What should FSU Countries do to reduce nosocomial TB transmission?
- especially MDR-TB
Institutional Transmission Fuels the FSU TB Epidemic

? General Population

Civilian Hospitals

Prisons

?
Institutional TB Transmission is a Global Problem

Homeless shelter - USA

Prison - South Africa
Response

• Good TB control is good infection control - but it is not enough

• Infection control in institutions
  - Civilian hospitals
  - Prisons
  - Other institutions?
At what stage is Infection Control in FSU?

- Infection control in E. Europe is now where MDR-TB treatment was more than 10 years ago.
  - While often spoken of, relatively little is actually being done that is likely to be effective
  - Approaches generally not evidence-based
    - Very little evidence available anywhere
New research is forthcoming to provide guidance

- New research facility in South Africa
  - Collaboration of MRC, CDC, and Harvard
  - All MDR-TB patients
  - Half with HIV co-infection
- Ability to measure TB concentration in the air by using guinea pig air sampling
  - can measure efficacy of control interventions
Airborne Infection Research Facility

Medical Research Council
HJE Schultz SANTA

in collaboration with

CDC
HARVARD SCHOOL OF PUBLIC HEALTH
CSIR

JAN 29 2005
AIR, Experimental Plan

Guinea Pig Air Sampling

Skin Test monthly

UVGI or other intervention

6 MDR-TB patients

Pt. TB RFLP

Guinea Pig TB RFLP
Investigations planned

• How infectious is MDR-TB?
  - Preliminary data - it is very infectious
• When does it become non-infectious on Rx?
• Does upper room UV work?
• Optimal ventilation configurations.
• Test other, novel interventions.
Evidence of transmission?


“Increased risk of tuberculosis among health care workers in Samara Oblast, Russia: analysis of notification data”

Samara Oblast 9-yr Study

- Compared the rates of TB 1994 - 2002 for 3 groups of workers:
  - TB health care workers
  - Workers in general health services
  - General population in the region
Samara Oblast 9-yr Study

- TB health workers: 741.6/100,000 person years at risk - 10X that of general population.
  - In-patient TB facilities: incidence ratio of 17.7 compared general health workers
Occupational Risk in Serbia

  - Skodric V, et al

- 12 year (1986 - 1997) retrospective risk assessment at the Institute for Pulmonary Diseases, Belgrade, Serbia

- Compared to the general population, HCWs had a cumulative incidence of 3451/100,000 compared to 454/100,000 in the general population for a relative risk of 7.6 (8 years ago)
Evidence of MDR transmission in Tomsk hospitals

- Recent study of non-adherence, default, and the acquisition of MDR-TB
- Substance abuse associated with
  - non-adherence, adj odds ratio = 4.7
  - default, adjusted odds ratio = 9.7
  - NOT associated with acquiring MDR during therapy, adjusted odds ratio = 0.8
- Patients more likely to develop MDR-TB who, compared to being treated as outpatients only:
  - began treatment in hospital, adjusted odds ratio = 12.7
  - were later hospitalized during treatment, adjusted odds ratio = 9.6
More Russian studies needed of transmission in hospitals and prisons

- New ways to diagnose TB infection among health care workers may help
  - Gamma interferon release assays
    - Independent of BCG vaccination
    - No boosting
    - One visit - 5 cc whole blood
  - But...
    - Technically demanding (within 12 hrs of draw)
    - Expensive
We know how TB is transmitted

- Large respiratory particles settle within about a meter of their source
  - Not a problem
  - No need to disinfect surfaces or empty rooms

- Fine particles dry into droplet nuclei - diluted and carried by air currents and ventilation
The danger of the unsuspected case

- Traditional infection control focuses on known or suspected cases, but it is the unsuspected case of TB that poses the greatest risk.
  - general hospitals - admitted for other reasons
  - Clinics - all kinds
  - Emergency rooms
  - prisons
250 of 349 pts admitted to on female ward in 1997 were screened for TB
- sputum
- CXR
- history
- physical exam
• 40 pts (16%) had positive cultures
  - 26/ 40 (65%) smear positive
  - 13/ 40 (33%) unsuspected
  - 8/ 40 (20%) had MDR
    • Incl. 6/ 8 MDR unsuspected
      - 3/ 6 were smear positive
Conclusion -

- 13% est. TB prevalence on admission to gen. med. ward in Lima
  - *Should be repeated in Russian hospitals*
- 3 in 250 (> 1%) new admissions had UNSUSPECTED smear + MDR TB!

Importance of:
1. improved triage
2. air disinfection in general care areas
High Risk in General Medical Areas

- In a study of high-risk hospitals in Canada, Menzies found that those who worked in isolation rooms were at lowest risk - even though ventilation was usually sub-optimal.
- Risk was higher in poorly ventilated general floors where unsuspected cases reside.
## Hospital Ventilation and risk of TB in HCWs

### Menzies’ Canadian Hospitals Study (Ann Intern Med 2000; 133:779-789)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Adj. Odds Ratio (95% CI)</th>
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<tbody>
<tr>
<td>Resp. therapy</td>
<td>6.1 (3.1 - 12.0)</td>
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<tr>
<td>Nursing</td>
<td>4.3 (2.7 - 6.9)</td>
</tr>
<tr>
<td>Housekeeping*</td>
<td>4.2 (2.3 - 7.6)</td>
</tr>
<tr>
<td>&lt; 2 ACH (non IR)**</td>
<td>3.4 (2.1 - 5.8)</td>
</tr>
<tr>
<td>Physiotherapy</td>
<td>3.3 (1.5 - 7.2)</td>
</tr>
<tr>
<td>Mod-high risk Hosps.</td>
<td>2.2 (1.3 - 3.5)</td>
</tr>
<tr>
<td>Isolation rm. - Low Ventilation</td>
<td>1.0 (0.8 - 1.3)</td>
</tr>
</tbody>
</table>
TB Infection Control

