Introduction to Economic Evaluation

Presented by Dr. Chrispus Mayora
Choice of Whether to Invest In Vaccines is a Complex Dynamic

- Availability
- Political reality
- Feasibility
- Economic reality
- Health impact
- Equity
- Health impact
- Economic reality
- Feasibility
- Political reality
- Availability
Recap: Central Debate during COVID-19 Pandemic

• Production capacity of vaccine (Supply-side issues)
  • Will global production output of the vaccine be enough to sustain demand?

• Price of vaccine and cost of immunization (Financing issues)
  • With shrinking economies, how will funds be reallocated towards COVID-19 immunization and vaccine procurement from – other vaccine/immunization efforts? From other public health interventions? From other social programs?

• Storage of vaccine (Logistic and Operational issues)
  • If the vaccine requires specialized cold-chain equipment, are EPI programs able to reallocate funding towards acquiring the equipment?
  • Decrease inventory of other vaccines to make space for COVID-19 vaccine?

• Uptake of the vaccine (Demand-side issues)
  • How to obtain high coverage despite recent rumors and false information in media about COVID-19 vaccine?
  • At what cost will mass immunization campaigns affect the risk of being infected?
  • If supply of vaccine is low, which population sub-group to target?
Economic Evaluation In Health Care

*Resources are scare – choices must be made!*

**Study Design**
- Characteristics of the target population
- Specification of alternative programs/interventions
- Quantify resources consumed – valuation of resources
- Identification of consequences – measurement of benefit
Economic Evaluation Methods For Immunization
Economic Evaluation Methods

- Cost Finding
- Cost-minimization
- Cost (burden) of Illness
- Cost-Consequence
- Cost-Effectiveness
- Cost-Benefit
Economic Evaluation Methods
Cost Finding

Objectives:
• Identify resources consumed in the provision of a specific program or intervention
• Estimate the monetary value of these resources
**Economic Evaluation Methods**

**Cost-Minimization Analysis (CMA)**

Objectives:

- Identify resources consumed in the provision of alternative interventions
- Estimate the monetary value of these resources
- Compare the cost of the alternative interventions
- **Identify the least costly alternative**
Objectives:

- Focus on current status of the target population without intervention
- Estimate health care resources consumed and associated costs
- Quantify “burden of Illness” with metrics such as
  - mortality (years of life lost)
  - disability (limitations on daily activity)
  - lost productivity
Economic Evaluation Methods
Cost – Consequence Analysis

Objectives:
• Identify resources consumed in the provision of alternative interventions
• Estimate the cost of each alternative intervention
• Identify and quantify effects of each intervention
  • Patient and Family
  • Community
  • Health Care System
  • Nation
# Potential Economic Consequences (Benefits) of A Vaccine Program

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health gains</td>
<td>Direct</td>
<td>Reduction in mortality/morbidity</td>
</tr>
<tr>
<td>Health care cost savings</td>
<td>Direct</td>
<td>Averted medical expenditures (outpatient visits, hospitalizations, diagnostics and treatments, transport to the facility)</td>
</tr>
<tr>
<td>Care related productivity gains</td>
<td>Indirect</td>
<td>Savings of parents’ productive time and lost wages</td>
</tr>
<tr>
<td>Outcome-related productivity gains</td>
<td>Broader</td>
<td>Improves cognition and physical development, as well as school enrollment, attendance and educational attainment</td>
</tr>
<tr>
<td>Behavior-related productivity gains</td>
<td>Broader</td>
<td>Improves child health and survival and thereby changes household choices, such as fertility and consumption choices</td>
</tr>
<tr>
<td>Community externalities</td>
<td>Broader</td>
<td>Improves health among unvaccinated community members, general economic improvement</td>
</tr>
</tbody>
</table>

Measuring the “Output” of a Vaccine Program or Intervention

- Ideal metric combines both the *quantity* and *quality of life* as a result of the program or intervention

*Quality adjusted life-year (QALY)* - duration of survival weighted by a factor representing consumer strength of preference for state of health during this period – more common in Western countries, recommended by U.S. cost-effectiveness panel

*Disability-adjusted life-year (DALY)* - years lost relative to optimum survival weighted by a factor representing level of impairment – more commonly used in Vaccine economics, recommended by WHO
**Economic Evaluation Methods**

