Global Health Policy: Vaccines

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Department of Pediatrics
Children’s Hospital Colorado
• Value of vaccines as a public health technology
• The global “preventive gap”
• Decision making and financing for world vaccines
• The road ahead: opportunities and challenges
Why are vaccines important?
Smallpox Eradication

Number of Countries Reporting Smallpox Cases 1950-1978

Beginning of WHO Intensified Worldwide Smallpox Eradication Program
Annual Count of Wild Poliovirus cases reported worldwide 1980-2010

No. of Poliomyelitis Cases, thousands

Year

No. of Cases, thousands

1293
Wild Poliovirus - 2013
01 January - 29 October

Excludes vaccine derived polioviruses and viruses detected from environmental surveillance.

Data in HQ as of 29 October 2013
Other diseases we have prevented with vaccines...

- Measles
- Diphtheria
- Tetanus
## EPI program success around the world

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diphtheria</td>
<td>7,088</td>
<td>5,000</td>
<td>82%</td>
<td>92.8%</td>
<td>26%</td>
</tr>
<tr>
<td>Tetanus</td>
<td>16,628</td>
<td>163,000</td>
<td>82%</td>
<td>85.8%</td>
<td>26%</td>
</tr>
<tr>
<td>Pertussis</td>
<td>151,568</td>
<td>254,000</td>
<td>82%</td>
<td>92.4%</td>
<td>26%</td>
</tr>
<tr>
<td>Polio</td>
<td>1,731</td>
<td>&lt;1000</td>
<td>83%</td>
<td>96.3%</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>600,000</td>
<td>281,972</td>
<td>*164,000</td>
<td>69%</td>
<td>NA</td>
</tr>
<tr>
<td>Measles</td>
<td></td>
<td></td>
<td>83%</td>
<td>93.6%</td>
<td>§ 58%</td>
</tr>
</tbody>
</table>

* 2008, § >90% coverage

http://www.who.int/immunization_monitoring/diseases/en/

Prepared by E. Asturias
Proportion of children younger than 1 year receiving three doses of diphtheria, tetanus, and pertussis vaccine, 1980–2009
• *Haemophilus influenzae* type b (Hib) is a bacterium which can cause meningitis and severe pneumonia

• 3 million cases of serious illness and 400,000 deaths each year in children under 5 years of age from Hib

• In 2006, only 26% of children worldwide received Hib vaccine

• 1/3 of the countries eligible for funding from the GAVI Alliance (i.e., Gross national income/capita <$1000 per year) are using Hib vaccines

• The Hib Initiative focuses on coordination, communication and research.
Countries having introduced Hib vaccine in 1997 and 2009

1997
- 29 countries introduced
- 2 countries partially introduced

2009
- 158 countries introduced
- 2 countries partially introduced

Source: WHO/IVB database, July 2010
193 WHO Member States. Date of slide: 29 July 2010
Vaccines as a public health technology

- Life saving
- Cost-effective
- Equitable
- Return on investment ± 18%
- But…
23 million children still unimmunised

Global number of under-five children unimmunised with 3 doses of DTP, 2011

GAVI-supported: 19.5 million
Non GAVI-supported: 3.4 million

India: 7.2 million
Nigeria: 3.1 million
Indonesia: 1.6 million
Ethiopia: 1.2 million
Pakistan: 0.9 million
DR Congo: 0.8 million
Afghanistan: 0.4 million
Chad: 0.3 million
Uganda: 0.3 million
Ukraine: 0.2 million
Rest of GAVI-supported: 3.5 million

Note: Revised figures for 2011 (July 2012)
Vaccination: WHO main functions

Immunization Policies
- Develop recommendations and strategies on vaccine use
  - Support strengthening of national decision making

Research on vaccines and implementation of vaccination
- Development of vaccines and related technologies
- Implementation research
- Evidence for decision making

Vaccine Quality and Safety
- Norms and Standards
- Prequalification
- Strengthening National Regulatory Authorities
- Global safety issues

