Inventory studies

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Outline

• Background
  – Estimating incidence
  – Evaluating the performance of TB surveillance

• TB inventory studies
  – Objectives
  – How do they work?
TB incidence

• National incidence surveys impractical

• Best documented through state-of-the-art TB surveillance. Estimates are uncertain due to
  – Under-reporting
  – Under-diagnosis

• Estimation from tuberculin surveys not satisfactory
Evidence of TB under-reporting of TB in China before the SARS epidemic

- Estimated incidence rate
- Notification rate
- Reporting reform following SARS epidemic
Under-reporting in India

From Where Are Tuberculosis Patients Accessing Treatment in India? Results from a Cross-Sectional Community Based Survey of 30 Districts

Srinath Satyanarayana¹,²*, Sreenivas Achutan Nair¹, Sarabjit Singh Chadha¹, Roopa Shivashankar³, Geetanjali Sharma¹, Subhash Yadav¹, Subrat Mohanty¹, Vishnuvardhan Kamineni¹, Nevin Charles Wilson¹, Anthony David Harries²,⁴, Puneet Kumar Dewan⁵

46% of cases on treatment *not known* to NTP
Assumptions about level in incidence in Vietnam (2007)

• **Under-reporting** $R$ from 2007 prevalence survey [1]
  – $R$ uncertainty range (7.1% - 20.3%)

• **Under-diagnosis** $D$ within plausible range for higher income countries with similarly good macro-indicators of health, e.g. Brazil
  – $D$ uncertainty range (5.6% - 35%)

• Incidence = $N / (R + D)$

1. Nguyen B Hoa et al. IED 2011;17:502-4
Estimated incidence rate in Vietnam, 1990-2011

Incidence Case notifications
When will case notifications start to decline in Indonesia?

New + relapses, all forms
Monitoring the global burden of TB

• Key indicators
  – Case notifications
  – Treatment outcomes
  – Incidence, Prevalence, Mortality

• Progress towards global targets

• Response needs, planning and evaluation
Strengthening surveillance of cases and deaths in all countries, with ultimate goal of directly measuring TB burden from notification and vital registration data.

National TB prevalence surveys in ≥ 21 global focus countries.

Periodic review and revision of methods used to translate surveillance and survey data into estimates of disease burden.
Standards and benchmarks for assessing TB surveillance

- **Goals**
  - Assess ability to measure TB cases and deaths
  - Identify gaps that need to be addressed

- **13 standards and benchmarks**
  - Data quality
  - System coverage
  - TB mortality
  - Drug resistant TB
  - HIV-associated TB
  - TB in children

- **All standards should be met**
Standards and benchmarks assessed in 15 countries
Inventory study objectives

- Quantify the level of TB under-reporting
- Demonstrate that under-reporting is limited
- Estimate TB incidence if capture-recapture modelling is applicable
Some recent inventory studies

capture-recapture
- Netherlands
- UK
- Egypt
- Syria
- Yemen
- Iraq
- Pakistan

NO capture-recapture
- USA (2 States)
- South Korea
- Taiwan
- India (study design not recommended in WHO guidelines)
- Vietnam (nested in prevalence survey)
- Indonesia (*nested in prevalence survey*)
How do inventory studies work?

- Cases detected by health providers recorded
  - **NTP providers** (e.g. TB dispensaries)
  - General hospitals
  - Private doctors
  - ...

- Match cases in non-NTP provider list with cases in NTP list
Principles – (1) under-reporting

BAD

Many detected cases *not* reported

GOOD

All detected cases reported
Principles – (2) incidence

Total TB cases = \( N \)

\( N_A \)
non-NTP

\( N_{AB} \)

\( N_B \)
Reported
Capture-recapture in 45 seconds

Assuming independence between events A and B,

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

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

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

Total TB cases = \( N \)

\( N_A \) \quad \text{non-NTP}

\( N_{AB} \)

\( N_B \) \quad \text{Reported}
Capture-recapture: augmented model for 3 lists

• For an incomplete $2^3$ contingency table

$$\log E(Z_{ijk}) = u + u_1 I(i = 1) + u_2 I(j = 1) + u_3 I(k = 1) + u_{12} I(i = j = 1) + \ldots + u_{123} I(i = j = k = 1)$$

• Model with 8 terms
  – Number expected in all list ($u$)
  – 3 main effects, log odds of appearing in list 1, 2, 3
  – 3 two-factor interactions $u_{12}, u_{13}, u_{123}$
  – 1 three-factor interaction, assumed zero
Three separate lists necessary for capture-recapture (e.g. Iraq)

1980 detected, under-reporting = 16%
473 additional cases estimated (394–565)
**3 main study designs**

<table>
<thead>
<tr>
<th>prospective</th>
<th>Retrospective</th>
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<tbody>
<tr>
<td>1. Quantify <strong>under-reporting</strong>, no incidence estimation <em>(untested)</em></td>
<td>3. Quantify <strong>under-reporting</strong> and estimate <strong>incidence</strong> using existing computerized records <em>(e.g. UK, Netherlands)</em></td>
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<tr>
<td>2. Quantify <strong>under-reporting</strong> and estimate <strong>incidence</strong> <em>(e.g. Iraq, Yemen)</em></td>
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Record linkage

- **Deterministic** ideal – need unique national ID number or equivalent (e.g. Iraq, Yemen)
- **Probabilistic** more work-intensive and may lead to misclassifications (e.g. UK)
Failures to match increase as sampled areas are smaller
Sampling challenges

• Sampling frame not documented
• Varying number of providers and cases per sampled area
• Missed linkages
  – Areas must be self contained (necessary to estimate incidence), OR
  – NTP data must extend beyond sampled areas
  – NTP data must extend before and after the study period (e.g. ±3 months)
In summary

• Under-reporting serious problem in some countries

• Inventory studies to document under-reporting and needs for PPM

• Inventory studies to evaluate the performance of TB surveillance

• Improve incidence estimation

• WHO guidelines