Report on the WHO consultation on the broader economic impact on vaccines and immunization programmes (BEIVIP)

28-29 June 2012, Geneva, Switzerland
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1 Introduction
(Presentation by Raymond Hutubessy)

- Traditional CEA/CBA methods (e.g. cost per QALY/DALY) are well-established tools for decision making about vaccines but may be seen as less useful with Ministries of Finance, donors and other stakeholders outside the health sector particularly in low and middle-income countries (LMICs). WHO aims to develop new methods and outcomes that are useful to these stakeholders.
- The current discussion focuses on vaccine-preventable diseases, but there are some similar discussions in WHO departments such as the health systems financing department (HSF) dealing with other diseases e.g. health systems financing have guidelines on the economic consequences of disease and applications to non-communicable diseases. It may be good to draw from frameworks to promote comparability between interventions.
- The Quantitative Immunization and Vaccines related Research (QUIVER) Advisory Committee (AC) is transitioning to the Immunization and Vaccines related Implementation Research (IVIR) AC which will discuss broader implementation issues, including but not exclusively quantitative issues.
- Since last year, activities have included (i) a systematic review conducted by Rohan Deogankar at the University of Birmingham, (ii) a stakeholder interview conducted by Inge van der Putten at the University of Maastricht, and (iii) an expert consultation in Toronto during the iHEA conference. A framework was developed during the Toronto consultation, and updated following the systematic review.
- WHO issued a request for proposals (RFP) to develop relevant tools. Four studies were selected by WHO following recommendations from the IVIR AC.
- The purpose of this work area is to promote the case for investment in vaccines and immunization programs among in-country stakeholders, rather than to compare between different interventions. Some of the outcomes measured may be too uncertain for priority setting. The purpose is to complement rather than replace traditional CEA. However, some use in prioritisation may be inevitable since stakeholders need to choose between competing interventions, ideally in a consistent and evidence-based manner.
- Vaccines need to be evaluated over long time horizons. Standard analyses assume that indicators remain unchanged during this time, but this may not be true for some broader indicators (e.g. epidemiology, demography, social indicators).
- Long-term randomised studies are important, because observational studies will be confounded by many unknown factors.
- The causal pathway is from vaccination to improved child health, so other child interventions are likely to use the same pathway. The synergies between different interventions should be made clear in the framework.
- There are dangers in limiting metrics to a single indicator – e.g. GNI per capita is sensitivity to petrochemical prices and hides within-country inequities. A basket of indicators including e.g. Gini coefficients may be useful.
- The current traditional framework is limited to child health because it does not take into account adult vaccines like influenza and HPV.

2 Stakeholder interviews
(Presentation by Inge van der Putten)

- The study consisted of an online survey (37 respondents, 26 completed survey) and interviews (14 respondents). Survey was sent out to ~150 participants of the NUVI meeting in
Interviewees were recruited from people expressing interest in the survey (7/14), and other known contacts (7/14).

- **Survey**
  - Likert-scale questions: Most important domains indicated were sectoral gains, burden of disease and ecological externalities. Outcome-related productivity gains were also seen as fairly important. Behavioural-related productivity gains and other externalities (e.g. equity) were not seen as important.
  - Open questions: benefits in using vaccination as a health care platform and to build health care capacity were mentioned.
  - Some measure of dispersion (e.g. standard deviation) is needed because of the dangers of using a 5-point Likert scale.

- **Interviews**
  - Traditional outcomes (burden of disease, school absence costs, safety) most commonly used. Asian countries are using DALYs but Brazil was reportedly not.
  - A few mentioned the benefit of some broader effects (especially for newer vaccines), although difficulty in measuring them was mentioned.

- **May be some bias since respondents were self-selected and the response rate was not high.**
- **NUVI may not be the right forum because in-country stakeholders are not always represented.** Many attendees are EPI managers who are implementers rather than decision makers. It may be more useful to repeat study in other fora (e.g. Ministry of Finance meetings organised by the World Bank late 2012) and other survey and interview methods (e.g. discrete choice experiments).
- **It may be fruitful to try a choice-based elicitation method – e.g. discrete choice experiments.**

