne by patients/families. The issue

of excluding shared costs means that it is difficult for international agencies to understand how new vaccines will be added other than by assuming sufficient services exist to allow addition. This area of research needs to be considered carefully in the future as it is not at all clear that cross-country comparisons should exclude shared costs.

The share of finances between donor and recipient countries was questioned by Swanson et al in terms of how best to judge what proportion of total immunization program costs should be borne by donors or national governments. Benchmarking may be a useful exercise and an array of potential indicators exist, although future work needs to encompass the addition of new vaccines (rather than focusing exclusively on the split in financing for the basic six EPI antigens); it should also consider the possibility of modeling optimal mix using a variety of indicators for all countries. Alternative approaches might include stochastic modeling, as well as data envelopment analysis.

Indicators of financial sustainability, as discussed in the paper by Makinen, include indicators of reliability not only of government but also donor funding, especially in light of the GAVI definition of financial sustainability. In the future it would be useful to document the impact with a range of data to help determine more clearly which indicators are likely to significantly impact on decision making by country. It would also help to clarify the likely impact of using particular indicators on the quality of reporting evidence over time.

FOLLOW UP OF THE MEETING

- A special issue of the WHO Bulletin on 'The Economics of Vaccination in Low and Middle Income Countries' (due autumn 2004) will publish revised versions of a selection of papers from this conference.
- It was recommended that a small meeting of a similar style be held in conjunction with the International Health Economics Association conference in Barcelona in June 2005.
- Many participants were interested in generating a website or listserv for information exchange on research and results.

Annex 1: Participants at the workshop



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Annex 2: Agenda

29 th October	
9.45	Registration and coffee
10.15	Welcome: Aims, objectives and process of workshop (Julia Fox-Rushby)
10.30 – 12.45	<p>Session 1: The efficiency of investing in vaccination</p> <p>Chair: Ulla Griffiths</p> <p>Walker D et al “Variation in the costs of delivering routine EPI and treatment of vaccine preventable disease in Peru; implications for cost-effectiveness analysis” (Discussant: Humphrey Karamagi)</p> <p>Constenla D “Predicting the source of variation in costs associated with pneumococcal disease in Brazil, Chile and Uruguay” (Discussant Ruth Levine)</p> <p>Brenzel L “Immunisation programme costs in relation to coverage” (Discussant: Gary Ginsberg)</p>
<i>12.45 – 13.45</i>	<i>Lunch</i>
13.45 -15.15	<p>Chair: Alastair Gray</p> <p>Griffiths U et al “The cost-effectiveness of accelerated vaccination activities against neo-natal tetanus in Loralai District, Pakistan” (Discussant: Philippe Beutels)</p> <p>Fox-Rushby J et al “The cost-effectiveness of adding HBV, Hib and Rotavirus vaccines and/or expanding existing routine vaccination services in Bangladesh and Peru” (Discussant: John Edmunds)</p>
<i>15.15 – 15.30</i>	<i>Break</i>
15.30 – 17.00	<p>Chair: Julia Fox-Rushby</p> <p>Bloom D et al “The economic benefits from investing in child health vaccination” (Discussant: David Bishai)</p> <p>Barrett S “The Economics of Eradication versus Control of Infectious Diseases” (Discussant: Alastair Gray)</p>
<i>19.00</i>	<i>Conference Dinner at Ozer</i>

30th October	
	Session 2: Equity of Vaccination and System Effects
9.00 – 10.30	Chair: Logan Brenzel Delamonica et al “Equality and Sustainability” (Discussant: David Bishai) Schwartz B & Bushan I “Improving Vaccination Coverage for the Poor: Public-Private Partnership in Cambodia” (Discussant: Supasit Pannarunothai)
<i>10.30-10.45</i>	<i>Break</i>
10.45 – 12.15	Chair: Miloud Kaddar Khaleghian P “Decentralisation and Public Services: The case of immunisation” (Discussant: Marty Makinen) Discussion of special issue of journal (introduced by Miloud Kaddar)
<i>12.00 – 13.00</i>	<i>Lunch</i>
13.00 – 15.00	Session 3: Immunisation Financing Chair: Raj Shah Kaddar M et al “A critical review of financial sustainability” (Discussant: Catriona Waddington) Swanson P et al “Developing benchmarks for financing vaccination” (Discussant: Peyvand Khaleghian) Makinen M “Indicators of financial sustainability of vaccination finance” (Discussant: Chris Atim)
<i>15.00-15.15</i>	<i>Break</i>
15.15 – 16.45	Session 4: Plenary Discussion “Mapping the research agenda” (Chair: Ruth Levine)
16.45 – 17.00	Closing (David Bishai)