**Cost - Effectiveness Analysis**

### Objectives:
- Compare alternative programs in terms of efficiency
- "Benefit" is defined as units of output
  - example: output for an intervention that reduces mortality could be specified as “years of survival”
  - Same metric must be used for each alternative to enable comparison
- Efficiency of each alternative calculated as "cost per unit of benefit"
Economic Evaluation Methods  
Cost - Benefit Analysis (CBA)

Objectives:
- Compare alternative programs in terms of net social cost
- "Benefit" is defined as the monetary value
  - All relevant consequences for each intervention must be given a specific monetary value
  - Requires assumptions for monetary value of years of survival gained, days of disability avoided
- Net social cost of a program = value of benefit – cost
- Assess a single program: worthwhile if net social benefit >0
- Compare alternative programs: which has greater net benefit?
## Types of Analysis

<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Input/Cost</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Minimization</td>
<td>Monetary terms ($)</td>
<td>Not considered</td>
</tr>
<tr>
<td>Cost-Effectiveness</td>
<td>Monetary terms ($)</td>
<td>Natural units (e.g. child mortality/morbidity)</td>
</tr>
<tr>
<td>Cost-Utility</td>
<td>Monetary terms ($)</td>
<td>Utility measures (QALYs, DALYs, etc.)</td>
</tr>
<tr>
<td>Cost-Benefit</td>
<td>Monetary terms ($)</td>
<td>Monetary terms ($) (capture wider range of benefits)</td>
</tr>
</tbody>
</table>
Economic Evaluation Methods

Other Methods

• Budget Impact
  • Cost of a Vaccine absorbed over a pooled risk
  • Commonly interpreted by government or vaccine payers
  • Measure of cost of intervention for all those in need to entire population in terms of “Per member per month” or “Per member per year”

• Return on Investment (ROI)
  • Long-term outlook of costs recouped from benefit
  • Vaccine cost tradeoff to medical expenses
  • Generally measured over: 5 or 10 years
Summary

Role of economic evaluation of vaccines in health policy

Efficiency
Cost-effectiveness

Affordability
Budget Impact

Equity
Return on Investment
Understanding the ICER Plane
Cost-Effectiveness Analysis: “ICER”

“ICER” – Incremental Cost-effectiveness Ratio

\[
\text{ICER} = \frac{\text{Cost}_{\text{NEW PROGRAM}} - \text{Cost}_{\text{ALTERNATIVE}}}{\text{Output}_{\text{NEW PROGRAM}} - \text{Output}_{\text{ALTERNATIVE}}}
\]

Example - Hib conjugate vaccination in India (versus no vaccination)

“From a government perspective, cost-effectiveness ranged from $192 to $1033 per discounted DALY averted. With the inclusion of household healthcare costs, cost-effectiveness ranged from $155 to $939 per discounted DALY averted.”

Clark et al, J Pediatrics 2013;163:S60-S72
Example: Clark et. al, Hib Vaccine

Table IV. Hib vaccine impact and cost-effectiveness by state: aggregate estimates over the period 2012-2031