3 Fiscal consequences of health status changes

*(Presentation by Mark Connolly and Nikos Kostopoulos)*

- The “government perspective” largely ignored in traditional health service/societal perspective health economic evaluations. The Black Review (2008) found that only 11% of costs due to illness in the UK fell on the health care sector.
- The generational accounting model captures relationship between population health, economic growth and tax revenue. It estimates tax revenues (from income, consumption, corporate, and excise taxes) and transfer receipts (social security, education, allowances, pensions, child subsidies, consumable costs) at different ages. Outcomes are shown in terms of internal rate of return (IRR) on investment and net present value (NPV) of investment.
- Paradigm shift from thinking about population health → economic growth → tax revenue to thinking about population health → tax revenue.
- In HICs, net revenues from an individual are negative until the 1930s, then become positive. In LMICs, the revenue base is largely from indirect taxes although some middle income countries have a more equitable tax base. Some governments do not achieve positive net transfers over an individual’s lifetime at any age (although this may change in the future with economic growth). However, vaccination may still improve the net return due to a reduction in morbidity and mortality.
- Age specific costs and earnings may need to be modelled when they are not readily available.
- Some issues that may be beyond the scope of the analysis include informal sector effects, rapid population growth and/or demographic changes, the intangible benefit of being healthy (relevant to end-of-life care and social welfare), long-term changes (e.g. economic growth) and the distributional/equity impact of decisions. It is also unclear whether the case for increasing vaccination coverage to hard-to-reach populations is really made by this method. It is likely to be a more attractive methodology for people working in finance ministries and actuary, people who think in terms of balance sheets, rather than health ministries.
4 Macro-economic burden of vaccine preventable diseases

(Presentation by Jonathan Weiss)

- This is an interface, called EPIC, for estimating the macroeconomic impact (in terms of GDP) of health interventions using the Cobb-Douglas equation.
- Tool is intended for country level generalist policy makers and top level ministries of health
- The initial focus was applying the model to a static model of rotavirus by Kim et al. The model estimated the impact of rotavirus vaccination on changes to GDP by 2030 in 52 GAVI-eligible countries.
- Tool is an attempt to provide a more complete picture than Cost of Illness studies do
- Difficulties raised included the appropriate valuation of productivity (human capital, friction costs etc.) and the validity of long-term projections.
- The epidemiological model for rotavirus was considered acceptable (despite approximations such as lack of indirect effects etc.) as the knock-on effects in the epidemiology are small compared to the uncertainty in the macroeconomic model. As a next step, HPV vaccination may be better choice than pneumococcal vaccination because for the latter serotype replacement may be crucial and is poorly captured in most models.
- It may be useful to disaggregate the effects of short-term productivity loss and mortality on GDP.
- There is a need to perform sensitivity analysis around the underlying Cobb-Douglas model, which is the simplest available macroeconomic model relating labour to income.
- The underlying relationship between health and economic growth has not actually been empirically demonstrated. However, the exercise is useful to examine the underlying assumptions made in health economic evaluations (e.g. economic growth, equity weights etc.) The standard of evidence is much weaker than for epidemiological studies, but may still be sufficient to many decision makers.
- It is important to find out what decision makers actually want. Different decision makers (finance, health) will want different information and have different standards of evidence.

5 Group A Streptococcus (GAS) vaccination

(Presentation by Till Baernighausen and Andrew Steer)

- The case for investment in a GAS vaccine needs to be made. Evidence on the economic burden is crucial for this. The project is a broad cost-of-illness study in Fiji (RHD), New Caledonia (RHD), UK (iGAS) and USA (iGAS) based on the Baernighausen framework. There is not enough information for a full economic evaluation (CEA/CBA).
- A literature review revealed limited useful cost information, so the study will involve new data collection activities.
- 2 vaccine products are in development: Multivalent is in Phase I and II trials, J8 vaccine is in preparation for trial.
- Direct medical costs, direct non-medical costs (transport, relocation) and indirect non-medical costs (lost wages, lost school time, childcare) will be collected in Fiji and New Caledonia. Data collection will also begin for the US and UK in July.
- A conceptual framework of broader costs and benefits will be presented and will point to further evidence that needs to be collected on this.
- The cost of vaccine development may be taken into account in a back-of-envelope way.
- The study can be generalised to countries with similar disease burden and health systems, by adjusting individual cost items. However, there are concerns around generalizability. Vaccination may be seen as saving more costs in New Caledonia where patients are flown to Australia than in countries where this is not done. In places with poor access to formal health care, the vaccine may not be seen as financially beneficial.
6 Measles vaccination as a delivery platform
(Presentation by Stephane Verguet)

