Reporting and Interpreting Results of Economic Evaluation
Overview

• Understanding a CEA Plane
• Willingness-to-Pay Threshold
• ICER calculation, incremental ratios and dominance
• Interpreting ICER/ICUR
  – Perspective
  – Time Horizon
• Reporting Quality of Analysis
  – Impact Inventory (Second Panel)
  – CHEERS Checklist
  – QHES Assessment Instrument
Objectives

• To provide background on the rationale and importance of Decision Analysis (DA) and Cost-effectiveness Analysis (CEA)

• To explain the theoretical foundations DA/CEA
# 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>
UNDERSTANDING THE COST-EFFECTIVENESS ANALYSIS (CEA) PLANE
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**
Grades for Adoption of New Vaccines

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

Example 1
Efficiency Curve/ Efficient Frontier

Example 2: PCV-10 vs. PCV-13

SA indicated that PCV-10 would generate more QALYs and save costs compared to PCV-13.
WILLINGNESS-TO-PAY THRESHOLD
Spending On Vaccine: The Heartbreak Of Budget Caps

Cost Difference

$1

Budget Cap
(never spend more than this on one vaccine)

Number of patients vaccinated
Spending On Vaccine: The Sorrow Of Consumption Quotas

Cost Difference

Consumption Quotas
(Cannot afford more than this many vaccines per year)

200,000 vaccines
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

A. Save Money, Improve Health

C. Spend Money, Reduce Health

D. Save Money, Reduce 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>∆C</th>
<th>∆E</th>
<th>∆C/∆E (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 saved</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+B+C
A+B
A

X

X+Y+Z

X+Y

X

Reproductive health programs
High Willingness To Pay

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

Vaccination Program

A+B+C

Cost

A

X

Y

Z

X+Y

X+Y+Z

X+Y+Z

Reproductive health programs
Low Willingness To Pay

Cost

Vaccination programs

A+B+C

A+B

A

X+Y+Z

X+Y

X

Reproductive health programs

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

Cost Difference

Health Lost

Health Gained

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\(^{nd}\) most expensive, to the 2\(^{nd}\) most expensive, to the 3\(^{rd}\) 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>Effect Increases 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

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

Cost Difference

Health Lost

Health Gained

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

“Expansion Path” Lines
Say what is possible to achieve at lowest cost per health gain.
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 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.
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
REPORTING ON QUALITY OF ANALYSIS
CHEERS Checklist

• **Aim:** Provide recommendations, in the form of a checklist, to optimise reporting of health economic evaluations

• **Primary Audience:** Researchers reporting economic evaluations, the editors and peer reviewers evaluating their publication potential

• Consists of a **24 item checklist** with recommendations on the minimum amount of information to be included
  

CHEERS Checklist - full list of items discussed

Title and abstract
1. Title
2. Abstract

Introduction
3. Background & Objectives

Methods
4. Target Population & subgroups
5. Setting and location
6. Study perspective
7. Comparators
8. Time horizon
9. Discount rate
10. Choice of health outcomes
11. Measurement of effectiveness
12. Measurement and valuation of preference based outcomes
13. Estimating resources and costs
14. Currency, price date, and conversion
15. Choice of model
16. Assumptions
17. Analytical methods

Results
18. Study parameters
19. Incremental costs and outcomes
20. Characterizing uncertainty
21. Characterizing heterogeneity

Discussion
22. Study findings, limitations, generalizability, and current knowledge

Other
23. Source of funding
24. Conflicts of interest

QHES Assessment

• Instrument designed to evaluate all 3 types of health economic analyses
  – cost-minimization
  – cost-effectiveness
  – cost-utility

• **Consists of 16 criteria** (based on criteria included in 19 existing guidelines and checklists for cost-effectiveness evaluations)

• Each criterion has a weighted point value
  • generated using random-effects general least-squares regression

• The perfect quality score for a study is 100
**QHES Assessment**

Examining the Value and Quality of Health Economic Analyses: Implications of Utilizing the QHES

