Cost Effectiveness of New Diagnostics for TB

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Outline

• Objectives
  – What combinations of sensitivity and price would result in a new test being
    ▪ A) A better thing than smear in places that don’t have smear?
    ▪ B) A worthwhile addition to smear in places that have smear

• Methods
  – Decision tree analysis
  – Parameters and Assumptions

• Results for South Africa, Kenya, and Brazil
• Sputum smear remains the principal diagnostic test in many low income countries
  – Smear sensitivity is low
    ▪ Low sensitivity can delay diagnosis and lead to secondary spread
  – Smear cost is low
    ▪ Low cost inhibits the introduction of new diagnostics
• New TB diagnostics have to be at least as good as smear and have acceptable cost
  – What are the acceptable tradeoffs?
Methods

• Use decision tree analysis to estimate the number of disability adjusted life years (DALYs), secondary cases, and costs that would ensue from:
  – Trying to diagnose TB with no tests, not even smear
  – Smear
  – A hypothetical new test
  – Smear plus a new test
• Plot results in costs vs. effects space
Cost-Effects Space

Cost

DALYs Averted

Sputum Smear

Culture
Price-Sensitivity Space

Price

Test Sensitivity

Better

Sputum Smear

Culture
Price-Sensitivity Space

Price

Sputum Smear

Tests that Dominate Smear
Cheaper and Better

Tests that might be cost effective in a place still using smear (Pay more, get more)
WHO country-specific estimates of:

- Case detection and treatment success, by smear status
- HIV prevalence in TB patients
- TB mortality rates, treated and untreated
- Cost of treating one TB case

ASSA survival estimates for HIV-positives

TB suspects have equal life expectancy to newly-diagnosed Stage IV
1.83 years (no ART), 7.30 years (on ART)

UNAIDS estimates of HIV prevalence, antiretroviral access
Standard DALY weights for HIV and TB, add 0.1 for being on
TB therapy

Assumptions about New Test

•Point-of-care new TB diagnostic test
•No infrastructure requirements
•Sensitivity 50-90%
•Specificity 90-100%
•Price $1-$20/test
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Sensitivity of Full Diagnostic Algorithm for Tuberculosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South Africa</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
</tr>
<tr>
<td></td>
<td>Kenya</td>
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<tr>
<td></td>
<td>Highly Infectious</td>
</tr>
<tr>
<td><strong>Interventions in Areas with No Sputum Smear</strong></td>
<td></td>
</tr>
<tr>
<td>Reference Standard, No Smear</td>
<td>0.67</td>
</tr>
<tr>
<td>New Test, No Smear</td>
<td>0.83-0.97</td>
</tr>
<tr>
<td>Sputum Smear, Newly-Implemented</td>
<td>0.91</td>
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<tr>
<td><strong>Interventions on a Country-Wide Basis</strong></td>
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<tr>
<td>Reference Standard, Country-Wide</td>
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<tr>
<td>New Test, Country-Wide</td>
<td>1.0</td>
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<tr>
<td>TB Culture, Country-Wide</td>
<td>1.0</td>
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</tbody>
</table>
“New Test vs. Smear” Analysis

Incremental Cost per DALY averted compared to trying to make the diagnosis with clinical judgment alone:

Smear:

$86 RSA, $130 Brazil, $37 Kenya

New Test (90% Sn, 95% Sp, $1/test):

$111 RSA, $149 Brazil, $48 Kenya

Improving sensitivity by 10% costs $36-75 per DALY averted
New Test: Pay more get more

DALYs Averted per TB Suspect

Costs per TB Suspect

Reference Standard, No Smear

New Test Sensitivity: 0.5, 0.6, 0.7, 0.8, 0.9

New Test: $1/test, $20/test

Sputum Smear, Newly-Implemented
## Results:
### Adding New Test to Current Strategies