- Measles burden in India is high due to heterogeneous vaccine coverage. MCV2 will be delivered through supplementary immunisation activities (SIAs) in 2010-2 in states with low coverage. The project aims to investigate using these SIAs as a delivery platform for other child and maternal health interventions, first in India, then potentially other parts of the world.
- Four components
  - Stakeholder survey among programme officers in all 14 SIA states.
  - Dynamic model to determine the optimal periodicity for measles SIAs.
  - Cost-effectiveness evaluation of using measles SIAs as a platform for other interventions.
  - Analysis of the impact of interventions on equity.
- The stakeholder survey suggested that programme officers value cheap, easily delivered nutritional, diarrhoea and parasitic interventions over vaccine-based interventions. However, newer vaccines were not on the list of interventions to consider as they are not being used in India at present. These may have been of more interest than BCG or DTP.
- Dynamic modelling and equilibrium analysis of the model suggests that SIAs of between 5-10 years apart can control measles.
- There are plans to calibrate the model to measles mortality from Million Deaths Study. Measles deaths could be estimated by explaining under 5 mortality (ideally by week or month) using notifications in seasonal diseases (measles, malaria etc.).

7 Broader Economic Impact Framework
(Presentation by Mark Jit)

7.1 Published sources

Bärnighausen et al (2011) proposed a framework in which the benefits of vaccination were divided into “narrow” benefits (that economic evaluations have traditionally adopted) and “broad” benefits. The broad benefits included outcome-related and behaviour-related productivity gains as well as community externalities. Later work by Bärnighausen et al (submitted) proposed that externalities could be divided into ecological externalities and macroeconomic externalities.

Deogaonkar et al (submitted) reviewed 26 studies that tried to capture the broader economic impact of vaccination in low and middle income countries. Based on the synthesis, it was proposed that the Bärnighausen framework is expanded to three categories: health-related benefits, productivity-related benefits and community externalities.

The WHO’s Health Systems Financing framework (WHO, 2009) suggests that methodological approaches for estimating the economic impact of health changes can be chosen based on (i) whether the analysis is conducted on the microeconomic (household, firm, government) and macroeconomic levels (societal), (ii) whether measured losses are
market goods (non-health consumption), non-market goods or both, and (iii) whether market losses are measured using general or partial equilibrium assumptions.

