

PREVENTION IN THE COMMUNITY. BIOSAFETY AND HOSPITAL CONTROL.

By far the best way to prevent tuberculosis is to diagnose and isolate infectious cases rapidly and administer appropriate treatment until patients are rendered noninfectious and the disease is cured. Additional strategies include BCG vaccination and treatment of persons with latent tuberculosis infection who are at high risk of developing active disease.

Social risk factors of active TB disease developing. Improving access to care for high-risk groups.

Social risk factors have a great role in active TB disease developing. Social prophylaxis includes social-economic measures on the national level which are directed to improvement of vital rate of the population, to protect environment, development of physical training and sport, sanatoriums network and recreation center. The social prophylaxis is aimed at improving the environmental and labor conditions, increasing the population's material well-being, strengthening people's health through the development of mass physical culture and propaganda of healthy life style, improvement of nourishment and home living conditions, as well as fighting alcoholism and other harmful habits. The effective prevention in community bases on early detection of TB cases and isolation of contagious patients.

Improving access to care for high-risk groups

Patients with tuberculosis often belong to the most disadvantaged population groups that have the most difficulty in accessing health care. Every effort must be made to improve the accessibility of care for these population groups, by providing free tuberculosis treatment; and decentralizing health services to make them more accessible for marginalized groups (in the poorest urban areas), in centers for drug-dependent individuals or alcoholics, in prisons, and in psychiatric services.

The most threaten groups are:

- ✓ material poor-being and poor nourishment
- ✓ migrants
- ✓ refugees
- ✓ prisoners
- ✓ homeless
- ✓ crowded and unfavorable living conditions
- ✓ alcohol addicted

In high TB prevalence countries crowded living conditions and poor family income increase the risk of infection and active TB disease.

All TB control activities are financed by national budget including the treatment of hospitalized patients and providing treatment on an outpatient basis.

Bacille de Calmette et Guérin vaccine. Organization of BCG-vaccination in high and low TB prevalence countries. Individual contraindications and complications of the BCG vaccination. Treatment of latent tuberculous infection (preventive chemotherapy).

BCG is the most widely used vaccine in the world. In the light of the results of various studies on BCG and the analysis of the different vaccination policies worldwide, WHO made the following recommendations:

- BCG vaccination should be included in national vaccination programs
- In countries with a high prevalence of tuberculosis, BCG vaccination should be administered to infants as soon as possible after birth, and in any case before the age of 1 year.
- In areas where tuberculin testing is used to decide whether individuals should be revaccinated, this practice should be stopped.
- In individuals who are BCG-vaccinated, revaccination is not recommended, and there is no scientific justification for this practice. Multiple revaccination is never recommended.

As BCG is a live vaccine whose mechanism depends on cellular immunity, the risks related to vaccination and its benefits in terms of protection of the child should be taken into account in determining the vaccination strategy.

BCG was derived from an attenuated strain of *M. bovis* and first administered to humans in 1921. Many BCG vaccines are available worldwide; all are derived from the original strain, but the vaccines vary in efficacy. BCG protects infants and young children from relatively serious forms of tuberculosis, such as tuberculous meningitis and miliary tuberculosis.

BCG vaccine is safe and rarely causes serious complications. The local tissue response begins 2–3 weeks after vaccination, with scar formation and healing within 3 months. Side effects—most commonly, ulceration at the vaccination site and regional lymphadenitis—occur in 1–10% of vaccinated persons. Some vaccine strains have caused osteomyelitis in ~1 case per million doses administered. Disseminated BCG infection and death have occurred in 1–10 cases per 10 million doses administered, although this problem is restricted almost exclusively to persons with impaired immunity, such as children with severe combined immunodeficiency syndrome or adults with HIV infection. BCG

vaccination induces TST reactivity, which tends to wane with time. The presence or size of TST reactions after vaccination does not predict the degree of protection afforded.

BCG vaccine should not be used in children who are known to be HIV-positive because of the increased risk, reported from some settings, of severe and often fatal disseminated BCG disease.

In infants whose HIV status is unknown and who are born to HIV-positive mothers and who lack symptoms suggestive of HIV, BCG vaccine should be given after considering local factors.