<table>
<thead>
<tr>
<th>Country</th>
<th>Cost, per 1000 TB Suspects</th>
<th>New TB Diagnoses</th>
<th>DALYs Averted</th>
<th>Secondary Infections Averted</th>
<th>Cost per DALY Averted</th>
<th>Cost per Infection Averted</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>$25,014</td>
<td>45</td>
<td>64</td>
<td>124</td>
<td>$396</td>
<td>$201</td>
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<td>$25,280</td>
<td>31</td>
<td>42</td>
<td>62</td>
<td>$604</td>
<td>$408</td>
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<tr>
<td>Brazil</td>
<td>$32,230</td>
<td>21</td>
<td>117</td>
<td>128</td>
<td>$276</td>
<td>$251</td>
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<td>$33,555</td>
<td>14</td>
<td>78</td>
<td>73</td>
<td>$430</td>
<td>$461</td>
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<td>Kenya</td>
<td>$40,875</td>
<td>129</td>
<td>892</td>
<td>850</td>
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<td>$35,428</td>
<td>88</td>
<td>604</td>
<td>497</td>
<td>$59</td>
<td>$71</td>
</tr>
</tbody>
</table>
Variation with Sensitivity, Specificity, and Price

Price: $1/test

Price: $20/test
Sensitivity Analysis: South Africa

- New Test Specificity (0.9:1.0)
- Discount Rate (0.07:0.005)
- New Test Cost ($20:$1)
- Reference Sensitivity, Less Infectious TB (0.84:0.5)
- Mortality, Less Infectious TB, HIV-negative (0.15:0.25)
- Reference Sensitivity, Highly Infectious TB (1.0:0.85)
- Cost of TB Treatment ($393:$235)
- New Test Sensitivity, Less Infectious TB (0.5:0.9)
- Proportion of Highly Infectious TB, HIV-negative (0.7:0.3)
- TB prevalence among TB Suspects (0.21:0.35)
Sensitivity Analysis: Brazil

- Reference Sensitivity, Highly Infectious TB (1.0:0.69)
- New Test Specificity (0.9:1.0)
- Discount Rate (0.07:0.005)
- New Test Cost ($20:$1)
- Cost of TB Treatment ($633:$379)
- TB Prevalence among TB Suspects (0.08:0.14)
- Mortality, Highly Infectious TB, HIV-negative (0.5:0.95)
- Proportion of Highly-Infectious TB, HIV-negative (0.7:0.3)
- New Test Sensitivity, Less Infectious TB (0.5:0.9)
- Life Expectancy, HIV-negative (29:49)
Sensitivity Analysis: Kenya

- Discount Rate (0.07:0.005)
- Mortality, Highly Infectious TB, HIV-negative (0.5:0.95)
- Proportion of Highly-Infectious TB, HIV-negative (0.7:0.3)
- Cost of TB Treatment ($329:$197)
- New Test Cost ($20:$1)
- New Test Specificity (0.9:1.0)
- Life expectancy, HIV-negative (29:49)
- Reference Sensitivity, Highly Infectious TB (0.58:0.34)
- TB Prevalence among TB Suspects (0.21:0.35)
- HIV Prevalence in TB Patients (0.34:0.21)
New Test vs. Smear

• Smear is more cost-effective…
  – Excellent specificity
  – Identifies “highest-yield” patients
  – New test needs >95% Sp, plus either >90% Sn or similar “auto-triage” property
• …but new tests add value.
  – $50-$150 per DALY averted
  – Markedly increase number of TB diagnoses
Sensitivity vs. Specificity

• Point for point, specificity is more important to cost-effectiveness.
  – Especially if new tests are cheap
• Important to measure sensitivity in current false-negatives
  – Not just a lab measure
Is It Cost-Effective?

• Compare incremental cost effectiveness ratio (ICER) per DALY averted by new TB test to GDP/capita
  – ICER: $396 (RSA), $276 (Brazil), $46 (Kenya)
  – GDP: $13,000 (RSA), $8,600 (Brazil), $1,200 (Kenya)
• New Test most cost-effective where existing infrastructure is weakest
Limitations

• Analysis is not a societal perspective
  – Neglects hospital costs, MD visits, etc.

• Heterogeneous implementation
  – Best facilities first?
  – Won’t help if MD doesn’t think of TB

• Static model
  – Neglects cumulative effects over time
Two Take-Home Messages

1. New TB diagnostic tests are likely to be highly cost-effective, even if not perfect.
2. Specificity, price, and existing level of infrastructure are key considerations.
Thanks!

BD Corporation

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