<table>
<thead>
<tr>
<th>Questions</th>
<th>Points</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Was the study objective presented in a clear, specific, and measurable manner?</td>
<td>7</td>
<td></td>
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</tr>
<tr>
<td>2. Were the perspective of the analysis (societal, third-party payer, etc.) and reasons for its selection stated?</td>
<td>4</td>
<td></td>
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</tr>
<tr>
<td>3. Were variable estimates used in the analysis from the best available source (i.e., randomized control trial - best, expert opinion - worst)?</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. If estimates came from a subgroup analysis, were the groups prespecified at the beginning of the study?</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Was uncertainty handled by (1) statistical analyses to address random events, (2) sensitivity analyses to cover a range of assumptions?</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Was incremental analysis performed between alternatives for resources and costs?</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Was the methodology for data abstraction (including the value of health states and other benefits) stated?</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3% to 5%) and justification given for the discount rate?</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described?</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Were the primary outcome measure(s) for the economic evaluation clearly stated and did they include the major short-term was justification given for the measures/scales used?</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Were the health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for the measures/scales used?</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Were the economic model (including structure), study methods and analysis, and the components of the numerator and denominator displayed in a clear, transparent manner?</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Were the choice of economic model, main assumptions, and limitations of the study stated and justified?</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Did the author(s) explicitly discuss direction and magnitude of potential biases?</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Were the conclusions/recommendations of the study justified and based on the study results?</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Was there a statement disclosing the source of funding for the study?</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL POINTS** 100

Case study review and application of the IMPACT/CHEERS checklist to score the quality of the study

Impact and Cost-Effectiveness of *Haemophilus influenzae* Type b Conjugate Vaccination in India

Andrew D. Clark, MA¹, Ulla K. Griffiths, PhD¹, Syed Shahid Abbas, MBBS, MPH², Krishna D. Rao, PhD², Lois Privor-Dumm, MIBS³, Rana Hajjeh, MD⁴, Hope Johnson, PhD³, Colin Sanderson, MA, MSc, PhD¹, and Mathuram Santosham, MD, MPH³
### Title and abstract

<table>
<thead>
<tr>
<th>1. Title (describe economic evaluation &amp; interventions)</th>
<th>- Compares the Hib vaccine and status-quo in CEA.</th>
</tr>
</thead>
</table>
| 2. Abstract (structured summary of obj, perspective, setting, methods--design & inputs, results--base case & SA, conclusion) | - Impact & CEA of Hib vaccine  
- Government Perspective,  
- State level analysis from India  
- Decision model & 2nd effects and cost data.  
- US$192-1,033/DALY averted (gov.t perspective) OR US$155-939/DALY averted (gov.t perspective). SA of key parameters.  
- CE under WHO guidelines. Hib increased costs are offset by healthcare savings |

### Introduction

- National safe & effective Hib vaccine implemented in most countries but slow adoption in India. Mixed regional evidence.  
- Lack of consensus on CE of national coverage in India.  
- Estimate state level and national level CE of Hib vaccine (compared to status-quo assumed)  
- Help decision-makers invest in the health interventions that provide greatest health returns per money invested