Annex 3: Summary of each paper presented

Session 1 – The efficiency of investing in vaccination

1. Variation in the costs of delivering routine EPI and treatment of vaccine preventable disease in Peru; implications for cost-effectiveness analysis (Walker D, Mosqueira R, Penny M, Lanata C, Clark A, Sanderson C, Fox-Rushby J)

This paper presents variation in the costs of delivering routine EPI and treatment of vaccine preventable disease in Peru. To date, estimates routinely provide point estimates with no presentation of variation in these costs. We consider the impact of variability on predictions of cost and reflect on the likely impact on expected cost-effectiveness ratios, policy decisions and future research practice.

Contribution

Efforts to breakdown national estimates are important. Intra-country cost variations and the significant variables which determine costs are necessary factors for Monte Carlo cost-effectiveness models.

Considerations for future research

The sample size and appropriateness of selected regions and facilities are key considerations for cost variation studies. It is therefore important to construct appropriate research methods and outline the type of analysis that will be performed from the outset e.g. variables under study. A framework for measuring the added value of conducting such detailed data collection from various levels of health facility and regions would be beneficial. For costing vaccine-preventable diseases, it is important to consider an appropriate strategy for determining aetiology of pneumonia and meningitis in the absence of data. Analysis should be considered alongside assumptions about how the health care system ‘is’ and ‘should’ be functioning. Cost variations and distributions around estimates should be supported by statistical evidence, and it is important to present the benefit of this data for the various decision makers and stakeholders involved in future vaccine policy e.g. GAVI, Vaccine Fund.

2. Predicting the source of variations in costs associated with pneumococcal disease in Brazil, Chile and Uruguay (Constenla D)

This study explores differences in average costs of pneumococcal disease across distinct settings. Objectives: To understand limitations and potential for generalizing cost-effectiveness studies. Methods: A regression model was constructed separately for each disease. A total of 183 (pneumococcal meningitis), 187 (pneumococcal pneumonia), 178 (unconfirmed pneumococcal pneumonia), and 205 (pneumococcal otitis media) observations were considered. The normality of the residuals and the heteroscedasticity were tested using the skewness-kurtosis test and the Cook-Weisberg test, respectively. Findings: Costs varied widely by country, with different practice patterns. Variability was found by type of disease, with meningitis being consistently the most costly to treat, and age, with younger children (<2 years) being the most resource-intensive. Level of care caused variability and some of this variation was associated with disease severity. Cost variability was also due to differences in how costs were defined, economies of scale, methodological biases, cost structures, and delivery strategies. For one of the models, the equations failed the normality and/or the heteroscedasticity tests, after various specifications for the models were used, casting doubt on ability to rely on the estimates of the standard errors. The equations for pneumococcal pneumonia, pneumococcal meningitis and otitis media passed the normality/heteroscedasticity tests. Conclusions: The work undertaken here shows that cost estimation for pneumococcal disease treatment can be achieved. The information derived can be used as “building blocks” to infer the costs and variability of costs in settings for which these are not yet available. This information is important because it helps to understand limitations and potential for generalising cost-effectiveness studies.

Contribution

Cost variation studies provide a basis for generalising data to other settings. This information is important for decision makers who wish to infer something about settings where data is unavailable.

