Scaling Up Infection Control - Laboratory Issues -

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**Mycobacterium tuberculosis**

- Prototype airborne infection
- Classified as WHO Risk Group 3 pathogen
Classification of infective organisms by risk group


- Risk Group 1
  ‘A microorganism that is unlikely to cause human or animal disease’

- Risk Group 2
  ‘A pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of infection is limited’

- Risk Group 3
  ‘A pathogen that usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another. Effective treatment and preventive measures are available’

- Risk Group 4
  ‘A pathogen that usually causes serious human or animal disease and that can be readily spread from one individual to another, directly or indirectly. Effective treatment and preventive measures are usually not available’
Classification of infective organisms by risk group

- **Risk Group 1**
  A microorganism that is unlikely to cause human or animal disease

- **Risk Group 2**
  A pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of infection is limited

- **Risk Group 3**
  A pathogen that usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another. Effective treatment and preventive measures are available

- **Risk Group 4**
  A pathogen that usually causes serious human or animal disease and that can be readily spread from one individual to another, directly or indirectly. Effective treatment and preventive measures are usually not available

- MDR-TB and XDR-TB?
- High HIV-burden settings?
# Excess occupational risk

<table>
<thead>
<tr>
<th>Work location</th>
<th>TB incidence rate ratio</th>
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<tbody>
<tr>
<td></td>
<td>(relative to general population TB incidence rate)</td>
</tr>
<tr>
<td>Outpatient facilities</td>
<td>4.2 – 11.6</td>
</tr>
<tr>
<td>General medical wards</td>
<td>3.9 – 36.6</td>
</tr>
<tr>
<td>Inpatient facilities</td>
<td>14.6 – 99.0</td>
</tr>
<tr>
<td>Emergency rooms</td>
<td>26.6 – 31.9</td>
</tr>
<tr>
<td>Laboratories</td>
<td>78.9</td>
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</tbody>
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Laboratory infection control

- Neglected
- Often ‘No Man’s Land’
- Technically complex
- Expensive
- Limited expertise and skills
- Lack of international standards
- Inadequate budgeting, also for maintenance
International standards

- Minimum biosafety levels
- Use of biological safety cabinets
- Core administrative controls
  - Specimen transport
  - Good Laboratory Practice
  - Standard operating procedures
  - Accident management plans
  - Waste management strategies
  - Staff health surveillance
- Use of personal respiratory protection
1. Minimum biosafety levels

- **American Institute of Architects (IAI) Guidelines for the Design and Construction of Health Care Facilities, 2006**
  - Minimum of 6ACH and 100% exhaust of air

- **CDC/NIH Biosafety in Microbiological and Biomedical Laboratories, 5th ed. 2007**
  - BSL2 (P2): ‘No specific requirement on ventilation systems. However, planning of new facilities should consider mechanical ventilation systems that provide and inward flow of air without recirculation to spaces outside of the laboratory.’
  - BSL3 (P3): ‘A ducted air ventilation system is required. This system must provide sustained directional airflow by drawing air into the laboratory from ‘clean’ areas toward ‘potentially contaminated areas’. The laboratory shall be designed such that under failure conditions the airflow will not be reversed.’

  - BSL2: ‘Planning of new facilities should consider mechanical ventilation systems that provide an inward flow of air without recirculation. If there is no mechanical ventilation, windows should be able to be opened. … a standby generator is desirable…’
  - BSL3: ‘There must be a controlled ventilation system that maintains a directional airflow into the laboratory. Air may be HEPA filtered, reconditioned and re-circulated within the laboratory.’ (In addition to separate anteroom to maintain pressure differential, as well as on-site autoclave for waste disposal)
2. Use of biological safety cabinets

BSC Class I

100% exhaust
~ 0.38 m/s

BSC Class IIA

70% recirculation
0.38 m/s

(Slides courtesy Paul Jensen)
A cabinet is not a cabinet…

(Slides courtesy Paul Jensen)
Where goes that air?

(Slides courtesy Paul Jensen)
The risks of inadequate maintenance

(Slides courtesy Paul Jensen, Sidney Parsons)
Good Laboratory Practice

‘Plan your work . . . Work your plan’ (Paul Jensen)
Waste management

(Slides courtesy Sidney Parsons, Giorgio Roscigno)
Respiratory protection

- Expanded use of appropriate respiratory protection
- CDC/NIOSH-certified N95 (or greater) or CEN-certified FFP2 (or greater)

(Slides courtesy Paul Jensen)
Staff health surveillance: SRL, Pretoria

Mandatory for laboratory and clinical staff, optional for administrative and support staff

1. Baseline
   - Detailed medical history
   - Targeted health assessment (TB history, TB exposure, tuberculin skin test, chest radiograph, sputum microscopy, culture and drug susceptibility testing)
   - HIV counseling and testing
   - Hepatitis B vaccination

2. Quarterly
   - Sputum microscopy, culture and drug susceptibility testing
   - Weight evaluation (monthly self-monitoring)
   - Respiratory signs & symptoms (monthly self-monitoring)

3. Annually
   - Chest radiography
   - Tuberculin skin test conversion

4. Post-exposure
   - Risk assessment
   - Targeted health assessment, repeated after 6 weeks
   - Preventive therapy (isoniazid, ARVs)
   - Compensation claim submission
Infection control costs: SRL, Pretoria

- Capacity: 40 000 specimens/year
- Annual budget: USD 50 000
- Excludes: HR, equipment, initial accreditation costs

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Proportion</th>
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<tbody>
<tr>
<td>Equipment validation &amp; maintenance</td>
<td>60%</td>
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<tr>
<td>Staff health surveillance</td>
<td>10%</td>
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<tr>
<td>Waste disposal</td>
<td>10%</td>
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<tr>
<td>Incidental costs</td>
<td>10%</td>
</tr>
<tr>
<td>Laboratory administration</td>
<td>5%</td>
</tr>
<tr>
<td>SANAS accreditation</td>
<td>5%</td>
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Scaling up laboratory networks also means scaling up infection control…

(Slides courtesy Gerrit Coetzee, NHLS South Africa)