<table>
<thead>
<tr>
<th>State</th>
<th>Region</th>
<th>Pneumonia lives saved</th>
<th>Meningitis lives saved</th>
<th>NPDM lives saved</th>
<th>Total lives saved</th>
<th>Percent of USMR averted</th>
<th>Vaccine costs (millions)</th>
<th>Gov cost savings (millions)</th>
<th>Family cost savings (millions)</th>
<th>Total DALYs averted</th>
<th>US$ per DALY averted (government perspective)</th>
<th>US$ per DALY averted (societal perspective)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delhi</td>
<td>North</td>
<td>278</td>
<td>807</td>
<td>34</td>
<td>1119</td>
<td>0.6%</td>
<td>$36</td>
<td>$0.6</td>
<td>$3.2</td>
<td>34,470</td>
<td>1,033</td>
<td>939</td>
</tr>
<tr>
<td>Haryana</td>
<td>North</td>
<td>472</td>
<td>1,038</td>
<td>42</td>
<td>1,552</td>
<td>0.3%</td>
<td>$43</td>
<td>$0.3</td>
<td>$4.9</td>
<td>47,096</td>
<td>903</td>
<td>800</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>North</td>
<td>253</td>
<td>506</td>
<td>13</td>
<td>773</td>
<td>1.0%</td>
<td>$10</td>
<td>$0.3</td>
<td>$1.0</td>
<td>20,314</td>
<td>500</td>
<td>453</td>
</tr>
<tr>
<td>Jammu and Kashmir</td>
<td>North</td>
<td>262</td>
<td>662</td>
<td>19</td>
<td>943</td>
<td>0.3%</td>
<td>$20</td>
<td>$0.5</td>
<td>$1.2</td>
<td>25,620</td>
<td>777</td>
<td>728</td>
</tr>
<tr>
<td>Punjab</td>
<td>North</td>
<td>364</td>
<td>1,048</td>
<td>41</td>
<td>1,453</td>
<td>0.4%</td>
<td>$45</td>
<td>$0.4</td>
<td>$3.7</td>
<td>44,145</td>
<td>1,017</td>
<td>934</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>North</td>
<td>2,942</td>
<td>5492</td>
<td>140</td>
<td>8,575</td>
<td>0.4%</td>
<td>$118</td>
<td>$3.0</td>
<td>$9.9</td>
<td>220,070</td>
<td>524</td>
<td>479</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>Central</td>
<td>6050</td>
<td>2,315</td>
<td>59</td>
<td>8,424</td>
<td>1.0%</td>
<td>$51</td>
<td>$2.8</td>
<td>$11.3</td>
<td>197,709</td>
<td>425</td>
<td>188</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>Central</td>
<td>21,415</td>
<td>7,010</td>
<td>152</td>
<td>28,578</td>
<td>1.1%</td>
<td>$133</td>
<td>$5.6</td>
<td>$24.4</td>
<td>661,798</td>
<td>192</td>
<td>155</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>Central</td>
<td>30,054</td>
<td>12,112</td>
<td>364</td>
<td>42,531</td>
<td>0.5%</td>
<td>$432</td>
<td>$24.6</td>
<td>$82.6</td>
<td>1,040,354</td>
<td>392</td>
<td>312</td>
</tr>
<tr>
<td>Bihar</td>
<td>East</td>
<td>19,200</td>
<td>6,431</td>
<td>179</td>
<td>25,810</td>
<td>1.0%</td>
<td>$169</td>
<td>$2.4</td>
<td>$24.4</td>
<td>61,764</td>
<td>269</td>
<td>229</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>East</td>
<td>7,482</td>
<td>2,493</td>
<td>68</td>
<td>10,043</td>
<td>1.2%</td>
<td>$62</td>
<td>$2.5</td>
<td>$7.8</td>
<td>237,934</td>
<td>252</td>
<td>219</td>
</tr>
<tr>
<td>Orissa</td>
<td>East</td>
<td>4,820</td>
<td>1,995</td>
<td>60</td>
<td>6,876</td>
<td>0.7%</td>
<td>$58</td>
<td>$4.7</td>
<td>$4.9</td>
<td>169,599</td>
<td>315</td>
<td>286</td>
</tr>
<tr>
<td>West Bengal</td>
<td>East</td>
<td>12,577</td>
<td>5,468</td>
<td>147</td>
<td>18,191</td>
<td>1.5%</td>
<td>$130</td>
<td>$8.3</td>
<td>$8.9</td>
<td>439,363</td>
<td>276</td>
<td>259</td>
</tr>
<tr>
<td>North East*</td>
<td>North East</td>
<td>614</td>
<td>1,170</td>
<td>23</td>
<td>1,807</td>
<td>0.9%</td>
<td>$19</td>
<td>$0.3</td>
<td>$0.4</td>
<td>43,599</td>
<td>420</td>
<td>411</td>
</tr>
<tr>
<td>Gujarat</td>
<td>West</td>
<td>2,419</td>
<td>3,793</td>
<td>94</td>
<td>6,305</td>
<td>0.6%</td>
<td>$83</td>
<td>$1.1</td>
<td>$7.0</td>
<td>161,467</td>
<td>506</td>
<td>463</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>West</td>
<td>6,073</td>
<td>7,993</td>
<td>233</td>
<td>14,299</td>
<td>1.0%</td>
<td>$204</td>
<td>$4.6</td>
<td>$22.2</td>
<td>374,003</td>
<td>533</td>
<td>474</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>South</td>
<td>6,019</td>
<td>7,979</td>
<td>188</td>
<td>14,186</td>
<td>1.0%</td>
<td>$147</td>
<td>$2.2</td>
<td>$7.7</td>
<td>351,765</td>
<td>411</td>
<td>389</td>
</tr>
<tr>
<td>Karnataka</td>
<td>South</td>
<td>3,645</td>
<td>4,636</td>
<td>127</td>
<td>8,408</td>
<td>0.9%</td>
<td>$104</td>
<td>$1.7</td>
<td>$7.1</td>
<td>216,132</td>
<td>474</td>
<td>441</td>
</tr>
<tr>
<td>Kerala</td>
<td>South</td>
<td>662</td>
<td>1,403</td>
<td>58</td>
<td>2,123</td>
<td>2.0%</td>
<td>$51</td>
<td>$1.3</td>
<td>$3.2</td>
<td>64,781</td>
<td>775</td>
<td>725</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>South</td>
<td>2,266</td>
<td>3,490</td>
<td>107</td>
<td>5,863</td>
<td>0.8%</td>
<td>$90</td>
<td>$3.1</td>
<td>$4.4</td>
<td>156,945</td>
<td>555</td>
<td>526</td>
</tr>
<tr>
<td>India</td>
<td></td>
<td>127,869</td>
<td>77,840</td>
<td>2,150</td>
<td>207,859</td>
<td></td>
<td>$2,006</td>
<td>$70</td>
<td>$240</td>
<td>5,125,128</td>
<td>378</td>
<td>331</td>
</tr>
</tbody>
</table>

