Prevalence to incidence

Philippe Glaziou
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Incidence \approx \frac{Prevalence}{Duration}
Two methods

1. Based on the ratio untreated / treated, using a very simple deterministic model
2. Based on standard assumptions about disease duration in 4 different case categories
\[
\frac{dU}{dt} = I - (\mu_u + \theta_u + \delta)U \\
\frac{dT}{dt} = \delta U - (\mu_T + \theta_T)T
\]

At equilibrium,

\[
I = \frac{U}{d_U} \\
\delta U = \frac{T}{d_T}
\]

\[
d_U = (1 - \pi) \frac{U}{T} d_T \\
\pi = \text{proportion of incidence that dies or self-cures before being treated}
\]
Method 1
$\pi \sim U (0, 0.1)$

<table>
<thead>
<tr>
<th></th>
<th>$U$</th>
<th>$T$</th>
<th>Prevalence (per 1000)</th>
<th>Duration (year)</th>
<th>Incidence (per 1000/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia 2002</td>
<td>260</td>
<td>42</td>
<td>12 (10-15)</td>
<td>2.9 (1.9-4)</td>
<td>4 (2.5-5.8)</td>
</tr>
<tr>
<td>Cambodia 2011</td>
<td>205</td>
<td>80</td>
<td>8.3 (7.1-9.8)</td>
<td>1.2 (0.8-1.6)</td>
<td>6.7 (4.5-9.3)</td>
</tr>
<tr>
<td>Myanmar 2009</td>
<td>300</td>
<td>79</td>
<td>6.1 (5-7.5)</td>
<td>1.8 (1.1-1.6)</td>
<td>3.3 (2-4.8)</td>
</tr>
<tr>
<td>Thailand 2012</td>
<td>136</td>
<td>60</td>
<td>2.5 (1.9-3.5)</td>
<td>1.1 (0.5-1.6)</td>
<td>2.3 (1-3.5)</td>
</tr>
</tbody>
</table>
Limitations of method 1

• Information on culture positivity for $T$ cases at onset of treatment not available (smear microscopy only)
  – $T$ may be over-estimated
  – $d_u$ and Incidence estimates may be biased

• Surveys not powered to estimate $U/T$ with precision
Method 2

• Reverse WHO method to estimate prevalence from incidence based on standard assumptions about disease duration (4 case categories)
  – Notified HIV- \( \sim \mathcal{U}(0.2 - 2) \) year
  – Not notified HIV- \( \sim \mathcal{U}(1 - 4) \) year
  – Notified HIV+ \( \sim \mathcal{U}(0.01 - 1) \) year
  – Not notified HIV+ \( \sim \mathcal{U}(0.01 - 0.2) \) year
Limitations of method 2

- Country and time dependencies of disease duration for each case category are unknown
- Biased estimates of incidence
Two methods compared: overlapping uncertainty ranges

<table>
<thead>
<tr>
<th></th>
<th>Prevalence (per 1000)</th>
<th>Incidence – method 1 (per 1000/yr)</th>
<th>Incidence – method 2 (per 1000/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia 2002</td>
<td>12 (10-15)</td>
<td>4 (2.5-5.8)</td>
<td>2.2 (1.5 – 2.9)</td>
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<td>3.4 (2 – 5.1)</td>
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<td>2.5 (1.9-3.5)</td>
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<td>1.1 (0.7 – 1.6)</td>
</tr>
</tbody>
</table>
In conclusion

• Prevalence surveys *not designed to estimate incidence*

• Uncertainty in estimated incidence due to:
  – Sampling uncertainty about prevalence of B+ in adults
  – Uncertainty about extra-pulmonary and childhood TB
  – Uncertainty about disease duration