Considerations for future research

It is important to clarify the research methods used to select facilities and patients and consider any bias which may result from this selection. Hospital care is shown to be a major driver of costs, which highlights the need to consider the added value of performing detailed data collection at lower level facilities. Meningitis is consistently the most costly, but given the frequency of Otitis Media cases, it may be important to include Otitis Media in the analysis. In fact, the decision to vaccinate in the USA was based entirely on Otitis Media. Aetiology is once again problematic in this area of study, with wild burden estimates in regions where a lack of diagnostic procedures prevent accurate reporting. It is important to set the study in the context of the disease burden, and provide all of the data so that it can be used to infer something about another setting using this model. Analysts should also put in context that the major impacts of this vaccine are on meningitis and otitis media rather than pneumonia.

3. Immunization programme costs in relation to coverage (Brenzel L)

Achieving high rates of immunization program coverage will likely require an ever-increasing rate of financing. However, there is limited empirical evidence in the literature regarding the structure of immunization program costs and the relationship between the level of scale (coverage) and program costs. This study represents an initial attempt to fill this gap in information based on cost data collected at the health subcenter level from one district in South India, and analyzed using standard costing methodologies. The study finds significant changes in total, variable, and unit immunization program costs, as coverage rates and outputs increased. In addition, the study finds evidence of increasing returns to scale with respect to provision of immunization services. Factors such as outputs, prices of inputs, and other production and efficiency related factors were found to be significant determinants of immunization program costs. Continued work in this area will be needed in order to more fully understand the relationship between program costs and scale.

Contribution

There is very little global literature on the costs of scaling coverage despite having huge implications for future policy. The relationship between coverage and scale is fundamental for determining the future cost-effectiveness of expanding coverage.

Considerations for future research

Expanding coverage (outputs) has implications (benefits) in terms of decreased morbidity and mortality, which may not themselves be linear, especially if the critical proportion is attained and the disease 'eradicated'. It is important to consider whether the administrative reforms over the period of study may confound the interpretation of the considerable rise in coverage rates ('behavioural response'). For many users of this information, the most interest is in what happens beyond 70%, but even looking at 5-70% can say a lot about how countries are struggling to expand. Incidence of vaccine-preventable diseases should also be presented to set the study in context. Consider that the differences in costs across countries can be considerable e.g. 16 times higher costs in reaching 'rural', rather than 'urban' Zambia. This was mainly due to cold chain and transport.

4. The cost-effectiveness of accelerated immunization activities against neo-natal tetanus in Loralai District, Pakistan (Griffiths U, Wolfson, L, Quddus A, Yonus, M)

Background: the aim of this study was to estimate the incremental cost-effectiveness of supplemental immunization activities (SIAs) to prevent neonatal tetanus (NT) in Loralai district, Pakistan. The vaccination SIAs under evaluation was carried out in two phases during 2001-2003. Methods: a compartmental model was used to estimate the effect of routine vaccination with Tetanus Toxoid (TT) (in childhood and for pregnant women) as well as TT vaccination during the SIAs. The model follows each woman in the target population from birth until the end of her child bearing age. During these years, the total number of doses of TT and the woman's current duration of immunity is tracked. When coupled with the probability of becoming pregnant, the number of births at risk for neonatal tetanus can be estimated. Recently published NT incidence data from Loralai was then used to determine the number of NT cases. NT deaths were estimated by multiplying cases by a case fatality ratio. Data on the costs of the SIAs were collected from the UNICEF office in Bolochistan and from the Provincial Health Department. Findings: we estimated that 303 NT cases and 242 NT deaths were prevented over then next 30 years by the SIAs. The implementation of the SIAs was relatively inexpensive. The cost per dose delivered was only US\$ 0.35. This is partly due to the fact that the TT is one of the most inexpensive vaccines available. In the base case analysis the cost per death averted was US\$ 94 and the cost per DALY gained was US\$ 2.95. Interpretation: compared to other interventions where similar analyses have been done US\$ 2.95 per DALY gained is an exceptionally favourable cost-effectiveness ratio. In Loralai district in Pakistan, the NT SIAs was thus an extremely cost-effective health intervention. However, the result can not be generalised to other settings. Loralai district has one of the highest incidence rates of NT in the world and, at the same time, very few births are protected against NT through routine immunization. However, our model also demonstrates that the impact of the NT SIAs would have been greater if routine coverage with childhood tetanus vaccination and also TT in pregnant women had been higher than seen over the past decades in Loralai.

