Methods to estimate TB Burden
Overview

- Estimating Incidence, Prevalence, Mortality
- Assessing and improving routine TB surveillance
<table>
<thead>
<tr>
<th>MDG</th>
<th>Reverse incidence by 2015</th>
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<tbody>
<tr>
<td>STP</td>
<td>50% reduction in prevalence and mortality by 1990 – 2015</td>
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<tr>
<td></td>
<td>Eliminate TB by 2050 (less than 1 case per million)</td>
</tr>
</tbody>
</table>
Sources of data on incidence

- Incidence surveys
- Tuberculin surveys
- Notifications
- Indirect estimation
incidence = \frac{\text{notifications}}{1 - \text{underreporting}}
## Quantification of under-reporting

<table>
<thead>
<tr>
<th>Source of data</th>
<th>DHS?</th>
<th>Capture-recapture</th>
<th>Survey?</th>
<th>Inventory study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not have access to health care</td>
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<tr>
<td>Have access but do not seek care</td>
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<tr>
<td>Seek care but not diagnosed</td>
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<tr>
<td>Diagnosed but not reported</td>
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</tbody>
</table>
1. Sample geographical areas randomly
2. Send teams to areas, map all providers
3. Enroll providers, give them TB registers
4. Visit providers regularly for say 3 months
5. Collect registers at the end of 3 months
6. Create providers database (list A)
7. Match records with NTP database (list B)
Capture recapture, lists A and B

$N$ total cases

$N_A$  $N_{AB}$  $N_B$
Capture recapture, estimation

Assuming independence,

\[ P(A \cap B) = P(A) \times P(B) \]

\[ \frac{N_{AB}}{N} = \frac{N_A}{N} \times \frac{N_B}{N} \]

\[ N = \frac{N_A \times N_B}{N_{AB}} \]
Capture recapture, estimation

In case of dependence, we cannot solve for $N$

\[ P(A \cap B) = P(A) \times P(B \mid A) = P(B) \times P(A \mid B) \]

\[
\frac{N_{AB}}{N} = \frac{N_A}{N} \times \frac{N_{AB}}{N_A} = \frac{N_B}{N} \times \frac{N_{AB}}{N_B}
\]

In practice, at least 3 lists needed to account for dependencies between pairs of lists
incidence = \frac{\text{mortality}}{\text{case fatality rate}}
incidence = \frac{prevalence}{duration}
Sources of data on Mortality

- Vital Registration Systems (n=89 countries in 2010)
- Indirect estimation through Bayesian modelling (uncertain estimates)
89 countries with quality VR data

Priors $b$ for Case Fatality Rates $\beta$
(literature review)

\[
y = (I - N) \beta_N + N \beta_U + \epsilon, \quad \epsilon \sim N\left(0, \sigma^2\right)
\]

\[
b \sim N\left(b_i, B_i^{-2}\right), \quad \sigma^2 \sim IG\left(5.10^{-4}, 5.10^{-4}\right)
\]

Normal priors

posterior errors

not notified

notified

conjugate prior variance

set to uninformative Inverse-Gamma
Sources of data on Prevalence

- National TB prevalence surveys
- Indirect estimation (very uncertain estimates)
Prevalence survey in Myanmar

Prevalence of bacteriologically confirmed TB in adults
$$\pi = 0.00613 \ [0.00502 - 0.00747]$$

How about TB in children?
How about extra-pulmonary TB?
Burden of extra-pulmonary and non-confirmed TB

- Equals bacteriologically confirmed TB times a multiplication factor $L$

- The value of $L$ is uncertain

$L \sim U (0.10 – 0.25)$
$R = \text{Prevalence rate children} / \text{adult}$

The value of $R$ is uncertain

$R \sim U (0.05 - 0.15)$

Proportion of children in Myanmar (2009)*

$c = 27\%$

* Source: UN Population Division, 2010 Update
Uncertainty in prevalence estimates, Myanmar example

\[ \pi_a = \pi (1 + L) ((1 - c) + R c) \]

Updated prevalence rate (population-based survey)

Uncertain prior prevalence rate (incidence \( \times \) duration)
PART 2 – TB surveillance
TB notification rates in China

Rate per 100,000

All forms

Smear pos
TB notification rates in India

Rate per 100,000

All forms

Smear pos
TB surveillance – data quality

- Records complete
- No implausible values
- Duplicated records removed
- Internally consistent (over time, between provinces,...)
- Distribution of cases consistent with expectations (e.g. %women)
- Underreporting < 10% (inventory study)

If yes ➔ notifications are the best source of information on TB morbidity
Main determinants of trends in case notifications

- Changes in case definitions
- Changes in recording and reporting
- Changes in case finding efforts
  - More labs, more trained physicians
  - Better tools (e.g. culture, Xpert MTB/RIF)
  - Improved health system performance and coverage
  - Health insurance
  - Expanding economy: more people can afford health services
- AND, changes in *incidence*
Main determinants of changes in incidence

- HIV
- Economic changes
- Demographic changes
- Other: diabetes, smoking,...
Changes in case notification
(Mansoer et al, Bull WHO 2009; 87: 186)
Changes in HIV prevalence in Kenya
(Mansoer et al, Bull WHO 2009; 87: 186)
Changes in case finding effort
(Mansoer et al, Bull WHO 2009; 87: 186)
Interpreting trends in notifications
(Mansoer et al, Bull WHO 2009; 87: 186)
Central Europe: 5yr+ delay in TB control
Albania, Bulgaria, Czech, Hungary, Poland, Romania
Did incidence decline in India?

Garbage data?

Why a peak?

Why a peak?

Why a fall and rise?
Increase in notifications, China

- Nationwide eRR + mandatory reporting
- All forms
- Smear pos
In summary,

- Best source of information on TB burden are
  - **TB notifications** when data meet quality criteria and underreporting low and documented
  - TB mortality from **Vital Registration**
  - Prevalence survey measurements from **national representative prevalence surveys**