Programme performance and new vaccines introduction
- Immunization system strengthening
- Accelerating disease control
- Support New Vaccine Introduction
- Strategic information and surveillance
WHO Vaccine Position Papers

- **Position papers = Key reference documents**
- **Developmental and review process** (follow recommendations of SAGE, extensive peer review, evidence-base, periodic updating)
- **Format**
  - Weekly Epidemiological Record
  - Current structure (Intro, background (Disease epidemiology, the pathogen, disease), info on vaccines (composition, safety, immune response, efficacy and effectiveness, cost effectiveness and any other relevant issue), WHO position on vaccine use)
- **Additional posting of information on the web**: Grading of Recommendations Assessment, Development and Evaluation (GRADE) tables, references, summaries (one pager and PowerPoint presentation)
Global Alliance for Vaccines and Immunization
Global coverage estimates, 1990-2010
DTP3, Measles, HepB3, Hib3, PCV3 and Rota

458,000 unvaccinated infants (DPT3) in EURO, 2010
29% live in countries eligible for GAVI Alliance funding

The Global Fund For Children’s Vaccines

GAVI Board
Establishes Principles recommendations on fund allocation

Contributors
Gates Foundation USA, UK, Norway, Netherlands, ...

The Fund
- Independent Board for fundraising & management
- Working Capital Account (at UNICEF) for vaccine procurement and resource disbursement

Financial Tools:
- Shares, matching grants

Vaccine procurement

Strengthened Immunization Services and New Vaccines Delivered in Countries

Immunization services
Vaccines & Safe injection materials
R & D (not yet active)
Five Strategic Objectives

- Improve access to sustainable immunization services
- Expand use of all existing cost-effective vaccines
- Accelerate introduction of new vaccines
- Accelerate R&D on vaccines for developing countries, (HIV/AIDS, malaria and tuberculosis)
- Make immunization coverage a centrepiece in international development efforts
Uptake of Hib and pneumococcal vaccines in high-income versus low-income countries

Hib = Haemophilus influenzae type b. PCV = pneumococcal vaccine.
Dashed line = projected uptake. Solid line = actual uptake

We still could reduce 1/5 of childhood deaths with current or upcoming vaccines.
# GAVI new vaccines support

<table>
<thead>
<tr>
<th>Vaccines currently supported</th>
<th>Under review 2013 and later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pentavalent</td>
<td>Japanese encephalitis</td>
</tr>
<tr>
<td>Pneumococcal conjugate</td>
<td></td>
</tr>
<tr>
<td>Rotavirus</td>
<td>Typhoid</td>
</tr>
<tr>
<td>Measles second dose</td>
<td>Dengue</td>
</tr>
<tr>
<td>Meningococcal A conjugate (campaigns)</td>
<td></td>
</tr>
<tr>
<td>Yellow Fever (routine &amp; campaigns)</td>
<td>Malaria</td>
</tr>
<tr>
<td>Measles campaigns in selected countries and outbreak response</td>
<td></td>
</tr>
</tbody>
</table>

**New in 2012:**

- HPV (national introduction & demo project)
- Rubella (MR campaigns)
- Also: meningitis and yellow fever vaccine stockpiles
Country eligibility policy:

- Threshold for 2012 is $1,520 GNI per capita (World Bank, Atlas method) – updated annually

- New vaccine introduction grant and operational support for campaigns policy – NEW!

- Co-financing policy
## Vaccine introduction grant levels

<table>
<thead>
<tr>
<th>GAVI support</th>
<th>Applicable to</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$0.80</strong> per child in the birth cohort</td>
<td>Penta, Rota, Pneumo, M2D, Rubella routine, YF routine</td>
</tr>
<tr>
<td>Or lump sum $100,000</td>
<td></td>
</tr>
</tbody>
</table>

- **HPV vaccines**

<table>
<thead>
<tr>
<th><strong>$2.40 per girl</strong></th>
<th>HPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Or lump sum $100,000</td>
<td></td>
</tr>
</tbody>
</table>