- Hierarchy of TB infection control interventions
  • Administrative
  • Engineering
  • Personal respiratory protection

- Where should Russia put precious resources?
Administrative controls

• Ambulatory treatment
  - Fewer, lower-risk contacts
  - Prisons - does not apply
• Early case detection - cough awareness, radiology, *new tests*
  - Triage
    • Prompt, effective treatment
    • *Isolation or separation*
    • *personal respirators*
• Unsuspected case
  - *General air disinfection*
Engineering Controls
Local exhaust ventilation

- Examples
  - Exhaust sockets
  - Exhaust cabinets
  - Simple biosafety cabinets
  - Simple isolation rooms

- Heat loss, drafts, may limit acceptance
Sputum Induction
Physical Environment:
Building configuration and usage are important - but often neglected
Annual Risk of Infection Among Medical Students of Universidad Peruana Cayetano Heredia in Lima, Peru

- 488 students
- Pos. PPD increased from 3.5% to 45.9% over 7 years
- 6%/yr. avg.
Comparing Infection Rates:
Hospital Cayetano and Hospital Loayza
Room Volume Per Bed:
Hospital Cayetano and Hospital Loayza

![Graph showing room volume per bed for Hospital Cayetano and Hospital Loayza. The graph indicates that Hospital Cayetano has a room volume of 41.4 m³ per bed, while Hospital Loayza has a room volume of 16.2 m³ per bed. The bar for Hospital Loayza is significantly higher than that for Hospital Cayetano.]

- Mechanical Ventilation
  - Yes
  - No
Buildings - conclusions

- Volume per person is important in diluting contagion and reducing risk
  - Many older Russian buildings are large and spacious, but...
  - Many patients are often together in tightly sealed rooms
- Crowding is an important transmission factor
  - Greater risk that of infectious case - many exposed
  - Patients on wards and prisoners should be in small groups if possible to avoid disease transmission
1 well mixed AC removes 63% of room air contaminants

- Next AC removes 63% of what is left (tot 86% removed)
- Next AC removes 63% of what is left (tot 95% removed), etc.
Increased building ventilation provides protection - but has its limits
Room Air Cleaners
Room air cleaners with UVGI
UV-fan or filter units

• Common in Russia, Eastern Europe
  - Usually hanging on walls in rooms and corridors
• Limitations:
  - Move very little air - few added air changes
  - Very little added protection
  - False assurance
  - Maintenance - may not be working
Germicidal UV Air Disinfection

- Can add air disinfection equivalent to increased ventilation more economically
- *Must be used optimally*
- Two types:
  - Direct, open UV room disinfection - common in Russia and E. Europe
  - Indirect, shielded upper room UV - commonly used in US, South Africa, elsewhere
Direct, open tube UV

- Used with occupants out of the room
  - But little danger when there is no source of infection
- Intended to disinfect surfaces
  - But surfaces pose no TB risk
- Can cause superficial UV injury if turned on while room is occupied
- Unproven for reducing airborne TB transmission
  - Unlikely to be useful
Shielded, upper room UV

- Intended to disinfect room air (not surfaces) while the room is occupied
  - with no risks to people below
- Proven efficacy in test rooms reducing airborne infectious particles equivalent to 10 or more added air changes.
- Long safety record in the West
  - no long-term consequences.
Upper Room UV Air Disinfection

- UV-C
- Warm contaminated air rises
- Disinfected air displaced
- 7 ft.
UVGI Occupational Exposure Limit

Bactericidal

Photokeratitis

Skin cancer

Skin erythema

Wave length (nm)

Relative effectiveness units

Graph showing the effectiveness of UV radiation at different wavelengths for various effects such as bactericidal, photokeratitis, skin cancer, and skin erythema.
Upper Air UVGI

0.2 $\mu W/cm^2$ for 8-hour continuous eye-level exposure

or

6.0 $mJ/cm^2$ for 8-hour period
Is upper room UV dangerous?

• Monitoring Human Exposure to Upper-Room Germicidal Ultraviolet Irradiation
  - First MW, Weker RA, Yasui S, and Nardell E.
Hospital Room - UV Lamp

Old style fixtures
- intensity 10 x 0.2 µW/cm²

Unventilated bldg.

MDR patients

No TST conversions
Results: Patients and nurses monitored
- Max. UV dose range: 1-33% of TLV
Conclusions

- **Current louvered fixtures are exceedingly safe,**
  - but this may be at the cost of reduced efficacy.
- **0.2 µW/cm² is not the standard,**
  - TLV is 6 mJ/cm², but how to estimate?
    - 0.4 µW/cm² is probably safe peak room eye level as an interim guide (recommended in South Africa)
  - **Need to work with Russian radiation exposure agency to allow 6 mJ/cm² TLV**
Upper Room UV Installations

• Experienced consultant needed
• Fixtures must be properly designed, installed, and operated
  - Need Russian guidelines
  - Need to develop Russian manufacturers and installers
• Fixtures must be maintained
  - easy, but maintenance records needed
Personal protective equipment

Respirators

Masks
Suggestions

• Develop national infection control guidelines appropriate to Russia
  - Consult international guidelines
  - Extensive national training
• Develop national expertise in air disinfection strategies
  - Engineering, manufacturing, consulting
• Discontinue practices that are contributing to transmission or not helping.