PREVENTION
PRINCIPLES OF TB CONTROL

- Prevention by BCG vaccine
- Case finding
- Proper treatment to cut off chain of transmission
- Treatment of latent infection
- Health education and public relation
Prevention

- Isolate and treat
- BCG Vaccine
- Treat Latent TB
Measures of prevention

- Treatment of smear-positive pulmonary tuberculosis
- Treatment of latent tuberculous infection (preventive chemotherapy)
Prompt and efficient treatment of active tuberculosis is a key element in the prevention of spread of TB infection.
Chemoprophylaxis and Preventive chemotherapy

- **Chemoprophylaxis** refers to the administration of a medication for the purpose of preventing disease or infection.

- **Preventive chemotherapy** prevents disease from appearing in infected individuals.
Tuberculosis chemoprophylaxis

- Tuberculosis chemoprophylaxis is a therapeutic measure for the prevention of infection by *M. tuberculosis* or to avoid development of the disease in individuals already infected with it.
- Isoniazid is the most commonly used therapy; however, the use of rifampicin and pyrazinamide has recently been introduced.
- Chemoprophylaxis with 300 mg of isoniazid 10 mg per kg for children - given daily for 6 months has been used to decrease the risk of active TB developing.
- The efficacy of chemoprophylaxis ranges from 65% to 98%, depending on the length of treatment and level of compliance.
Treatment of latent tuberculous infection (preventive chemotherapy)

- prevents disease from appearing in infected individuals
- it is targeted mainly at contacts aged less than 18 years living in the same household as a newly identified case of pulmonary tuberculosis
- depending on the situation, preventive chemotherapy may be extended to other groups at risk
- the regimen consists of isoniazid given at doses of 10mg/kg for 6 months
BCG vaccination
Vaccine BCG

- BACILLUS CALMETTE GUERIN
- Lived attenuated vaccine
- Efficacy to prevent pulmonary TB 0-80% (overall protection 50%)
- Disseminated TB 78%
- TB meningitis 64%
Vaccine BCG

- Vaccine finally first used in July 1921, providing mainly children with protection
- Derivative of virulent *Mycobacterium bovis*
  - $1/10000$ of $1$ mg of *M. bovis* killed a $400$g guinea pig
- With a protective waxy coating and resistant to many physical and chemical agents, the slow-growing deadly strain was tamed by Calmette and Guérin in Lille, France
  - Used transplantation every 3 weeks in potato-beef bile medium
Vaccine BCG

- BCG vaccine consists of live bovine tubercle bacilli whose virulence has been attenuated by multiple passages through glycerinated potato.
- The bacilli of the vaccine are therefore alive, but have lost some of their virulence.
- When these bacilli are injected into the body the development of protective immunity is stimulated, and the person’s means of defence is increased without causing disease.
Vaccine BCG

- Will be applied to every newborn, normally on the second, third or fourth day and
- Asymptomatic newborn children with a positive HIV test must be immunized
How do you vaccinate?

- the skin must be disinfected on the front of the left upper arm in deltoid region
- the dose is drawn into the syringe - 0.05ml for newborns and children aged up to one year
- the injection must be given intradermally
- if the injection is done subcutaneously local complications can developed
- injection of the dose should raise a wheal, and the skin takes on an “orange peel” aspect
- after injection, the arm should be wiped and left open to the air for several minutes
How do you vaccinate?
How does the normal reaction of vaccination develops?

- The weal from the vaccination disappears within half an hour.
- After 3 or 4 weeks, a small red induration appears which swells to 6–8mm in diameter and can persist for one or two months.
- It may ulcerate and ooze serous fluid.
- This stops after 2 to 8 weeks, a scab forms and later a **scar** develops which is round, lightly depressed, and approximately **half a centimeter** in diameter (5 -10 mm).
- The child’s parents and the health personnel should be informed that this process of scar formation is normal, and that the vaccination site should not be cleaned with any product.
Contraindications to BCG Vaccination

- Inherited disorders of immunity (e.g. congenital alymphocytic agammaglobulinaemia, thymic hypoplasia etc.)
- Children during lymphocyte-depressing viral infections (e.g. measles or rubella). They can, however, be vaccinated after the acute infection is over
- Immunosuppressed children, except asymptomatic HIV+ children
- Dermatitis in the deltoid region
BCG complications
Possible factors affecting the rate of adverse reactions

- the BCG dose
- vaccine strain
- method of vaccine administration
Errors made by a new member of the health staff