*The North East region includes Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, and Assam.
Four Regions in Space

A. Save Money, Improve Health

B. Spend Money, Improve Health

C. Spend Money, Reduce Health

D. Save Money, Reduce Health

Cost Difference

Health Lost

Health Gained
Cost-Effectiveness Plane

Standard of care
“No vaccination program”

New intervention
“Vaccination program”

Disability-adjusted life years averted
Cost-Effectiveness Plane

Reference Point (0,0) “No Vaccination Program”

Disability-adjusted life years averted
Interpreting the ICER (1)

Disability-adjusted life years averted

New Intervention
"Vaccination Program"
Interpreting the ICER (2)

New Intervention “Vaccination Program”
Interpreting the ICER (3)

Disability-adjusted life years averted

Cost

New Intervention
“Vaccination Program"
Interpreting the ICER (4)

Disability-adjusted life years averted

Cost

New Intervention “Vaccination Program”
Decision Rules for Vaccine CEA

<table>
<thead>
<tr>
<th>Cost Higher</th>
<th>Cost Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome Worse</td>
<td>Outcome Better</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Higher cost</td>
<td>Lower cost</td>
</tr>
<tr>
<td>Worse outcome</td>
<td>Worse outcome</td>
</tr>
<tr>
<td><em>Never prefer this alternative</em></td>
<td><em>Always prefer this alternative</em></td>
</tr>
<tr>
<td>Higher cost</td>
<td>Lower cost</td>
</tr>
<tr>
<td>Better outcome</td>
<td>Better outcome</td>
</tr>
<tr>
<td><em>Prefer if “Good value”</em></td>
<td></td>
</tr>
</tbody>
</table>

28
Grades for Adoption of New Vaccines

A: Compelling evidence for adoption
B: Strong Evidence
C: Moderate
D: Weak
E: Compelling evidence for rejection

When is an intervention “cost-effective”?