Latent Tuberculosis Infection: Treatment

Latent tuberculosis infection (LTBI) is defined as a state of persistent immune response to stimulation by *Mycobacterium tuberculosis* antigens without evidence of clinically manifested active TB. One-third of the world's population is estimated to be infected with *M. tuberculosis*. The vast majority of infected persons have no signs or symptoms of TB disease and are not infectious, but they are at risk for developing active TB disease and becoming infectious. The lifetime risk of reactivation TB for a person with documented LTBI is estimated to be 5–10%, with the majority developing TB disease within the first five years after initial infection. However, the risk of developing TB disease following infection depends on several factors, the most important one being the immunological status of the host.

Reactivation TB can be averted by preventive treatment.

Identification of at-risk populations for LTBI testing and treatment

- Systematic testing and treatment of LTBI should be performed in people living with HIV, adult and child contacts of pulmonary TB cases, patients initiating anti-tumour necrosis factor treatment, patients receiving dialysis, patients preparing for organ or haematologic transplantation and patients with silicosis. Either interferon-gamma release assays (IGRA) or Mantoux tuberculin skin test (TST) should be used to test for LTBI.
- Systematic testing and treatment of LTBI should be considered for prisoners, health workers, immigrants from high TB burden countries, homeless persons and illicit drug users. Either IGRA or TST should be used to test for LTBI.
- Systematic testing for LTBI is not recommended in people with diabetes, people with harmful alcohol use, tobacco smokers.

Individuals should be asked about symptoms of TB before being tested for LTBI. Chest radiography can be done if efforts are intended also for active TB case finding. Individuals with TB symptoms or any radiological abnormality

should be investigated further for active TB and other conditions. TST or IGRA can be used to test for LTBI.

Treatment options for LTBI

The following treatment options are recommended for the treatment of LTBI: 6-month isoniazid, or 9-month isoniazid, or 3-month regimen of weekly rifampicin plus isoniazid, or 3–4 months isoniazid plus rifampicin, or 3–4 months rifampicin alone.

Respiratory isolation of persons with active TB disease as a measure to limit MBT transmission. Screening and management of active TB contacts. Tuberculosis in cattle-boosting TB control.

Tuberculosis in the lung is by far the most important source. Coughing and talking produce very small droplets that contain TB. They are so small that they float in the air. These may be inhaled and cause infection and then disease. The closer someone is to the patient and the longer the two live together, the higher the chance that the person in contact with the patient will inhale TB. An infant of an infectious mother will be at particular risk.

Chemotherapy rapidly reduces infectiousness, usually within 2 weeks, if the bacilli are susceptible. This is why good treatment of all tuberculosis patients, and particularly patients with a direct positive sputum smear, is by far the most effective method of prevention. But if treatment is not continued for the full period, the patient may develop disease again and become infectious again.

In prevention, the most important priority is to diagnose patients with a direct positive sputum smear and to make sure that they complete a standardized treatment. These sputum-smear-positive patients are also usually the most ill. They need treatment urgently to save their lives.

Contact investigation

Those who live in the same household as a person with pulmonary tuberculosis should be examined for evidence of tuberculous infection and disease. All individuals with respiratory or extrapulmonary symptoms indicative of tuberculosis should undergo diagnostic examination and, if shown to have tuberculosis, given treatment.

The implementation of TB contact investigation activities by the NTP should use clear definitions of the TB index case and contacts, procedures to be used in evaluating contacts, policies for treating LTBI and monitoring of the results of contact investigations.

Decisions about contact investigation and treatment of LTBI should be based on the burden of TB in the country and the resources available.

Definitions for contact investigation

Index case	<ul style="list-style-type: none">•all smear-positive pulmonary TB cases•all children with TB•smear-negative pulmonary TB cases•any form of pulmonary TB irrespective of its bacteriological status
Contacts	any household member at the moment of the identification of the index case all children in the household, especially those aged under 5 years individuals in congregate settings (e.g. the workplace, schools, social gatherings, prisons, hospitals, other health facilities) if prolonged contact with an index case has taken place.