## Operational support for campaigns level

<table>
<thead>
<tr>
<th>GAVI support</th>
<th>Applicable to</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$0.65</strong> per target person</td>
<td>MenA campaign, YF campaign, MR campaign, measles campaigns</td>
</tr>
</tbody>
</table>
GAVI programmatic policies
Co-financing Policy

• Objective: to enhance ownership and put countries on a trajectory towards financial sustainability to prepare for phasing out of GAVI support.
  • All countries applying for NVS are required to co-finance a portion of the cost of requested vaccines*
  • 3 country groupings according to GNI per capita:

<table>
<thead>
<tr>
<th>Country group</th>
<th>GNI per capita threshold</th>
<th>Co-financing requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income</td>
<td>currently &lt;$1,005</td>
<td>$0.20 per dose</td>
</tr>
<tr>
<td>Intermediary</td>
<td>currently &gt;$1,005 to &lt;$1,520</td>
<td>$0.20 per dose + 15% annual increase</td>
</tr>
<tr>
<td>Graduating</td>
<td>Currently &gt; $1,520</td>
<td>Gradual ramp up over five years to reach projected price after GAVI</td>
</tr>
</tbody>
</table>

*The only exceptions from co-financing are vaccines for measles second dose, MenA and YF preventive campaigns and MR. Countries are however expected to pay a share of operational costs of campaigns.
UNICEF is the world’s largest purchaser of vaccines for developing countries and a key partner in global immunisation efforts.

Its supply division, based in Copenhagen, is responsible for global purchasing, including some $100 million per year spent on vaccines and safe injection equipment.
Who produces the vaccines of the world?

6.3 Billion Dose Global Market

- **sanofi pasteur**: 14% (.9 B)
- **GSK**: 20% (1.2 B)
- **Merck**: 1% (.4 B)
- **Wyeth**: 1%
- **Chiron**: 7%
- **Others**: 57% (3.6 B)

Source: WMA 2004, SP Internal
Note: SP MSD sales split by origin
Who shares the market from the vaccines of the world? (2008)

- **GSK**: 21.2%
- **Merck**: 21.6%
- **Wyeth**: 12.3%
- **Novartis**: 8.0%
- **Sanofi Aventis**: 21.8%
- **Others**: 15.0%

€15 B Global Market

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(1) Based on reported FY2008 results and sanofi-aventis internal estimates for "Others"
(2) Includes 50% of Sanofi Pasteur MSD joint venture sales
Competition and tiered pricing

Figure 21: Tiered pricing: vaccine prices in different markets

- **UNICEF/GAVI market**
- **US public market**

<table>
<thead>
<tr>
<th>Vaccine Type</th>
<th>Price per Dose (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monovalent* (HepB)</td>
<td>0.21</td>
</tr>
<tr>
<td>Tetravalent* (DTP3-HepB)</td>
<td>0.88</td>
</tr>
<tr>
<td>Pentavalent* (DTP3-HepB-Hib)</td>
<td>3.52</td>
</tr>
<tr>
<td>Pneumococcal**</td>
<td>70.29</td>
</tr>
<tr>
<td>Rotavirus***</td>
<td>55.73</td>
</tr>
</tbody>
</table>

* Average price per dose for 3-dose vaccines between 2006-2009
** 2010 price for 7-valent vaccines (US public market) and price for AMC vaccines (UNICEF/GAVI market)
*** 2010 average price per dose assuming 3-dose equivalence among available products (US public market)

Source: UNICEF Supply Division, CDC Vaccine Price List
### Prices of selected vaccines 2010 (in US$ and weighted average)

