Cost-effectiveness of typhoid vaccine strategies: evidence gaps and recommended methods

Ginny Pitzer
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What are the types of questions that can be addressed through economic evaluations?

- Is it cost-effective to implement typhoid vaccination in conjunction with existing public health interventions?
- Is it more cost-effective to introduce routine vaccination with TCV alone or in combination with a one-time catch-up campaign?
- Is targeted or universal typhoid vaccination more cost-effective?
• Clearly define question and target audience (e.g. MoH vs Gavi)

• Type of evaluation
  – **cost-utility analysis** ($ per DALY averted) vs **cost-benefit analysis** (compare monetary investment vs costs averted)

• Target population
  – e.g. specific age group or geographic area

• Define comparators:
  – type of vaccine (e.g. TCV vs Vi-PS)
  – delivery strategy (routine EPI vs catch-up campaign) and coverage
  – “current practice” should be baseline comparator

• Perspective of analysis:
  – healthcare provider vs societal (ideally)

• Analytical horizon:
  – should be long enough to capture all impacts from the vaccine (at least 10 years for TCV)
Cost components of economic evaluations

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine costs</td>
<td>• Include wastage rate and uptake of vaccination</td>
</tr>
<tr>
<td>Administration associated costs</td>
<td>• Depends on the vaccine delivery strategy selected</td>
</tr>
<tr>
<td>Costs of strategies to increase uptake of typhoid vaccination</td>
<td>• The uptake of typhoid vaccination affects both costs and outcome of the program</td>
</tr>
<tr>
<td>Costs for patients and family</td>
<td>• Inclusion of indirect costs in societal perspective or patients out of pocket expense when patient perspective is selected, but report separately</td>
</tr>
<tr>
<td>Typhoid fever treatment costs</td>
<td>• Inclusion of medical costs related to typhoid treatment, possibly accounting for AMR</td>
</tr>
</tbody>
</table>

- *Which costs components to be included depends primarily on the perspective of the analysis*
Assessing the impact of vaccination

- Should be based upon the best available evidence of vaccine effectiveness
  - including duration of protection
  - rate of vaccine uptake

Incorporation of herd effects

- **Dynamic transmission models** needed to estimate the overall impact across different levels of coverage.
- **Chronic carriers** are expected to affect the level of indirect protection: the more carriers, the lower the level of indirect protection expected.
- Indirect effects could lead to an **increase in age of infection** by decreasing transmission and the rate at which immunity from natural infection is acquired among unvaccinated.
- Incorporating indirect effects in **static models** should be done in sensitivity analysis only.
Presenting results of economic evaluations

- Incremental Cost-Effectiveness Ratio (ICER) should be calculated and presented with a range of willingness-to-pay thresholds

\[
\frac{\Delta \text{Costs}}{\text{DALYs averted}}
\]

<table>
<thead>
<tr>
<th>Program</th>
<th>D</th>
<th>A</th>
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</thead>
<tbody>
<tr>
<td>Incremental Cost</td>
<td>-4</td>
<td>4</td>
</tr>
<tr>
<td>Incremental Benefit</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>Preference</td>
<td>Dominant</td>
<td>Dominated</td>
</tr>
<tr>
<td><strong>ICER</strong></td>
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</tbody>
</table>
Sensitivity analyses

- Some parameters are uncertain or unknown especially for newly-developed TCVs
- Uncertainty can be explored using *probabilistic sensitivity analysis*, with results presented using cost-effectiveness acceptability curve (CEAC)
- Uncertain parameters:
  - costs of illness
  - vaccine price and delivery costs
  - vaccine effectiveness
  - hospitalization rate
  - case fatality rate
  - incidence of typhoid
- **Value of information analysis** (estimating EVPPI) is also recommended
Example: Cost-effectiveness of TCV strategies

Cost-effectiveness plane

Cost-effectiveness acceptability curve (CEAC)

Cost-effectiveness acceptability frontier (CEAF)

Cambodia
Example: Cost-effectiveness of TCV strategies

Cost-effectiveness plane

Cost-effectiveness acceptability curve (CEAC)

Cost-effectiveness acceptability frontier (CEAF)

WTP

GDP

Willingness-to-pay threshold ($/DALYs averted)

Incremental costs (2016US$)

Not cost-effective

Cost-effective

Cost-saving

DALYs averted

Probability highest net benefit

Probability highest net benefit

Willingness to pay threshold ($/DALYs averted)

Cambodia

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GDP

Not cost-effective

Cost-effective

Cost-saving

10mil

0

-10mil

-20mil

-30mil

0

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4 mil

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Value of information analysis

- Decisions need to be made in the context of uncertainty
- TCV introduction including a catch-up campaign is likely to be cost-effective in most Gavi-eligible countries

- Probability of hospitalization, case fatality rate, and typhoid incidence rate were the primary sources of uncertainty in most settings

Bilcke et al, Lancet Infect Dis (in press)
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