The index case should be interviewed as soon as possible after diagnosis to identify contacts. The interview should, as a first priority, focus on the household, but the questions should cover other environments, as mentioned above.

A home visit should be made to obtain a clearer understanding of the patient's circumstances and to confirm the results of the interview.

All identified prioritized contacts of the index case should be instructed to come to the health facility for evaluation. The identified contacts should be listed; if they do not appear for evaluation, a home (or other setting) visit should be made. As a priority, every effort should be made to assess children and people living with HIV/AIDS or those with other conditions and situations associated with an increased risk of TB. After listing the contacts, the results of their assessment should be recorded.

The procedure for screening TB contacts should be clearly defined. The evaluation may be limited to determining whether the contact has symptoms that may suggest TB. As a minimum, all adolescent and adult TB contacts should be asked whether they have a persisting cough (>2 weeks). Sputum smear examinations should be carried out on those with a persistent cough. All children and HIV should be more thoroughly assessed for TB, including of extrapulmonary sites.

Four important considerations should be taken into account when providing treatment:

1) Any contact identified as having active TB should be registered and treated.

2) Children aged under 5 years who are close contacts and who do not have evidence of TB should be systematically treated with isoniazid chemoprophylaxis: 5 mg/kg daily for six months.

3) Children aged 5 years and above who are in good health do not require chemoprophylaxis but should be followed up on a clinical basis.

4) HIV who are close contacts of an infectious index case and who do not have evidence of TB should be treated with isoniazid: 300 mg/day for 6–9 months.

All patients receiving isoniazid preventive therapy should be seen at regular intervals at least early in the course of treatment to determine whether any adverse effects of isoniazid occur and to encourage adherence. After completing treatment, patients should be asked to seek care if a cough or other possible symptoms of TB develop; there is no need for further follow-up. Contacts with no evidence of TB should be asked to visit a health facility if a persistent cough or other symptoms develop in the following weeks or months.

Tuberculosis infection control activities - aims and levels. Biosafety and hospital control. The high TB transmission risk zones.

Health-care workers are at much higher risk of TB infection and disease compared with the general population. In health-care settings, other non-medical staff may also be at risk through contact with infectious sources. Measures to control infection are needed in all settings where there is a significant risk of transmission of TB infection. These settings include general health facilities where patients with cough and in whom pulmonary TB has been diagnosed are in close contact with health staff and others in a crowded and poorly ventilated environment. Waiting rooms (or corridors) where patients and accompanying people, including children, wait to receive medical care are often areas of particular risk.

In hospitals, the risk of transmission is relatively high, especially in pulmonary disease wards. The risk of spread increases when the prevalence of HIV in the contacts (staff and other patients) is high. Laboratories, particularly those carrying out *M. tuberculosis* culture procedures, are also high-risk areas. Other high-risk settings include institutions such as jails, prisons and detention centers, and drug rehabilitation centers. Other situations, such as enclosed environments during prolonged travel, may require special attention.

The main infection control measure is the proper organization and implementation of case detection procedures. Patients receiving adequate treatment are rapidly rendered non-infectious.

Infection control strategies.

The three levels of TB infection control are:

- **workplace and administrative** control measures reduce the exposure of staff and patients;

- **environmental** control measures reduce the concentration of infectious droplet nuclei;

- **personal** protective equipment (respiratory protection) protects staff in specific settings where the concentration of droplet nuclei cannot be adequately reduced by administrative and environmental control measures.

Each level operates at a different point in the transmission process.

Workplace and administrative control measures

Workplace and administrative control measures have the greatest impact on preventing TB transmission. They serve as the first line of defense for preventing the spread of TB in health-care settings. The goals are to prevent TB exposure of staff and patients and to reduce the spread of infection by ensuring rapid and recommended diagnostic investigation and treatment for patients and staff suspected or known to have TB.

The five components of good workplace and administrative control are:

- an infection control plan;
- administrative support for procedures contained in the plan, including quality assurance;
- training of health-care and other staff;
- education of patients and increasing community awareness;
- coordination and communication with the TB control program.