Contribution

A simple compartmental model with appropriate data and assumptions is a suitable approach for capturing vertical transmission and the impact of SIAs on neonatal tetanus. Collecting data in such challenging health care settings is commendable.

Considerations for future research

Consideration of the impact on those who did and did not receive the vaccine could be set in the context of the propaganda against vaccines at the time. The existing structure of the health system before SIAs should be reported along with the salaries paid to health care workers. This allows for a direct comparison in the 'pre' and 'post' SIAs period e.g. determining whether or not people receive extra salary to perform work that they should have been doing anyway. Models such as this could be validated by comparing the model-generated birth cohorts with estimates from other sources. It would also be interesting to perform uni/bivariate sensitivity of epidemiological variables as well as testing various different scenarios e.g. 5 dose campaign, routine versus SIAs.

5. The cost-effectiveness of adding HBV, Hib and Rotavirus vaccines and/or expanding existing routine vaccination services in Bangladesh and Peru (Fox-Rushby J, Walker D, Clark A, Mosquera R, Sabina N, Liku N, Castillo-Riquelme M, Penny M, Lanata C, Hossain S, Gribble S, Sanderson C)

This paper outlines the methods used in the first micro-simulation model of alternative policies to expand existing vaccinations and/or add in new vaccines to current schedules in Peru and Bangladesh. The methods focus on the modelling approach, sources of public health data and approach to costing. Partial results for parameters of the model are presented and expected future results outlined in 'dummy tables'. The discussion raises the pros and cons of micro-simulation modelling and issues of interpretation and method for costing. All work is presented as work in progress for critically constructive discussion at the workshop.

Contribution

This paper presents a rare attempt to try and integrate costs, facilities and various diseases into one model. Very few studies have compared the cost-effectiveness of alternative strategies.

Considerations for future research

Clear presentation of the research methods and assumptions used to generate baseline parameters is essential. Future studies should consider the cost-effectiveness of acquiring such detailed information. The appropriateness of a model is also a key question. Micro-simulation models and compartmental models both have advantages for modelling the cost-effectiveness of vaccination scenarios. Micro-simulation provides an opportunity to run models with as little or as much complexity as is desired. This is important for modelling the effects of combination vaccines and co-circulating diseases e.g. where a death from one disease reduces the number susceptible to another. However, in order to harvest the benefits of this approach, it may be tempting to add model complexity in order to more closely mimic reality. This can create a 'data hungry' model which lends itself to over-reliance on expert opinion for generated parameter values. These types of model can also be computationally intensive which limits the length of model runs and the amount of sensitivity and scenario analysis that can be performed. Further to this, the large number of parameters used provides lots of room to manoeuvre in terms of calibration. Analysts should calibrate in the sense of datasets but not in the sense of modifying the model so much that its predictive ability come into question.

6. The economic benefits from investing in child health immunization (Bloom D, Canning D, Seiguer, E)

Objective: To determine the effect of childhood immunization on factors that influence adult earnings.

Methods: We use a sample of children born between May 1983 and April 1984 from the Cebu Longitudinal Health and Nutrition Survey in the Philippines to link vaccination (measles, polio, DPT, and TB) in the first two years of life with measurements in 1994-1995 of factors, such as height, weight, and language, mathematical and non-verbal reasoning test scores, that have been linked to higher earnings in adults. We carry out multivariate regressions, controlling for confounding factors such as the child's age, sex, birth weight and birth height, mother's height, parents' education, and family socio-economic factors such as size of home, ownership of household appliances and household water supply and toilet facilities.

Findings: We find that childhood vaccinations do not seem to affect the child height at age twelve, but they do significantly increase weight. Childhood vaccinations also appear to significantly increase all test scores, with vaccination against measles being the crucial factor for the mathematical and non-verbal reasoning test scores. Conclusion: Childhood vaccination has previously been linked to reduced morbidity and reductions in stunting and wasting in young children. Our results suggest that these positive effects persist, and in young teenagers appear in the form of increased weight and greater cognitive ability. These factors have been linked in adults to higher earnings, suggesting that improving child health through vaccination may be a cost effective method of generating income and alleviating poverty.