- who has not been adequately trained
- who makes injections that are too deep
- who gives newborns 0.1ml instead of 0.05ml
- or who prepares the vaccine incorrectly before injection (insufficient volume of solvent, solution insufficiently mixed)
BCG: complications

- Local ulcers and regional lymphadenitis in normal hosts
- Osteomyelitis
- Disseminated BCG infection
- Keloid scar formation
- Death: 0.02 per million
Subcutaneous abscesses

- Subcutaneous or subepidermal collections of pus may form around the vaccinal ulcer and empty intermittently through a tiny central opening.
- This complication is rare and is usually due to too deep an injection or the percutaneous vaccine being wrongly given intradermally.
- Scar formation may be delayed but invariably takes place within six months.
Extensive ulceration

- An ulcer over 10mm formed at the vaccinal site, may be considered unduly extensive.
- Healing is often also delayed.
- This complication is usually due to the inoculation of an excessive amount of vaccine.
Local ulcers
Local ulcers
Local ulcers
Lymphadenitis

- Lymphadenitis is the most frequent, and the only common complication of BCG vaccination. It may occur with either the intradermal or percutaneous technique.
- The lymph node involved is usually the one draining the site of penetration of the vaccine.
- Occasionally more than one lymph node in the same region is involved.
- With vaccination given in the lower deltoid region, lymphadenitis occurs in the axillary group, but if vaccination is inadvertently given higher up — near the shoulder — the supraclavicular group will be involved.
Lymphadenitis

- Clinically evident lymphadenitis usually develops two to four months after vaccination, when the local lesion may have completely cleared up.
- Some cases may occur much later, sometimes up to a year after vaccination.
- This complication occurs more frequently in vaccinated infants than in school children.
Regional lymphadenitis
Lymphadenitis

- The recommendations for management of BCG adenitis are variable (i.e., the recommended management ranges from no treatment to treatments such as surgical drainage, administration of anti-TB drugs, or a combination of drugs and surgery)

- For adherent or fistulated lymph nodes, the World Health Organization (WHO) suggests drainage and direct instillation of an anti-TB drug into the lesion

- Nonadherent lesions will heal spontaneously without treatment
Osteomyelitis

- BCG osteitis affecting the epiphyses of the long bones, particularly the epiphyses of the leg, can occur from 4 months to 2 years after vaccination.

- The skeletal lesions can be treated effectively with anti-TB medications, although surgery also has been necessary in some cases.
Osteomyelitis
1. The protective efficacy is uncertain and unpredictable (varied from 0 to 80%)

2. Protective effect against meningeal TB of 64% and against disseminated TB of 78%

3. Skin test reactivity resulting from vaccination does not correlate with protection against tuberculosis
4. BCG should not be given to infants with active HIV disease; it is contraindicated in older asymptomatic children who are found to be HIV positive.

5. It may protect the immunized individuals; it will not affect the spread of the disease and thus can do little ultimately to control TB.
Future Vaccination Strategies

- ‘heterologous prime-boost strategy’
- ‘PRIMED’ with BCG or recombinant/genetically modified BCG (rBCG)
- ‘BOOSTED’, using some of the antigens derived from MTb, but delivered in a different way, hence ‘heterologous’
Guidance on BCG Immunisation

- WHC 2005 (062): Changes to BCG Immunisation Programme, 8th July, 2005
- WHC 2005 (077): Guidance on changes to the BCG vaccination programme, 6th September, 2005
- NPHS has prepared a ‘Framework Document for BCG Vaccination of infants and children up to under 16 years of age in Wales’
Infection Control
A need for infection control
What is Infection Control?
Infectiousness

Patients should be considered **infectious** if they

- Are coughing
- Are undergoing cough-inducing or aerosol-generating procedures, or
- Have sputum smears positive for acid-fast bacilli and they
  - Are not receiving therapy
  - Have just started therapy, or
  - Have poor clinical response to therapy
Infectiousness

Patients **no longer considered infectious** if they meet **all** of these criteria:

- Are on adequate therapy
- Have had a significant clinical response to therapy,
  and
- Have had 3 consecutive negative sputum smear results

- Retreatment /MDR cases may take longer to convert

  The only objective criteria is negative bacteriology
Infection Control Measures

- Management / Administrative Controls
- Engineering Controls
- Personal Respiratory Protection
Methods of Infection Control

- **Patient Management & Administrative controls** to reduce risk of exposure, infection, and disease through policy and practice
  (applicable to HCWs, Patients, visitors & health facility)

