Infection Prevention and Control for Tuberculosis

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Loss of fitness, 1953

- Middlebrook, G., and M. L. Cohn

  “Some observations on the pathogenicity of isoniazid-resistant variants of tubercle bacilli”

  (Science, 1953, 118:297-299)
Regaining fitness

- Compensatory mutations
- ? Other mechanisms

highly successful resistant strains

- Beijing
- F28
- F16/LAM4/KZN

? over-compensation
Competition in mice: fitness test

(collaborative project with Duke University, Sunhee Lee et all)
Cytotoxicity of F15/LAM4/KZN isolates on alveolar epithelium

Average % cytotoxicity

\( P < 0.0001 \)

(Sturm laboratories, KZN)
Bacterial burden of F15/LAM4/KZN in lung and spleen and lung pathology

(collaborative project with Duke University, Sunhee Lee et all)
Virulent (fit), resistant *M. tuberculosis* strains are a reality!

How do we deal with that?
TB control = prevention of transmission

• Decreasing infectiousness of patients
• Prevention of transmission
  – infection prevention in health care facilities
  – infection prevention in public transport and buildings
  – infection prevention at home
• Prophylaxis for the non-infected
  – vaccination
  – prophylactic medication
TB control = prevention of transmission

- Decreasing infectiousness of patients
- Prevention of transmission
  - infection prevention in health care facilities
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- Prophylaxis for the non-infected part of the population
  - vaccination
  - prophylactic medication
XDR in KZN = TDR

<table>
<thead>
<tr>
<th>Medicine</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>isoniazid</td>
<td>R</td>
</tr>
<tr>
<td>rifampicin</td>
<td>R</td>
</tr>
<tr>
<td>pyrazinamide</td>
<td>R</td>
</tr>
<tr>
<td>ethambutol</td>
<td>R</td>
</tr>
<tr>
<td>streptomycin</td>
<td>R</td>
</tr>
<tr>
<td>ethionamide</td>
<td>R</td>
</tr>
<tr>
<td>ofloxacin</td>
<td>R</td>
</tr>
<tr>
<td>moxifloxacin</td>
<td>R</td>
</tr>
<tr>
<td>kanamycin</td>
<td>R</td>
</tr>
<tr>
<td>amikacin</td>
<td>R</td>
</tr>
<tr>
<td>capreomycin</td>
<td>R</td>
</tr>
<tr>
<td>PAS</td>
<td>S</td>
</tr>
<tr>
<td>linezolid</td>
<td>S</td>
</tr>
<tr>
<td>meropenem/clavulanic acid</td>
<td>S</td>
</tr>
</tbody>
</table>
Different epidemics per geographical region

• Western Cape province
  – MDR transmitted
  – XDR not transmitted

• KwaZulu-Natal
  – MDR transmitted (Beijing, F28 and F15/LAM4/KZN)
  – XDR transmitted: F15/LAM4/KZN only
TB control = prevention of transmission

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  - infection prevention in health care facilities
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  - prophylactic medication
Prevention of transmission in health care facilities

• Administrative control
  – triage

• Environmental control
  – ventilation
  – airflow control

• Personal protection
  – masks/respirators

Where is the problem?
Risk assessment in specialised TB facilities in KZN

IPC unit
KZN Department of Health
Challenges with triage

- At which point in the patient flow?
- What to do with (many) coughing patients?

over-crowding in OPD  where?
Challenges with environmental control

• Building structure
  – ventilation systems
  – ceiling height
  – isolation wards

• Overcrowding
  – ward
  – OPD

• Cough areas/booths
Challenges with personal protection

• Adherence
  – unpleasant for user
  – unfriendly for patients

• Confusing information
  – when to discard?
Filter efficiency

- Particle capture efficiency of electret (charged) filters decreases with filter load
- Maximum filter load for N series masks $\geq 200$ mg

\[ \text{efficiency insufficient} \]
\[ \text{bacteria first} \]
Challenges with personal protection

• Adherence
  – unpleasant for user
  – unfriendly for patients

• Confusing information
  – when to discard?

• Fit-testing
  – consistancy in donning the mask
  – procurement system
Risk assessment in specialised TB facilities in KZN

• All 8 facilities had major challenges in all areas

• Need for structural changes in OPDs/clinics and wards
  – no short term solutions
  – maximise ventilation systems

• Need for optimisation of personal protection
TB control = prevention of transmission

- Decreasing infectiousness of patients
- **Prevention of transmission**
  - infection prevention in health care facilities
  - infection prevention in public transport and buildings
  - infection prevention at home
- **Prophylaxis for the non-infected part of the population**
  - vaccination
  - prophylactic medication
Infection prevention outside health care facilities

• Community education
  – household education/counseling
  – targeted group education
TB control = prevention of transmission

- Decreasing infectiousness of patients
- Prevention of transmission
  - infection prevention in health care facilities
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- Prophylaxis for the non-infected part of the population
  - vaccination
  - prophylactic medication
INH resistance in culture
confirmed cases in KZN
1 Jan 2006 – 30 June 2007
n=25537

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>6543</td>
<td>25.6</td>
</tr>
<tr>
<td>Single INH resistant</td>
<td>807</td>
<td>3.2</td>
</tr>
<tr>
<td>MDR</td>
<td>5377</td>
<td>21</td>
</tr>
<tr>
<td>pre-XDR</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>XDR</td>
<td>610</td>
<td>2.4</td>
</tr>
<tr>
<td>others</td>
<td>1785</td>
<td>7</td>
</tr>
</tbody>
</table>
Botswana IPT trial

- INH resistance in those receiving 36 mths IPT: 14%
- Background INH resistance: 9%
- Increase: 5% (55% in 3 years)
Extrapolation of Botswana results to KZN

<table>
<thead>
<tr>
<th></th>
<th>Background resistance</th>
<th>Resistance after 3 years IPT</th>
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</thead>
<tbody>
<tr>
<td>Botswana</td>
<td>9 %</td>
<td>14 %</td>
</tr>
<tr>
<td>KZN</td>
<td>26 %</td>
<td>40.3%</td>
</tr>
</tbody>
</table>
Public health responsibility

Should we introduce IPT everywhere or allow for differential approach?
Back to basics

• The current epidemic in KZN is the result of:

  – a high density of TB transmitters in the population

  – a high density of highly TB susceptible individuals in the population (the HIV infected)
Back to basics

• We need to decrease both these groups of individuals!
• How?
  – Active, early case finding
    • before patients become infectious
    • before a productive cough develops
  – Early ARV treatment
    • before the CD4 count starts dropping
    • immediately on diagnosis (active case finding)
Acknowledgements

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  – Prashini Moodley
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Thank you