Contribution

This paper illustrates that although lives saved are good in themselves, they also have an economic benefit that flows. Economic growth provides all the resources you need to implement a plan in the future. Things that produce economic growth may have far more weight for attracting investment than those which are purely consumption.

Considerations for future research

There is evidence that fewer children getting sick leads to a higher health stock in adulthood, but economists have to be very cautious about confounding. For studies such as this, economists may be more comfortable receiving data on the link between investing in vaccination and child sickness from a randomised controlled trial. The relevance of the diseases under study should also be considered i.e. 'not every sneeze and snuffle stunts'. The returns-to-investment story is important, and economists have to continue with empirical data collection, but should be looking towards a highly morbid and prevalent gateway disease that will leave stunting at age 12. Experimental trials of new vaccines provide an opportunity to study this by following up a population cohort to measure for stunting effects. Other factors to consider may be 'location and timing of mass campaign', 'cold chain compliance', 'cluster mean

variance uptake', 'grandparental schooling', 'nutritional levels of families' etc. The potential audience for this type of study may include the IMF and WorldBank.

7. The economics of eradication versus control of infectious diseases (Barrett, S)

The epidemiology of eradication has been studied extensively. The economics of eradication are less well understood, but no less important. Epidemiology determines the technical feasibility of eradication, and suggests effective strategies for reaching the goal. Economics determines the desirability of the goal and the incentive problems that might be encountered in achieving it. Economics can also suggest institutional arrangements that can overcome these incentive problems. This paper develops the economic case for the eradication as contrasted with the control of infectious diseases. The main conclusion of the paper is that, from the perspective of economics, eradication has a number of advantages over a policy of control. The implications for a number of different eradication programs are discussed.

Contribution

This paper gives a very good account of the current predicament concerning eradication. It is important to highlight the relevance of issues such as game theory, equilibria and envy when discussing eradication issues.

Considerations for future research

The model of the self-interested donor country is rejected on a number of counts. Consider the objective function of USAID or of the American citizen writing a cheque to an NGO. Is it really beneficial for these donors to maximise health? It would be interesting to develop the idea that eradication may require less international enforcement than control, and therefore may be better suited to agencies such as WHO. Future research could consider developing themes such as the game theoretic approach and 'rational' epidemics models which incorporate public or private incentives and full welfare losses. It could also be beneficial to include more detailed empirical examples of cost-effectiveness of eradication versus control with different perspectives/assumptions. From a strategic perspective, it is interesting to understand what the breakeven point is in the game between different states. How much would it cost to eradicate now? Bargaining theory and understanding how people might reveal they are willing to eradicate would be worth further consideration? Who are the key players? It is important to consider the level of uncertainty associated with vaccination? For example, if you can't isolate the last case, then all the financial effort is wasted. There are also important issues about the time perspective and the effects of discounting worth further investigation.

Session 2 – Equity of Immunization and System Effects

8. Monitoring Immunization Performance: Coverage, equity and sustainability issues (Delamonica E, Gulaid J, Minujin, A)

The Expanded Program on Immunization (EPI) has promoted performance monitoring from inception. A central feature of this system was the assessment of the program reach (how many people benefited from immunization services). Coverage rates are calculated using routine data collected at service delivery points and estimates of target populations. In addition, survey techniques have been employed to provide supplementary and often more reliable estimates of performance. Information from these sources (the routine data and coverage surveys) has been used for multiple purposes. These include program planning such estimation of inputs such as vaccines to assessment of program impact; and from monitoring progress toward the attainment of national and international goals such as the UCI goal in 1990 to advocacy. After the attainment of the UCI goal in 1990, attention shifted first to sustainability of EPI achievements and, more recently, to equity. Despite the changes in interest, there is little practical guidance for program staff on how these issues could be assessed. This paper presents the results of an effort to address the equity

issue. The paper begins with a review of inequality and its multiple dimensions, arguing for a simultaneous analysis of changes in averages and disparities along variables of interest such as wealth, gender, and place of residence in order to achieve a more thorough understanding of trends. The next section focuses on the measurement of wealth disparities and other methodological problem encountered, followed by a section trends on immunization by wealth. The paper concludes with a discussion of major issues including sustainability.