- **Environmental controls** to reduce concentration of infectious bacteria in on surfaces, in the air, in specimens, and in equipment
  (applicable to HCWs, Patients, visitors & health facility)

- **Respiratory protection** to protect personnel who must work in environments with droplets (large and small)
  (applicable to HCWs, Patients & visitors)
Administrative Controls

- Infection control plan
- Administrative support for procedures in the plan, including quality assurance
- Training of staff
- Education of patients and increasing community awareness
- Coordination and communication with the TB program
Administrative Controls

- After diagnostic evaluation, patients for whom TB has been confirmed or is suspected should start appropriate therapy at once
Administrative Controls

- Patients should be educated about the transmission of TB, the reasons for TB isolation, and the importance of staying in their rooms.
- Every effort should be made to help the patient follow the isolation policy - including the use of incentives, such as providing telephones or televisions or allowing special dietary requests.
- As few persons as possible should enter the TB isolation room, and anyone entering the room should wear respiratory protection.
Administrative Controls

- In addition, all health care workers should be educated about the basic concepts of TB transmission and pathogenesis, infection control practices, the signs and symptoms of TB, and the importance of participating in the employee skin testing program.
Environmental Controls

- Control source of infection

- Dilute and remove contaminated air

- Control airflow
  - Keep infectious air moving outside
  - Keep HCWs ‘upwind’, infectious patients ‘downwind’
Engineering Controls

- For preventing spread and reducing concentration of infectious droplet nuclei through:
  - use of ventilation systems in TB isolation rooms
  - use of HEPA filtration
  - ultraviolet irradiation with other infection control measures
In isolation rooms, ventilation systems are necessary to maintain negative pressure and to exhaust the air properly.

Isolation rooms should be monitored daily when in use to ensure the negative pressure maintained.

Isolation room doors should be kept closed, except when patients or personnel must enter or exit the room, in order to maintain negative pressure.

Ventilation systems can also be designed to minimize the spread of TB in other areas of the health care facility.
What is ventilation?

- Movement of air
- “Pushing” and/or “pulling” of particles and vapors
- Preferably in a controlled manner
Ventilation control

- Types of ventilation
  - Natural
  - Local
  - General
Local exhaust ventilation

- Source capture
  - Exterior hoods
  - Enclosing hoods

Uganda
Natural vs Mechanical Ventilation

- Good natural ventilation is better than bad mechanical ventilation

- Major limitation of natural ventilation is that it depends upon outdoor weather conditions

- Can control odor and improve comfort of occupants, but not if very cold or very hot

- Usually we do not have a choice and must work with where we are!
HEPA filtration

Must be used

- When discharging air from local exhaust ventilation booths or enclosures directly into the surrounding room, and

- When discharging air from an All room into the general ventilation system
HEPA filtration

- HEPA filters can be used in ventilation systems to remove droplet nuclei from the air.
- These filters can be installed in ventilation ducts to filter air for recirculation into the same room or recirculation to other areas of a facility.
- All HEPA filters must be carefully installed and maintained to ensure adequate function.
Room Air Cleaners
TB Outpatient unit – Helio Fraga Institute, MoH, Rio de Janeiro
Ultraviolet Germicidal Irradiation (UVGI)

- Used as supplement or back-up to dilution ventilation
- Does NOT provide negative pressure
- Requires maintenance, esp. cleaning bulbs
- Not effective at high humidity (>70%)
- Occupational exposure limits: eye & skin
Ultraviolet Germicidal Irradiation (UVGI)

- UVGI, or ultraviolet lighting, may kill *M. tuberculosis* contained in droplet nuclei.
- Because exposure to ultraviolet light can be harmful to the skin and eyes, the lamps must be installed in the upper part of rooms or corridors or placed in exhaust vents.
- The effectiveness of UVGI in preventing the transmission of TB is not known.
Ultraviolet Germicidal Irradiation (UVGI)

Ultraviolet irradiation kills M. tuberculosis in 5 min

- UV lamps open
- UV lamps closed
Open UV lamps
Open UV lamps
Closed UV lamp screened
Closed UV lamps
Fig. 3. Effectiveness of UVGI-induced microbial inactivation for constant-generation method experiments with 0 or 6 air changes per hour (ACH) ventilation rate for *B. subtilis* spores, *M. parafortuitum*, and *M. bovis* BCG. Height of the bar represents the average of breathing-zone measurements at 9 room locations; error bars represent the standard deviation. Experiments were repeated:  indicates experiment 1;  indicates experiment 2.
Figure 2. Schematic of the Airborne TB Transmission Study Facility on the Roof of an HIV-TB Ward in Lima, Perú

TB-HIV negative pressure isolation rooms with upper-room UV light fixtures and mixing fans. Air extract vents were located at bed height.
Environmental Controls: Which one and When?