Cost

Societal maximum willingness to pay for Vaccine intervention “cost per DALY averted”

Disability-adjusted life years averted
WILLINGNESS-TO-PAY THRESHOLD
Spending On Vaccines: The Sorrow Of Consumption Quotas

Money Spent

THRESHOLD
SLOPE
(never spend more than $1 Per Vaccine)

Angle that represents $1 per Vaccine

200,000 Vaccinated children
Price Thresholds are Efficient

**Cost Difference**

Health Lost

C. Spend Money, Reduce Health

D. Save Money, Reduce Health

Health Gained

A. Save Money, Improve Health

B. Spend Money, Improve Health

THRESHOLD SLOPES (never spend more than this per unit)
Health Programs in Region B

<table>
<thead>
<tr>
<th></th>
<th>Cost In $100</th>
<th>Effect</th>
<th>C/E</th>
<th>ΔC</th>
<th>ΔE</th>
<th>ΔC/ΔE (ICER)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø</td>
<td>$0</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>A</td>
<td>$100</td>
<td>100</td>
<td>1</td>
<td>100</td>
<td>100</td>
<td>$1 per YLL</td>
</tr>
<tr>
<td>A+B</td>
<td>$150</td>
<td>140</td>
<td>1.1</td>
<td>50</td>
<td>40</td>
<td>$1.25 per YLL</td>
</tr>
<tr>
<td>A+B+C</td>
<td>$200</td>
<td>165</td>
<td>1.2</td>
<td>50</td>
<td>25</td>
<td>$2 per YLL</td>
</tr>
</tbody>
</table>

YLL is “year of life lost”
Choose your Strategy

Cost

Vaccination programs

A

A+B

A+B+C

Effect

X

X+Y

X+Y+Z

Reproductive health programs
High Willingness To Pay

Cost

Vaccination Program

A+B+C

A

X+Y+Z

THRESHOLD SLOPE 1 (never be on a slope that is steeper than these slope indicators)

X+Y

X

Reproductive health programs
Low Willingness To Pay

THRESHOLD SLOPE 2
(never be on a slope that is steeper)
Two Kinds of Lines

- **Cost Difference**

  - **THRESHOLDS LINES**
    Say “What slopes are acceptable”

  - **“Expansion Path” Lines**
    Say What is possible to achieve
Willingness-to-Pay Thresholds

• The ceiling ICER beyond which interventions are not considered to be cost-effective.
• Reflects the maximum value decision makers attach to health benefits
• More simply, represents the budget constraint faced by decision-makers.
• Three general approaches for identifying thresholds:
  – Based on % per capita GDP (most common)
  – Based on % per capita national incomes
  – Based on benchmark interventions
  – Based on league tables.

Willingness-to-Pay Threshold

• Under WHO-CHOICE recommendations:
  – if the ICER (valued in DALYs averted) is between the GDP per capita and 3 times the GDP per capita => cost-effective
  – if the ICER (valued in DALYs averted) is less than the GDP per capita => very cost-effective

• Common U.S. WTP thresholds:
  – $50,000/QALY to $150,000 per QALY
  – Some Economists argue patients are willing to pay 1x-3x of annual income
  – Could the increase in WTP be related to Pharmaceutical Pricing indices?

• U.K. Method

<table>
<thead>
<tr>
<th>Cost per QALY</th>
<th>Accepted</th>
<th>Restricted</th>
<th>Rejected</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; £20,000</td>
<td>14</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>£20,000 - £30,000</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>&gt; £30,000</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Towse and Pritchard, 2002
ICER CALCULATION, INCREMENTAL RATIOS AND DOMINANCE
Incremental cost-effectiveness ratio (ICER)

Incremental Thinking

• Compare one alternative with another
  – Start by comparing the least expensive to the 2\textsuperscript{nd} most expensive, to the 2\textsuperscript{nd} most expensive, to the 3\textsuperscript{rd} most expensive, etc.

• Focus on
  – Difference in costs: \(\text{Cost}_O - \text{Cost}_N\)
  – Difference in effects: \(\text{Effect}_O - \text{Effect}_N\)
  – where O is Old intervention and N is New intervention

<table>
<thead>
<tr>
<th>Effectiveness Decreases</th>
<th>Effectiveness Increases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Increases</td>
<td>Never Do</td>
</tr>
<tr>
<td>Cost Decreases</td>
<td>Cost-effective</td>
</tr>
</tbody>
</table>
Incremental cost-effectiveness ratio (ICER)

- Defined as the ratio between the incremental cost and the incremental effect between two interventions

\[
\frac{\text{Cost}_O - \text{Cost}_N}{\text{Effect}_O - \text{Effect}_N} = \frac{\Delta \text{Cost}}{\Delta \text{Effect}} = \text{ICER}
\]