Contribution

A good contribution with some elegant sensitivity analysis to demonstrate the situation in a variety of different countries. This work provides a platform from which many interesting questions can be addressed.

Considerations for future research

Some interesting data from Matlab (Bangladesh) measles vaccine trial showed that there is more efficiency in getting the that poor child if you can get to them. The elegant sensitivity analysis using a map of equity versus efficiency showed that most vaccination programmes are in a position of equity-inefficiency. However, Guatemala and Egypt are in the good zone of improving equity and efficiency and it would be interesting to explore how this was achieved. Future analysis might also draw on pooled data from DHS to increase statistical power, given consideration of the similarity of questions. Using a geographical variable might then enrich analysis further. Data from the West African Spatial Analysis Project could be considered. One issue to consider is that the 'gap' is a relative measure. Focusing on this gap can create the paradox that someone would be willing to give up some absolute immunisation to make the 'relatives' better. A focus on the absolute level of immunisation for poor children is therefore still of interest. In raising the profile of these issues, there is a danger that a pro-equity bias becomes a pro-poor bias. The programme may become stigmatised, and the powerful elites may lose interest in funding the 'poor problem'.

9. Improving Immunization Coverage for the Poor: Public-Private Partnership in Cambodia (Schwartz B & Bushan I)

Improving the access of Inequitable immunization services for the poor is a coverage is a well-documented policy challenge problem in developing countries. Government provided immunization services tend to be distributed in favour of the non-poor at the expense of the poor, especially those living in remote and rural areas. In addition to household wealth, factors such as whether the household lives in an urban or rural area, mother's education, mother's age, the child's gender, parity and religion have been found to be related to whether a child is immunized. However, the impact of alternative service delivery systems on immunization coverage for poor population has never been analyzed. In this paper, we examine the effect of contracting health services to NGOs on immunization coverage, especially for the poor. In particular, we focus on differences in the relationship between household wealth and fully immunized children (FIC) in contracted and non-contracted districts, using information from household surveys taken in 1997 and 2001 in nine large rural districts. Five of these districts were contracted to non-government organizations (NGOs) to provide primary health care services. Whether the child lives in an area that has been contracted for service delivery while controlling for these other factors associated with equity, however, has never been analyzed using data from a large scale intervention. The paper first gives a description of the recent development of the primary health care system in Cambodia and the contracting experimental design. We then present the survey data, survey methodology, and a description of the methods used to measure and test the equity of immunization coverage. The results of the analysis follow, where we present bivariate and multivariate analysis of factors related to immunization status and compare the equity of the distribution of fully immunized children in contracted and non-contracted districts. The results demonstrate that, while controlling for other factors related to FIC, living in a contracted area is related to a more equitable, but not equal, distribution of immunization coverage. While these results are descriptive, and not based on a rigorous estimation model of immunization consumption, they do provide estimates of each of the relationships of the included factors, which likely are causal controlled, and have important policy implications.

Considerations for future research

Very stimulating and well designed study which attempts to find the private sector role in improving equity. The value of this study can go beyond immunization alone.

Considerations for future research

It is important to clearly show the interaction between districts and the intervention (i.e. contracting) in the model. Where sampled regions are very much different, Hawthorne bias can be very prominent. Introducing qualitative data can be an effective approach to examining and demonstrating the differences between regions. This might include examining: reward structures in place before and after contracts; satisfaction and motivation of human resources; and capacity and cost of monitoring quality contract. For policy relevance, it may be of interest to focus on public & private participation in achieving equity in delivery of EPI programmes. Do private providers deliver services more efficiently than public providers? Information about the nature of the contract with NGOs is of interest and there is little information on this in the vaccination area. A key difficulty to consider in the development of future research is that the control groups may not be 'business as usual' as, for example, simply being given performance targets may have an effect.