- Dilution ventilation, UVGI, and HEPA filter units are all effective under IDEAL laboratory conditions.
- Best data in field support dilution ventilation.
- Advantage of ventilation is usually ‘always on’, minimizing human errors.
- Disadvantages of UVGI and HEPAs:
  - Maintenance (increased human errors)
  - Large variability of effectiveness
  - May cause false sense of reassurance.
Summary – TBIC Engineering Controls

- First priority is **ADMINISTRATIVE** controls, but EC are complementary
- Dilution ventilation is most important for all
  - Can add to comfort
  - But limited by technology, comfort, expense
- Negative pressure or directional airflow can keep infected air away (even if diluted) from HCWs
- UVGI and filtration devices are adjuncts for high risk areas
  - Back-up when not possible to ventilate well
Personal Respiratory Protection

Respirators can protect health care workers

Respirators may be unavailable in low-resource settings

Face/surgical masks act as a barrier to prevent infectious patients from expelling droplets

Face/surgical masks do not protect against inhalation of microscopic TB particles
Masks and Respirators

Respirators rely on an airtight seal and have tiny pores which block droplet nuclei.

Masks have large pores and do not have an airtight seal to around the edge, permitting inflow of droplet nuclei.

Face/surgical mask
Personal Respiratory Protection

Use of respirators should be encouraged in high risk settings:

Rooms where cough-inducing procedures are done (i.e., bronchoscopy suites)

TB “isolation” rooms

Referral centers or homes of infectious TB patients

CDC/NIOSH-certified N95 (or greater) respirator should be used
Personal Respiratory Protection
N95 Respirator Dos and Don’ts

*Image courtesy of: CDC Image Library*
Do Be sure your respirator is properly fitted!

[Should fit snugly at nose and chin]

*Image courtesy of: CDC Image Library*
Note poor fit at the bridge of nose

Note poor fit at the chin -

Respirator should cover chin and create a seal
Don’t forget to WEAR it!

*Image courtesy of: CDC Image Library*
Efficacy

Respiratory protection is effective only if:

- The correct respirator is used,
- It’s available when you need it,
- You know when and how to put it on and take it off, and
- You have stored it and kept it in working order in accordance with the manufacturer’s instructions

http://www.cdc.gov/niosh/npptl/topics/respirators/factsheets/respfact.html
Summary: Infection Control for TB

To reduce risk of TB to HIV positive patients and health workers, you can:

- Develop IC plan and identify responsible health workers
- Train staff on TB and TB infection control
- Screen HIV positive clients for TB symptoms and refer promptly
- Provide separate waiting areas and expedited care for TB suspects
- Use personal respiratory protection when indicated
- Use simple environmental control measures, like opening windows, turning on fans, etc.
Cough Etiquette
Thank you
Infection Control (IC) for TB

To reduce risk of TB to HIV positive patients and health workers, you can:

- Screen HIV positive clients for TB symptoms and refer promptly
- Provide separate waiting areas and expedited care for TB suspects
- Provide surgical masks or tissues to TB suspects
- Use simple environmental control measures, like opening windows, turning on fans, etc.
- Screen health workers periodically for TB symptoms
5-Steps to Prevent TB Transmission

1. SCREEN  
   Early recognition of subjects with suspected or confirmed TB

2. EDUCATE  
   Instruct patients on cough hygiene when sneezing or coughing; provide tissues or mask

3. SEPARATE  
   Request patients to wait in a separate and well-ventilated area

4. PROVIDE HIV SERVICES  
   Triage symptomatic patients to front of line for services sought, so they spend minimal time around other patients

5. INVESTIGATE FOR TB  
   TB diagnostics (sputum smear) should be completed ASAP
Infection Control (IC) for TB

- Risks to Patients and Health Care Workers Alike!
  - Patient to patient
  - Patient to providers
    - Nurses, doctors, pharmacists, FWEs
  - Provider to patients

- Reduce TB transmission in health care settings

- Devise an Infection Control Plan with your clinics

- Teach your colleagues to protect themselves
Thank you for attention