Net Monetary Benefit

\[
\text{NMB} = (\text{WTP} * \Delta \text{Effect}) - \Delta \text{Cost}
\]
Strong Dominance

"Expansion Path" Lines
Say what is possible to achieve at lowest cost per health gain

Dominant choices lie below the expansion path. A choice here costs less and has a better outcome than choices in the Expansion Path.
Strong Dominance Example

Cost-effectiveness of infant vaccination with the 10-valent pneumococcal (PCV-10) vaccine vs. the current 13-valent (PCV-13), in Hong Kong in 2011

- PCV-10 exhibits dominance because it has a lower cost and higher health gains (e.g. QALYs gained) compared to PCV-13

Strong Dominance

• It is important to also put results in tables
  – Lining up alternatives in order by costs helps to make it obvious that the higher cost alternatives are associated with lower effectiveness

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Cost</th>
<th>QALYs</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV-10</td>
<td>$641,860,544</td>
<td>1,242,615</td>
</tr>
<tr>
<td>PCV-13</td>
<td>$675,994,429</td>
<td>1,242,525</td>
</tr>
</tbody>
</table>
Dominated Choices

Cost Difference

Dominated choices lie above the expansion path. They are possible to achieve but deliver less health at higher cost than other options. They are “dominated” so we do not choose them.

“Expansion Path” Lines
Say what is possible to achieve at lowest cost per health gain
Eliminating Dominated Alternatives Graphically

- Non-dominated alternatives get increasingly flatter as we move from less expensive to more expensive undominated alternatives

- Graph should resemble a “production function”
  - First unit of input produces more output than next unit of input and this trend continues
  - Creates a graph looking like the one below
BI and ROI Calculation
Budget Impact (Simplified)

• Assume the difference in cost of an ACE represents the gain or expense for implementing a vaccine per-patient.

• In order to support investment in vaccines, these gains or expenses multiplied by the entire at-risk population (i.e. the population that you intend to vaccinate) represent the total cost for society to implement.

• The budget impact is not the total cost, but the cost per person who pays into the health system (e.g. taxes)

\[
\text{Cost Difference } \frac{dCost \times N}{P} \text{ Total Paying Population } P = \text{ Budget Impact } \frac{dCost \times N}{P}
\]
There are 227 million children in India who would benefit from Hib vaccine. There are 1.3 billion people living in the country, of which half are taxpayers. As a health economist you have calculated the cost-effectiveness of the Hib vaccine from the societal perspective.

The government of India, would like you to assess the total cost for the country to implement this vaccination program which will be financed from the taxes collected. What is the budget impact per person per year?
Answer

• Cost difference = -$3.63
• No. of children vaccinated = 22 million
• **Total program cost** = $3.63 x 22 million
  
  = $80 million

• Total population of India = 1.3 billion
• **Total paying population** = 0.5 x 1.3 billion = 650 million

• **Budget Impact** = Total program cost / paying population
  
  = $80 million / 650 million
  
  = $0.12 per person per year
Return on Investment (ROI)

\[ ROI \ (%) = \frac{Net \ Profit}{Investment} \times 100 \]

\[ Net \ Profit = Total \ Program \ Savings - Total \ Program \ Cost \]

- A linear function, not adjusted for anything else
- Important to define the amount of time over which an investment is being measured
- Expressed as a percent of total investment returned or lost at the end of the time horizon
- Can also be considered as the time to achieve 100% ROI (full return)
  - \[ = \frac{Time \ Period \ considered}{ROI} \]
Question

Assume that the program cost calculated above represents an up-front for all children between Years 0 and 1. Investing in the Hib vaccine will save $180 million in healthcare treatment costs over the next 10 years.

1. What is the return on investment (ROI) for introducing Hib vaccine?
2. How long will it take to receive a full return on the investment?
Answer

• Total program cost = $80 million
• Total program savings = $180 million
• Total time period = 10 years

• **Net profit** = $180 million - $80 million
  = $100 million

• **ROI** = (Net Profit / Investment) x 100 = $100 million x 100 = 125% $80 million

  *for every 1$ invested, you get $1.25 back*

• **Time to receive 100% ROI** = 10 years = 8 years
  125%