10. Decentralisation and Public Services: The case of immunisation (Khaleghian P)

This study examines the impact of political decentralization on an essential public service provided in almost all countries: childhood immunization. The relationship is examined empirically using a time-series data set of 140 low- and middle-income countries from 1980 to 1997. The study finds that decentralization has different effects in low- and middle-income countries. In the low-income group, decentralized countries have higher coverage rates than centralized ones, with an average difference of 8.5 percent for the measles and DTP3 vaccines. In the middle-income group, the reverse effect is observed: decentralized countries have lower coverage rates than centralized ones, with an average difference of 5.2 percent for the same vaccines. Both results are significant at the 99 percent level. Modifiers of the decentralization-immunization relationship also differ in the two groups. In the low income group, development assistance reduces the gains from decentralization. In the middle-income group, democratic government mitigates the negative effects of decentralization, and decentralization reverses the negative effects of ethnic tension and ethno-linguistic fractionalization, but institutional quality and literacy rates have no interactive effect either way. Similar results are obtained whether decentralization is measured with a dichotomous categorical variable or with more specific measures of fiscal decentralization. The study confirms predictions in the theoretical literature about the negative impact of local political control on services that have public goods characteristics and inter-jurisdictional externalities. Reasons for the difference between low- and middle-income countries are discussed.

Contribution

Thorough and analytically sophisticated, making use of a variety of data sources. Introduces concepts which consider the wider research agenda.

Considerations for future research

It is important to differentiate between 'health sector decentralisation' and 'political decentralisation'. This paper took a definition based on political decentralization, leaving some gap for future research in working through the impact of decentralization in the health sector (with and without political decentralisation). Future research may also consider the role of democracy, as well as how this might be accounted for in such analysis. More research is needed on how to make decentralisation work better for immunization and consider the time period necessary for such analysis.

Session 3 – Immunization Financing

11. A critical Review of financial sustainability (Kaddar M, Lydon P, Levine R)

This paper focuses on how the Global Alliance for Vaccines and Immunization has conceptualized and made progress on the challenge of sustaining adequate and reliable funding for immunization in poor countries. In it, we present GAVI's approach to long-term financing for immunization, and indicate how it has tackled this issue through the use of financial sustainability plans. The paper also presents the findings from this experience in several countries, describes some of the lessons learned, and offers suggestions as to the way forward.

Contributions

Financial Sustainability plans are a useful mechanism for a variety of stakeholders, and highlight the importance of reducing risk given the uncertain future of donor funds. FSPs address the funding gap and raise big issues that are three or four years down the line following the end of current agreements on funding levels.

Considerations for future research

More aid is becoming more aggregate and large chunks of money are going to ministries of health which shows a move away from a project approach. Governments are also receiving large sums of money through the ministry of finance with loose statements on how that money should be spent. In the health sector, harmonisation of donors and governments shows a move away from vertical disaggregated approach. This presents a creative tension e.g. the Vaccine Fund works very quickly, whereas the alternative aggregated approach is much slower. Historically, sustainability means a country is self-sufficient. GAVI's definition talks about efficiency, reliability and the ability to mobilise funds. This is probably a more useful definition but it is also that the definition and future research consider the time period over which sustainability is expected. Most donors tend to consider 3-4 years ahead and there are often fears that 'budget support' might be withdrawn. Both may affect current behaviour in a rational way or not, and this should be considered. Finally it would be worth linking the data on FSPs more clearly, at a country level, on beliefs and evidence of cost-effectiveness and cost-benefit.

12. Developing benchmarks for financing immunization (Swanson P, Bartlett S, Hindman Persson T)

This paper is based on a study by ECON Analysis to advise the Global Alliance for Vaccines and Immunization (GAVI) on the development of benchmarks for splitting the cost of immunization coverage increases between donors and recipient countries. It focuses on the "basic six" vaccines: diphtheria, pertussis, tetanus, measles, BCG, and polio. The study was commissioned by the Bill and Melinda Gates Foundation. GAVI wishes to help countries increase and maintain their childhood immunization coverage levels on a sustainable financial basis. Promoting financial sustainability will involve encouraging countries to cover the cost of their own programs in the long run. To get to that point, GAVI proposes to develop benchmarks for the devotion of internal government funds for step increases in coverage levels of the "basic six" that could be used in the "medium term", which could be over 10 years in some cases. Noting that use of peer groups could provide important incentives for countries to improve performance, GAVI wishes to develop benchmarks for country groupings based on the performance of "good practice" countries in each group. The study is divided into an examination of indicators on which GAVI could 1) base immunization financing benchmarks, 2) divide countries into relevant peer groups, and 3) identify "good practice" countries within groups. It examines the conceptual and practical pros and cons of a number of potential indicators in each area, including issues such as data availability. After a review of candidate indicators in each area, ECON concludes by recommending development of own-spending benchmarks and selection of "good practice" countries based on government health expenditure per capita instead of direct use of immunization financing figures, and development of country peer groups based on national income.