**Table 1 Classification of benefits**

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Study designs</th>
<th>Indicators</th>
<th>Key references</th>
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<tbody>
<tr>
<td><strong>A. Health-related benefits to vaccinated individuals</strong></td>
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<tr>
<td></td>
<td></td>
<td>Epidemiological models</td>
<td>Deaths averted</td>
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<td></td>
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<td>QALYs/DALYs saved</td>
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<tr>
<td>A2. Health care cost savings</td>
<td>Reduction in direct cost of health care borne by the public sector or private individuals</td>
<td>Cost of illness studies</td>
<td>Health care costs saved by Ministry of Health</td>
<td>Stack 2011</td>
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<td></td>
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<td></td>
<td>Health care costs saved by individuals</td>
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<tr>
<td><strong>B. Productivity related benefits</strong></td>
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<tr>
<td>B1. Productivity gains related to care</td>
<td>Reduction in lost days of work due to sickness or caring for a sick patient</td>
<td>Clinical trials</td>
<td>Value of productivity</td>
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<tr>
<td>B2. Productivity gains related to health effects</td>
<td>Reduction in lost days of work due to sickness or death of sick patient</td>
<td>Clinical trials</td>
<td>Friction costs</td>
<td>Koopmanschap 1995</td>
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<td></td>
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<td>Potential lifetime earnings</td>
<td>Stack 2011</td>
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<tr>
<td>B3. Productivity gains related to non-utility capabilities</td>
<td>Increased lifetime productivity because of enhanced capabilities not easily measured using utility-based preference measures (such as improved cognition and educational attainment)</td>
<td>Longitudinal data sets</td>
<td>Educational outcomes</td>
<td>Coast 2008</td>
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<td></td>
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<td>Cognitive outcomes</td>
<td>Bärnighausen 2011</td>
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<td>Potential lifetime earnings</td>
<td>Canning 2011</td>
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<td>Bloom 2012</td>
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<tr>
<td><strong>C. Community externalities</strong></td>
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<tr>
<td>C1. Ecological effects</td>
<td>Health improvements in unvaccinated community members as a result of ecological effects such as herd immunity, eradication and reduced antibiotic usage.</td>
<td>Household or cluster RCTs, transmission dynamic models</td>
<td>Indirect vaccine protection</td>
<td>Drummond 2007</td>
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<td></td>
<td>Prevalence of antibiotic resistance</td>
<td>Beutels 2008</td>
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<td></td>
<td>Future cost of</td>
<td>Laxminarayan 2001</td>
</tr>
<tr>
<td>C2. Equity</td>
<td>More equal distribution of health outcomes</td>
<td>Clinical trials, surveys</td>
<td>Distribution of health outcomes</td>
<td>Barrett 2004</td>
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<tr>
<td>C3. Financial and programmatic synergies and sustainability</td>
<td>Improved financial sustainability as a result of effects such as synergies with other health care programmes (e.g. delivery platforms), stimulation of private demand and mechanisms to enhance group purchasing power (e.g. PAHO revolving fund)</td>
<td>Costing studies, Financial forecasts</td>
<td>Financial benefits, Private demand estimates</td>
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<tr>
<td>C4. Household security</td>
<td>Improved financial security of household as a result of reduced risk of catastrophic expenditure</td>
<td>Clinical trials, Economic models</td>
<td>Actuarial value of security</td>
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<tr>
<td>D. Broader economic indicators</td>
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<tr>
<td>D1. Changes to household behaviour</td>
<td>Economic improvements due to changes in household choices such as fertility and consumption/saving as a result of improved child health and survival</td>
<td>Longitudinal data sets</td>
<td>Productivity, Female labour participation, Household investment/child, Dependency ratio</td>
<td>Knodel 1979</td>
</tr>
<tr>
<td>D2. Public sector budget impact</td>
<td>Change to an individual’s net transfers to the national budget over his/her lifetime.</td>
<td>Generational accounting models</td>
<td>Return on investment, Net present value of investment</td>
<td>Connolly 2010</td>
</tr>
<tr>
<td>D3. Short-term macroeconomic impact</td>
<td>Changes to national income or production as a result of short-term exogenous shocks to the economy.</td>
<td>Computable general equilibrium (CGE) models</td>
<td>Change in GDP (per capita), Change in sectoral output</td>
<td>Beutels 2008</td>
</tr>
<tr>
<td>D4. Long-term macroeconomic impact</td>
<td>Changes to national income or production as a result of long-term changes to drivers such as labour supply and foreign direct investment</td>
<td>Macroeconomic models (e.g. Cobb-Douglas)</td>
<td>Change in GDP (per capita)</td>
<td>Dahan 1998, J Weiss (unpublished)</td>
</tr>
</tbody>
</table>
7.2 Strength of evidence

The benefits in category A (health-related benefits to vaccinated individuals) are usually supported by the strongest grade of evidence, i.e. randomised trials without major perceived limitations (Guyatt 2008). Increasingly randomised studies are also being conducted to measure some of the productivity gains related to care and health effects (categories B1 and B2) (e.g. Bridges 2000). The impact of immunisation on equity (category C2) could in principle also be measured in randomised studies, although existing analyses have been observational (e.g. Bawah 2010; Bishai 2003).

Benefits in category C could in principle be investigated with experimental studies. However, since deal with externalities occurring on the population or health systems level, and hence are likely to require cluster randomised studies. For example, household-level studies have been conducted on the indirect effect of vaccination on herd immunity (category C1) (e.g. Esposito, 2006)

Benefits in category D (broader economic indicators) are supported by the weakest evidence; it appears unlikely that there will ever be experimental studies (and in some cases, even any prospective studies at all) investigating these benefits. Hence benefits may be extrapolated mainly from models. However, this does not necessarily mean that the benefits do not exist; models that are based on established economic theory may meet the standard of evidence in many fields outside clinical epidemiology. It may also be possible to theorise about the direction of an effect without being able to quantify it, although for priority setting quantification would appear necessary.
7.3 **Good practice guidelines**

7.3.1 **Suitable to audience.**

The indicators selected to show the impact of vaccination must be useful to enable better decision making by the audience they are presented to. In particular, immediate health-related indicators (categories A1, A2, B1, B2, C1 and C2) may be of most relevance to national policy makers in the health field, while financial indicators (categories C3 and D1-3) may be of most relevance to those in finance and budgeting departments of government. Longer-term development related indicators (categories B1-3, C2, C4) may be of greatest interest to donors and external aid agencies.