### Methods

<table>
<thead>
<tr>
<th>4. Target Population</th>
<th>All children in India under 5 years of age with Hib disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Setting and location</td>
<td>State-level estimates</td>
</tr>
<tr>
<td>6. Study perspective</td>
<td>Societal: Including costs incurred by the Indian Government, the GAVI Alliance, and Indian households</td>
</tr>
<tr>
<td>7. Comparators</td>
<td>Hib vs. non-Hib conjugate vaccination</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>8. Time horizon</strong></td>
<td>Aggregated costs &amp; benefits of routine vaccination over 20 years, 2012-31 -Vaccine costs occur during the 1st year of each cohort. -Disease cases, deaths, and treatment costs estimated for 1st 5 yrs. of age -DALYs and sequelae costs estimated over lifetime.</td>
</tr>
<tr>
<td><strong>9. Discount rate</strong></td>
<td>Costs and health benefits discounted by 3%/year</td>
</tr>
<tr>
<td><strong>10. Choice of health outcome</strong></td>
<td>-Primary health outcomes: Hib related lives saved and DALYs averted -Secondary health outcomes: No. of Hib cases: Hib Meningitis, Hib Pneumonia, Hib NPNM, and sequelae, outpatient visits, hospitalizations, -Population simulation model parameters: births, infant mortality, mortality of under-5 yrs. olds, LE, vaccine coverage and efficacy</td>
</tr>
<tr>
<td><strong>11. Measurement of effectiveness</strong></td>
<td>-Secondary literature for both primary and secondary health outcomes. -For DALYs: age distribution of Hib disease, disability weights, incidence of sequelae cases</td>
</tr>
<tr>
<td><strong>12. Measurement and valuation of preference based outcomes</strong></td>
<td>N/A, used DALYs</td>
</tr>
<tr>
<td><strong>13. Estimating resources and costs</strong></td>
<td>Health care: outpatient and hospital cost at public and private facilities (varied by level and type), traditional healers and drugs, -Household medical expenses for respiratory ailments in children &lt;5 years old by type (medicines, user fees, lodging, transport, etc.) -Opportunity costs (time spent while looking after a sick child) -Government costs (from micro-simulation study) &amp; NGO costs -Hib Conjugate Vaccine Cost</td>
</tr>
<tr>
<td><strong>14. Currency, price date, and conversion</strong></td>
<td>Secondary literature for price data. Costs were estimated in 2010 US$ using an exchange rate of 45.7 Indian rupees for one US$</td>
</tr>
</tbody>
</table>
15. Decision-analytical model used

Figure 1. Hib CEA decision model used in prior literature, Clark et al (2012)

| 16. Assumptions  
(decision-analytical model) | **Cases incidence**  
-On the % of bacterial meningitis cases caused by Hib, assumed the % of unconfirmed cases attributable to Hib to be the same as the % of confirmed cases attributable to Hib (44%)  
-Final adjusted Hib meningitis incidence was 22/100K children same in all states  
-Clinical pneumonia incidence varied by site, assumed national range  
-23.6% CFR for all severe untreated pneumonia  
-23% of the cases had no access to formal medical care  
**Costs**  
-Children with access to medical care were admitted to hospitals |
|---|---|
| 17. Analytical methods  
(approaches to validate or make model adjustments, etc.) | **Sensitivity Analysis**  
-Varied each parameter in turn by 10% (univariate 1-way sensitivity analysis)  
-Changed combinations of influential parameters (multivariate scenario analysis), ran 19 alternative scenarios, including worst case. |
Results

18. Study parameters (report values, ranges, references, and table)

Tables 1-3, Figures 2 & 3

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>NPNM lives saved</th>
<th>Total lives saved</th>
<th>Percent of U5MR 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>1033</td>
<td>939</td>
</tr>
<tr>
<td>Haryana</td>
<td>North</td>
<td>472</td>
<td>1038</td>
<td>42</td>
<td>1552</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>1048</td>
<td>41</td>
<td>1453</td>
<td>0.4%</td>
<td>$45</td>
<td>$0.4</td>
<td>$3.7</td>
<td>44 145</td>
<td>1017</td>
<td>934</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>North</td>
<td>2942</td>
<td>5492</td>
<td>140</td>
<td>8575</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>2315</td>
<td>59</td>
<td>8424</td>
<td>1.0%</td>
<td>$51</td>
<td>$2.8</td>
<td>$11.3</td>
<td>197 709</td>
<td>245</td>
<td>188</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>Central</td>
<td>21 415</td>
<td>7010</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>6431</td>
<td>179</td>
<td>25 810</td>
<td>1.0%</td>
<td>$169</td>
<td>$2.4</td>
<td>$24.4</td>
<td>617 964</td>
<td>269</td>
<td>229</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>East</td>
<td>7482</td>
<td>2493</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>4820</td>
<td>1995</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>5468</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>256</td>
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<tr>
<td>North East*</td>
<td>North East</td>
<td>614</td>
<td>1170</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>
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<tr>
<td>Gujarat</td>
<td>West</td>
<td>2419</td>
<td>3793</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>6073</td>
<td>7993</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>6019</td>
<td>7979</td>
<td>188</td>
<td>14 186</td>
<td>1.0%</td>
<td>$147</td>
<td>$2.2</td>
<td>$7.2</td>
<td>351 765</td>
<td>411</td>
<td>389</td>
</tr>
<tr>
<td>Karnataka</td>
<td>South</td>
<td>3645</td>
<td>4636</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>1403</td>
<td>58</td>
<td>2 213</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>2266</td>
<td>3490</td>
<td>107</td>
<td>5 683</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>2150</td>
<td>20 785</td>
<td></td>
<td>$2006</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.
20. Characterizing uncertainty