Contribution

The idea of benchmarking and levels of optimal mix of qualities is an interesting one, which may be useful for macro-level decision making.

Considerations for future research

Future research could consider testing alternative parameters and alternative ways of combining parameters for benchmarking and comparing the impacts of choices on all countries. It is also important to consider the impact of variation in costs between countries and variation in coverage rates. There appears to be a background assumption that the Government will make up the difference in funds which needs to be explored further too.

13. Indicators of financial sustainability of immunization finance (Makinen M)

The Global Alliance on Vaccines and Immunization (GAVI) used input from some of the countries it supports (Zimbabwe, Benin, Ukraine, and Bangladesh) to devise an innovative definition of financial sustainability – “Although self-sufficiency is the ultimate goal, in the nearer term sustainable financing is the ability of a country to mobilize and efficiently use domestic and supplementary external resources on a reliable basis to achieve target levels of immunization performance”. In addition, GAVI requires each of its beneficiary countries to produce a financial sustainability plan (FSP) during the second year that it receives assistance. In the FSP, the beneficiary countries are to show the projected costs of their immunization programs and sketch out how they intend to meet them. The methods that they use are to address the four major dimensions of the definition of financial sustainability (FS). Those dimensions are: mobilization of domestic and external resources, efficiency, and reliability. The set of methods proposed constitute the financial sustainability strategy for the country. GAVI also requires that the FSP contain indicators to be used to track progress in each dimension of the strategy. Finally, GAVI requires the countries to submit annual reports, including a tracking of the indicators of FS. GAVI’s Financing Task Force (FTF) organized a committee to suggest indicators that might be used in FSPs. The FTF asked the committee to work with the definition of FS and additional suggestions about indicators that came from the four countries that had contributed to it. The use of the GAVI definition of FS represents a departure from the traditional approach of making self-sufficiency the major FS objective. The indicators committee recognized this change of direction in its work. This paper addresses the indicators nominated by the FTF committee that capture national resource mobilization “effort” relative to ability to pay. It leaves aside the committee’s work on indicators of efficiency, reliability, and external resource mobilization issues. Further this paper focuses on indicators of performance in national resource mobilization, rather than process indicators. Many countries may include process indicators in their FSPs that address related matters, but these kinds of indicators are not taken up here.

Contribution

It is interesting to measure how far a country can afford and how far it is willing to continue its resource space using fairly robust indicators which facilitate cross-country comparisons and benchmarking. Indicators were developed based on a consensus exercise between representative of Zimbabwe, Benin, Bangladesh and the Ukraine.

Considerations for future research

It would be interesting to link the ideas within the paper to further analysis of data and facilitate further questioning of the approaches proposed. It might be possible to explore how data from the 12 FSP available on the GAVI website can be used to test these indicators. In particular alternative indicators that reflect more of the change in GAVI’s definition of sustainability might be considered. Should there be an indicator to capture reliability and adequacy of donor expenditures? It is important to clarify why some other indicators were not used as major indicators e.g. donor expenditures and pledges as % of gap for adequacy. It was recognized that the ease of using GDP in the denominator needs further consideration. There is a large non-market sector in many poor GAVI countries, and there is no allowance for capital depreciation in GDP which is important for the poorest countries. Other effects include the exchange rate movements relating to exportable versus domestic market goods. How does the use of the entire pool of GDP as a denominator square with GAVI’s position of discouraging private spending on immunization? Is all of a country’s GDP available as a pool for discretionary allocation. Net domestic product could be considered as an alternative to GDP.