In countries without formal pharmacoeconomic evaluation mechanisms, most decisions are not made by explicitly optimising a single composite measure. Hence presenting multiple indicators may often be preferable over single summary figure.

7.3.2 **Transparent and evidence-based**

Evidence (or lack thereof) informing the causal pathways between vaccination and changes in reported indicators should be made explicit, in a way that is understandable by their target audience. Some indicators are difficult to measure directly and are inferred using modelling. In these cases, the models built should be based on established economic and epidemiological theory, and the assumptions used made explicit.

7.3.3 **Feasible**

To be practical, collection of the outcomes of interest should be possible in expense and time commensurate to the importance of the decision being informed.

8 **Plans for future work**

- **Role of the GAVI Alliance**
  - GAVI does not envisage being a major financer of research except for small scale work that directly supports the five year business plan (i.e. not basic research or major trials). Current WHO BEIVIP work fits into the plan, but the countries and vaccines selected will need to fit into GAVI portfolio and priorities (rotavirus, pneumococcal, HPV, JE and rubella in GAVI-eligible countries).
  - GAVI is interested in work to support decision making by finance ministers of current and graduating GAVI countries about co-financing vaccines, as well as to make the case for funding to donors after 2015 (when current funding ends). The strongest case will need to be made at the end of 2013 (mid-term replenishment) and end of 2014 (new funding round), so projects that deliver results by then are most helpful.
GAVI can be a convening platform to bring funders (e.g. private donors, countries) and researchers together.

- Survey-based stakeholder research among finance ministers was proposed.
- Develop a choice-based survey and test it – e.g. use Discrete Choice methods.
- Strengthening empirical evidence behind causal links in the framework. Gold standard is RCTs with long-term follow-up and limited differential loss to follow-up. This has the potential to address the whole causal chain (from intervention to improved health status to downstream benefits) but would be too expensive to fund.
- Retrospective analyses alongside existing trials e.g. PCV and Hib trials in the Gambia (although it may be hard to identify an effect), trials in Bangladesh, malaria vaccine trials in Mozambique, Kenya (Kilifi), Tanzania (Ifakara/Bagomoyo), or pertussis trials in Sweden.
- Addressing the endogeneity problem (underlying differences between vaccinated and unvaccinated households) using statistical approaches like instrumental variables.
- Economic implications of sequelae of congenital rubella syndrome – especially mild impairment. There is a small study in Vietnam currently ongoing. Other experts like psychologists may need to be involved.
- Economic tools like generational accounting and EPIC are useful and could be presented to finance ministers.
- Generational accounting
  - Partly conditional on results of stakeholder research.
  - Looking across the entire vaccine portfolio, and investigating the impact of different investments.
  - Looking at other countries. Ideal candidates are low-income countries with reasonably functioning tax systems and social services.
  - PCV, HPV or Hib may be future possibilities to look at the impact of changes to cognition. The evidence behind such changes may be difficult to interpret – especially for subtle changes (i.e. not related to limb amputation or total deafness). However, the analysis could suggest whether such changes are likely to be economically important (and hence whether it is worth doing further studies to quantify).
  - Could communicate with Julia Stone who is conducting a literature review on the cognitive effects of vaccine-preventable diseases.
  - Further sensitivity analyses e.g. one-way, probabilistic and break-even analyses.
- Further sensitivity analyses for the EPIC model.
- Looking at catastrophic expenditure and equity, possibly involving willingness to pay studies.
- Assessing the uncertainty in evidence supporting links in the causal pathways, and the impact that this uncertainty has on model results.

9 Next steps
- Circulate draft report.
- Decide on work plan for 2013/4.
- Hold meeting in first half year of 2013 to report on final results.
10 Acknowledgments

Participants at discussions about the broader economic impact of vaccination in Toronto (2011), Geneva (2012) and the WHO QUIVER meeting in 2011.
11 References


Beutels P, Schuffman PA, MacInyre CR. Funding of drugs: do vaccines warrant a different approach? Lancet Infect Dis 2008; 8:727.


