The Challenges of TB Infection Control in Southern Africa

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South Africa
Infectious Disease Cycle of Transmission

- a **reservoir** for the organism
- a susceptible **host**
- **transmission** from one to the other

- each of these is a target where we can prevent infections from occurring

- **transmission of TB**
  - droplet
  - airborne
TB control

• decreasing infectiousness of patients/reservoir
• 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/susceptible host
  – vaccination
  – prophylactic medication
TB control

• 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
Infectiousness in relation to bacterial load

- Acquisition of infection
- Time to diagnosis
- Initiation of treatment

[bacilli/ml]

10^3
Infectiousness in relation to bacterial load

- Acquisition of infection
- Initiation of treatment

$[\text{bacilli/ml}]$

1000

Months
• fast tracking of diagnosis
  – turn a patient non-infectious through treatment
    ➢ decrease the number of exposed people
    ➢ decreasing the likelihood of transmission/exposure
XDR in KZN = TDR

<table>
<thead>
<tr>
<th>Drug</th>
<th>Result</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>
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<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>
TB control

• 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
Prevention of transmission in health care facilities

- **patient management and staff practice**
  - triage and separation
  - cough education
  - fast tracking care and diagnosis

- **infrastructure**
  - ventilation systems
  - negative pressure
  - size of OPD/wards vs patient volumes

- **personal protective equipment**
  - N95 respirators
Infection prevention for tuberculosis

• patient management and staff practice
  – triage and separation
  – cough education
  – fast tracking care and diagnosis

• infrastructure
  – ventilation systems
  – negative pressure
  – size of OPD/wards vs patient volumes

• personal protective equipment
  – N95 respirators
Goals

• separation to protect non-coughing patients

• cough education to protect patients in the coughing group
  – mix of TB infected patients (S, MDR, XDR, TDR)
  – HIV infected and uninfected
Risk assessment in specialised TB facilities in KZN
Challenges with triage

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

over-crowding in OPD ➔ immediate attendance

separate waiting area ➔ where?
Infection prevention for tuberculosis

- **patient management and staff practice**
  - triage and separation
  - cough education
  - fast tracking care and diagnosis

- **infrastructure**
  - ventilation systems
  - negative pressure
  - size of OPD/wards vs patient volumes

- **personal protective equipment**
  - N95 respirators
Challenges with environmental control

• building structure
  – ventilation systems
  – ceiling height
  – isolation wards
• overcrowding
  – ward
  – OPD
• cough areas/booths
Waiting Areas

• rooms with rapid air changes (6-12/hr) (depending on number of people in waiting areas)
• and negative pressure
  or
• structures with roofs only

What about wards and other areas?

airflow control in all areas with (potential) TB patients
Ventilation systems

• air changes
  → at least 6 changes per hour

• air flow
  – controlled
  – HEPA filtered
    • (Highly Effective Particulate Air filter)
  – UV irradiated
Ventilation systems

• air changes

• air flow
  – controlled
  – HEPA filtered
  – UV irradiated
In most provincial hospitals .....
Ventilation systems

• Air changes
  - at least 6 changes per hour

• Air flow
  - controlled
  - HEPA filtered
  - UV irradiation
  - recirculation
  - kill of bacteria
  - assist sub-optimal circulation
UV irradiation

Works only with special devices!

Kill

No kill

< 1 m

> 1 min
Negative pressure

regulation of inflow and outflow

outflow > inflow

most infectious patient in room with lowest pressure
An outbreak of multi-drug-resistant tuberculosis in a London teaching hospital

- Breathnach AS et al
MDR TB outbreak in Hospital Ward

- HIV –ve patient with drug susceptible TB
  - developed MDR-TB ? poor adherence to therapy
  - admitted to an isolation room in a ward with HIV-positive patients

- isolation room
  - at positive-pressure relative to the main ward

- MDR TB outbreak
  - 7 HIV-positive contacts developed MDR-TB
  - MTB isolates were indistinguishable by molecular typing
Prevention of transmission in health care facilities

- patient management and staff practice
  - triage and separation
  - cough education
  - fast tracking care and diagnosis
- infrastructure
  - ventilation systems
  - negative pressure
  - size of OPD/wards vs patient volumes
- personal protective equipment
  - N95 respirators
Reasons for failing of the filter

- Filter saturation
- Face-seal leaks
- Damage
- Manufacturing defects

Prevented by restricted period of use

Detected by fit testing

Depends on the contamination level of the air you breath
Challenges with personal protection

- **adherence**
  - unpleasant for user
  - unfriendly for patients

- **confusing information**
  - when to discard?

- **fit-testing**
  - consistency in donning the mask
  - procurement system
TB control = prevention of transmission

• decreasing infectiousness of patients

• prevention of transmission
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• 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

  – How ???
Can social interventions prevent tuberculosis?: the Papworth experiment (1918-1943) revisited.


- Bhargava A et al.
• **rationale**
  
  – consensus on the need to address social determinants of tuberculosis for TB control
  
  – evidence based on interventions is lacking

• **objectives**
  
  – reanalyzed data from the sociomedical experiment performed at the Papworth Village Settlement in England
  
  – impact of stable employment and adequate housing and nutrition on the incidence of TB infection and disease in children living with parents with active TB was documented during 1918-1943
• social interventions including adequate nutrition
  – did not reduce TB transmission
  – did reduce the incidence of TB disease in children living with parents with active TB
  – the susceptible host

• results relevant today
  – prevention of TB in children of patients with active TB in our high-burden setting
Tuberculosis transmission to young children in a South African community: modelling household and community infection risks

• Clin Infect Dis. 2010 Aug 15;51(4):401-8

• Wood R et al
Conclusions

• annual risk in preschool children
  – greatest if infectious residents in the home
  – substantial proportion of transmissions may occur from non resident adults

• benefits of increased ventilation
  – maximized when the period of infectivity is reduced
  – (prompt treatment reservoir/infected case)
Indoor Social Networks in a South African Township: Potential Contribution of Location to Tuberculosis Transmission

- Wood R et al
Conclusions

• increasing numbers of social contacts occurred throughout
  – childhood, adolescence, and young adulthood
  – predominantly in school and public transport

• rapid increase in non-home socialization
  – parallels the increasing TB infection rates during childhood and young adulthood

• further studies of the environmental conditions
  – schools and public transport indicated
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 (new vaccines – many years before 1\textsuperscript{st} one could be available)
  - antimicrobial prophylaxis
Back to basics

- A reservoir for the organism
- A susceptible host
- Transmission from one to the other

- each of these is a target where we can prevent infections from occurring
Back to basics

• The current epidemic in KZN is the result of:
  – a high density of TB transmitters in the population (massive reservoir)
  – a high density of highly TB susceptible host individuals in the population (the HIV infected)
  – ongoing transmission
Back to basics

- We need to address each of these
  - Active, early case finding (reservoir)
    - Before patients become infectious
    - Before a productive cough develops
  - Decreasing host susceptibility
    - Early ARV treatment
    - Socio economic factors – nutrition
    - ? prophylaxis
    - Vaccines
  - Transmission
    - Effective barrier between infected and non-infected
    - Difficult to achieve