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>CDC (public)</th>
<th>CDC (private)</th>
<th>UNICEF to GAVI</th>
<th>PAHO Revolving fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTwP-Hib (10 doses per vial)</td>
<td>N/A</td>
<td>N/A</td>
<td>3.40</td>
<td>3.30</td>
</tr>
<tr>
<td>DTwP-HepB-Hib (pentavalent vaccine; one dose per vial)</td>
<td>N/A</td>
<td>N/A</td>
<td>3.01</td>
<td>3.20</td>
</tr>
<tr>
<td>Hib (one dose per vial)</td>
<td>N/A</td>
<td>N/A</td>
<td>3.40</td>
<td>2.25</td>
</tr>
<tr>
<td>Pneumococcal conjugate ten-valent (one or two doses per vial)</td>
<td>N/A</td>
<td>N/A</td>
<td>7.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Pneumococcal 13-valent (one dose per vial or prefilled syringe)</td>
<td>91.75</td>
<td>114.15</td>
<td>7.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Rotavirus (two-dose schedule)</td>
<td>83.75</td>
<td>102.50</td>
<td>N/A</td>
<td>7.50</td>
</tr>
<tr>
<td>Rotavirus (three-dose schedule)</td>
<td>59.18</td>
<td>69.59</td>
<td>N/A</td>
<td>5.15</td>
</tr>
</tbody>
</table>

* Pneumococcal vaccine prices based on AMC of $3.50 per dose + $3.50 subsidy

### Education in low-income countries yields high returns

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Private rate of return</th>
<th>Social rate of return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary schooling</td>
<td>26.4</td>
<td>20.6</td>
</tr>
<tr>
<td>Secondary schooling</td>
<td>18.5</td>
<td>14.1</td>
</tr>
<tr>
<td>Higher education</td>
<td>22.4</td>
<td>11.3</td>
</tr>
</tbody>
</table>

The economic impact of the demographic dividend

Demographic changes in China and India

Higher proportion of healthy young adults = wealth

Ethiopia 2010

Ethiopia 2030

[Diagrams showing population pyramids for Ethiopia 2010 and 2030, comparing male and female age groups]
Lifetime earning trajectory

- Income unskilled uneducated worker
- Income after schooling
- Fixed cost

Adapted from DE Bloom. Value of vaccines 2011
Extra-income after schooling

Earnings effects from vaccination

Income unskilled uneducated worker

Fixed cost

Adapted from DE Bloom. Value of vaccines 2011
Effect of vaccine prevention on earnings and wealth

- Fewer missed school days (better attendance)
- Less long term disability
- Changes in household behavior after survival
- Better cognitive development
  - Philippines: vaccination effect on scores in math, language and cognition
- Estimated return on investment of 21%
Global Immunization Vision and Strategy (GIVS) for the period 2006-2015

- UNICEF/WHO initiative
- Reduce mortality due to vaccine-preventable diseases by 2/3 by 2015
- Reach 90% coverage by 2015
- Introduce new vaccines (which?)
- Can we afford GIVS? Wolfson et al. (2008) try to answer this!
Current vaccines and vaccines on the horizon and impact on mortality

- Diphtheria
- Pertussis
- Tetanus
- Polio
- Measles
- Mening (conj)
- Hib (conj)
- Typhoid
- Cholera
- Rotavirus
- Pneumo (conj)
- HIV/AIDS
- Malaria
- TB
- Dengue
- Mening (conj)
- HP (conj)
- Rotavirus
- YF
- Influenza
- JE
- Rubella
- HepB
- Typhoid
- Hib (conj)
- Cholera
- Rotavirus
- Pneumo (conj)
- HIV/AIDS
- Malaria
- TB
- Dengue
- Mening (conj)
- HPV
- Pneumo (conj)
- Typhoid
- Hib (conj)
- Cholera
- Rotavirus
- Pneumo (conj)
- HIV/AIDS
- Malaria
- TB
- Dengue
- Mening (conj)
- HPV

Source – WHO, 2005
• Investment in vaccines by governments and the private sector
• Vaccines the number-one priority at the Gates Foundation
• Prevent the deaths of some 7.6 million children under 5 from 2010-2019
• 1.1 million children could be saved with the rapid introduction of a malaria vaccine beginning in 2014
Social Problems for the 21st Century

- Safety and Acceptance
- Cost and Availability
- Sufficient Production
Final Remarks on Vaccine Policy

- One of the most effective and equitable health preventive technologies
- Global Policy requires sound epidemiology, science, commitment and partnership
- Use of vaccines is key to their preventive success
- Addressing the safety and societal concerns is a priority