Figure 5

Figure 5. Scenario analysis showing the cost per DALY averted for the base case scenario and the cumulative effect of introducing favourable and unfavorable assumptions in sequence. The plus symbol (+) indicates the sequential and cumulative addition of assumptions to the base case. These are either favorable to the vaccine (bottom half of chart) or unfavorable to the vaccine (top half of chart).
21. Characterizing heterogeneity

Figure 4

*Figure 4. Impact and cost-effectiveness of Hib vaccination by State of India.*

### Discussion

**22. Study findings, limitations, generalizability, and current knowledge**

- Authors report a cost of US$819/DALY from the gov. perspective, and report similarity with prior estimates from similar Haryana State study (US$903).
- Hib vacc. would increase costs by US$130M. But $ is much less than other countries, & is offset by healthcare savings (77% of which is from OOP).
- Limitations: Lacking or uncertain info. on risk factors for “Hib pneumonia” were assumed same as “all-cause pneumonia”. Also, assumptions on state-level variation. Ex: tested a 50% of the base case incidence for Hib pneumonia. Uncertain parameters varied in SA. Results consistent.

### Other

**23. Source of funding**

Author M.S. received research funding from GlaxoSmithKline, Merck, and Pfizer (previously Wyeth Lederle Vaccines), served on their scientific advisory boards and received honoraria for these activities.

**24. Conflicts of interest**

Other authors declare no conflicts of interest, real or perceived.
## Impact Inventory Template (1)

### Formal Health Care Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Type of Impact (list category within each sector with unit of measure if relevant)a</th>
<th>Included in This Reference Case Analysis From...Perspective?</th>
<th>Notes on Sources of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Health Care Sector</td>
<td>Socetal</td>
</tr>
<tr>
<td>Health</td>
<td></td>
<td></td>
<td>1st 5 yrs. of age</td>
</tr>
<tr>
<td></td>
<td>Health outcomes (effects)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longevity effects</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td></td>
<td>Health-related quality-of-life effects</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td></td>
<td>Other health effects (eg, adverse events and secondary transmissions of infections)</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td></td>
<td>Medical costs</td>
<td>☑</td>
<td>NGO</td>
</tr>
<tr>
<td></td>
<td>Paid for by third-party payers</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paid for by patients out-of-pocket</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Future related medical costs (payers and patients)</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Future unrelated medical costs (payers and patients)</td>
<td>☑</td>
<td></td>
</tr>
</tbody>
</table>

### Informal Health Care Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Type of Impact (list category within each sector with unit of measure if relevant)a</th>
<th>Included in This Reference Case Analysis From...Perspective?</th>
<th>Notes on Sources of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Health Care Sector</td>
<td>Socetal</td>
</tr>
<tr>
<td>Health</td>
<td></td>
<td></td>
<td>1st 5 yrs. of age</td>
</tr>
<tr>
<td></td>
<td>Patient-time costs</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Unpaid caregiver-time costs</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Transportation costs</td>
<td>☑</td>
<td></td>
</tr>
</tbody>
</table>

a. Categories listed are intended as examples for analysts.