12 Annexes

12.1 Annex 1: Agenda and list of Attendees

WHO Consultation on the Broader Economic Impact on Vaccines and Immunization Programmes (BEIVIP)
C202, WHO-HQ, 28-29 June 2012

Agenda

Objectives:
- To present and discuss the interim results of the WHO study proposals.
- To propose modifications to the study proposals if possible based on feedback and comments from the meeting participants
- To identify common areas of interest where applicable
- To discuss the WHO framework on BEIVIP and its wider applicability to low and middle income countries

Expected outcomes:
- A common understanding of the different study proposals by the participants
- Agreed study proposals which contribute to the overall WHO framework on BEIV

Chair: P. Beutels
Rapporteur: M. Jit and J. Stone

**DAY 1 Thursday, 28 June**

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<th>Time</th>
<th>Activity</th>
<th>Presenter(s)</th>
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<td>09:00</td>
<td>Welcome and introduction of participants</td>
<td>R. Hutubessy</td>
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<td>09:15</td>
<td>Policy makers survey on BEIVIP (10’)</td>
<td>I. Van der Putten</td>
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<td>09:30</td>
<td>Presentation: Fiscal consequences for governments associated with population health changes in LMIC (15’)</td>
<td>M. Connolly/ N. Kotsopoulos</td>
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<td></td>
<td>Discussion</td>
<td>Plenary</td>
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10:30 **Coffee**

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<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>11:00</td>
<td>Presentation: Assessment of macroeconomic impact of vaccine preventable disease (15’)</td>
<td>J. Weiss</td>
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<tr>
<td>Time</td>
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<td>Speaker</td>
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<td>12:00</td>
<td>Presentation: Refine the decision analysis tool to inform policy discussions, in collaboration with stakeholders in India (15’)</td>
<td>S. Verguet</td>
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<tr>
<td>13:00</td>
<td>Lunch</td>
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<td>14:00</td>
<td>Presentation: To explore the broader economic benefits of prospective group A strep vaccination (GAS) (15’)</td>
<td>T. Barnighausen</td>
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<td></td>
<td>Discussion</td>
<td>Plenary</td>
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<tr>
<td>15.00</td>
<td>Discussion of interim results</td>
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<td>15:30</td>
<td>Coffee break</td>
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<tr>
<td>15:30</td>
<td>Discussion of interim results (continued)</td>
<td>Plenary</td>
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<td>17:45</td>
<td>Adjourn</td>
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<td><strong>DAY 2</strong></td>
<td><strong>Friday, 29 June 2012</strong></td>
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<tr>
<td>09:00</td>
<td>Generic Framework of the Broader Economic Impact on Vaccines and Immunization Programmes (15’)</td>
<td>M. Jit</td>
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<td>Discussion</td>
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<td>10:00-10:30</td>
<td>Recommendations on methods, use and study design</td>
<td>R. Hutubessy</td>
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<tr>
<td>10:30 – 11:00</td>
<td>Coffee</td>
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<tr>
<td>11:00</td>
<td>Future activities and studies</td>
<td>Plenary</td>
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<tr>
<td>12:30</td>
<td>Next steps and closure</td>
<td>R. Hutubessy</td>
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<tr>
<td>13:00</td>
<td>Adjourn</td>
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12.2 Annex 2: List of participants

Philippe Beutels, WHO IVIR AC member, University of Antwerp, Belgium

John Edmunds, WHO, IVIR AC member, London School of Hygiene and Tropical Medicine, London, UK

Mark Jit, WHO consultant, Health Protection Agency, UK

Peter Hansen, GAVI secretariat, Geneva, Switzerland

Juliana Stone, GAVI intern, Harvard School of Public Health, Boston, USA

Geoff Adlide (second day), GAVI secretariat, Geneva, Switzerland

Stephane Verguet, University of Washington, Seattle, USA

Jonathan Weiss, UNICEF, Copenhagen, Denmark

Nikos Kotsopoulos, University of Groningen, Netherlands

Mark Connolly, University of Groningen, Netherlands

Till Barnighausen, Harvard School of Public Health, Boston, USA (by telephone)

Andrew Steer, University of Melbourne, Australia (by telephone, first day)

Inge van der Putten, WHO intern, University of Maastricht, Netherlands

Raymond Hutubessy, WHO Initiative for Vaccine Research (IVR), Geneva, Switzerland