Impact Inventory Template (2)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Type of Impact</th>
<th>Included In This Reference Case Analysis From...Perspective?</th>
<th>Notes on Sources of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non--Health Care Sectors (with examples of possible items)</td>
<td>Labor market earnings lost</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost of unpaid lost productivity due to illness</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost of uncompensated household production</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Productivity</td>
<td>Future consumption unrelated to health</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>Cost of social services as part of intervention</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Social Services</td>
<td>Number of crimes related to intervention</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Legal or Criminal Justice</td>
<td>Cost of crimes related to intervention</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Impact of intervention on educational achievement of population</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Housing</td>
<td>Cost of intervention on home improvements (eg, removing lead paint)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Production of toxic waste pollution by intervention</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Other (specify)</td>
<td>Other impacts</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

b. Examples include activities such as food preparation, cooking, and clean up in the household; household management; shopping; obtaining services; and travel related to household activity

Sanders et al (2016)
Exercise: Reporting and Interpreting Vaccine CEA Results

• Review questions in groups
• Discuss potential responses
• Respond to questions online
Discussion Questions (Quiz)

1. Looking at the CEA Plane, interventions that fall under which of the four quadrants should never be implemented or should be stopped.
   a. Quadrant I. Interventions that increase costs and increase effectiveness
   b. Quadrant II. Interventions that increase costs and decrease effectiveness
   c. Quadrant III. Interventions that safe money and decrease effectiveness
   d. Quadrant v. Interventions that safe money and increase effectiveness

2. What is an efficient Willingness-to-Pay threshold?
   a. Budget caps (e.g. spend up to $200 in 1 year)
   b. Consumption quotas (e.g. get up to 5 hospital beds in 1 year)
   c. Prices caps (e.g. spend up to the average price)
   d. Both a and c

3. Which of the following statements is TRUE about the incremental-cost-effectiveness ratio (ICER)?
   a. The ICER informs about the extra amount of money that will be spent
   b. Decision maker is left to decide if spending the amount implied by the ICER to reach the next most expensive alternative is worthwhile
   c. Decision maker uses his or her own judgment to decide how much is worthwhile to spend
   d. If there are multiple undominated programs, first ask if it is worthwhile to spend the additional amount on the next to the least expensive undominated alternative. If it is worthwhile, then ask about moving up to
   e. All of the above

4. Which of the following statements about dominant and dominated alternatives is/are true?
   a. A dominated alternative is worse than some combination of two alternatives
   b. A dominant alternative is always more effective and more expensive
   c. A dominant alternative is both more effective and less expensive
   d. Both a and c

5. Which of the following is/are not one of the items part of the minimum information to be included when reporting economic evaluations
   a. Conflict of interest
   b. Currency, price date, and conversion
   c. Setting and location
   d. Incremental costs and outcomes
   e. Author’s affiliation
# Decision Tree Model in Excel

## Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy of Hib Vaccine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability of Hib Meningitis/Pneumonia with No Vaccine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability of Hospitalization following Hib</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability of All-cause Hospitalization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs ($)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Hib Vaccine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of ReVaccine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Pay for Hib Vaccine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Pay for ReVaccine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Patient for Hib Vaccine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Government/Payer for Hospitalization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Patient for Hospitalization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Government/Payer for Outpatient Care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Patient for Outpatient Care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility (QALY)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility for Hospitalization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility for Outpatient Care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility for No Utilization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Expectancy for those hospitalized</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Expectancy for those not hospitalized</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Decision Tree

- **Hib Vaccine**
  - Hospitalization
  - No Illness
    - No Utilization
- **No Vaccine**
  - Hospitalization
  - No Illness
    - No Utilization

## Probabilities

- **Probability of Outcome**
  - Societal Cost
  - Cost to Government/Payer
  - Cost to Patient
  - Weighted Societal Cost
  - Weighted Payer Cost
  - Weighted Patient Cost
  - Health Utility
  - Expectancy
  - Weighted Life Expectancy
  - DALY
  - Weighted DALY

## Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>No Vaccine</th>
<th>Hib Vaccine</th>
</tr>
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<tbody>
<tr>
<td>Societal Cost</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Payer Cost</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Patient Cost</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Life Expectancy</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>DALY</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>