Each facility should have a written TB infection control plan with a protocol for the prompt recognition, separation, provision of services, investigation for TB and referral of patients with suspected or confirmed TB disease. A designated infection control officer is responsible for overseeing the implementation of infection control measures and providing infection control training for healthcare and other staff who may be exposed to TB infection.

All staff working in a facility should understand the importance of infection control policies and their role in implementing them. As part of training, each health-care worker and staff member, including any lay workers, should receive job category-specific instruction. Training should be conducted before initial assignment, and continuing education should be provided to all employees and volunteers annually.

Reminders that health-care workers and other staff can develop TB, regardless of previous infection status or BCG vaccination, should be given as part of annual retraining on infection control. Staff should be investigated for TB free of charge if they have a cough for two weeks or longer. The infection control

plan should list designated staff members to be contacted to initiate confidential TB investigations.

Patients should receive instruction on how to protect others from exposure to TB by simple cough hygiene measures.

Environmental control measures

Environmental controls are the second line of defense for preventing the spread of TB in health-care settings. It is important to recognize that if workplace or administrative controls are inadequate, environmental controls will not eliminate the risk. Many environmental control measures are technically complex and expensive, and therefore only practical for referral hospitals.

Environmental controls include:

- ventilation (natural and mechanical)
- filtration
- ultraviolet germicidal irradiation.

Ventilation. Controlled natural ventilation considerably reduces the risk of spreading *M. tuberculosis*. When fresh air enters a room, it dilutes the concentration of particles in room air, such as droplet nuclei containing *M. tuberculosis*. Natural ventilation relies on open doors and windows to bring in air from the outside; controlled natural ventilation includes checks to ensure that doors and windows are maintained in an open position that enhances ventilation. Fans may also assist in distributing the air. However, the use of ceiling fans is only justified if there is free air flow out from the room through open windows. Designing waiting areas and examination rooms to maximize natural ventilation can significantly reduce the spread of TB. In warm climates, open-air shelters with a roof to protect patients from sun and rain are appropriate.

Negative pressure ventilation is another method used to prevent contaminated air from flowing out of the room into adjacent areas in laboratory or health-care facilities, by maintaining an air pressure difference between the two areas. Air is drawn into the room from adjacent areas and exhausted directly to the outside, removing and diluting any infectious particles. This may be the method of choice in some settings, depending on factors including climatic conditions and available resources. The necessary equipment requires continued maintenance and the air exchange rate may be less than that achieved by well-designed natural ventilation.

When patients provide sputum smear specimens for TB diagnosis, they should do so outside, in the open air away from other people. When this is not possible because of climatic constraints, it should be done in an adequately ventilated booth and not in small rooms such as toilets or other enclosed areas.

Filtration. In small rooms with a limited number of patients or in other small, enclosed areas, room air cleaners with high efficiency particulate air (HEPA) filters may be a useful alternative to mechanical ventilation requiring structural changes. Room air cleaners with HEPA filters may be free-standing or may be permanently attached to floors or ceilings to minimize tampering. Correct maintenance of the filter is essential.

Ultraviolet germicidal irradiation. *M. tuberculosis* is killed if the organisms are exposed to sufficient ultraviolet germicidal irradiation. However, effectiveness depends on close contact with the UV light source and may be limited if humidity is high (over 60%) and where dust levels are high. UV lights should be directed to the ceiling, associated with adequate air flow and regularly maintained.

Personal protective equipment (respiratory protection)

Personal respiratory protection involves training in the selection and use of respirators. Respirators should not be relied upon to protect health care workers from inhaling *M. tuberculosis* in the absence of standard workplace and environmental controls. Their use should be restricted to specific high-risk areas in hospitals and referral centers, such as rooms where spirometry or bronchoscopy are performed or specialized treatment centers for patients with MDR -TB.

Respirators should be distinguished from face masks, such as surgical masks made of cloth or paper. Use of face masks is not generally recommended for health-care staff because they do not protect against TB transmission by aerosol.

However, the use of face masks in high-risk settings for drug resistant-TB is recommended for patients to reduce the risk of droplet nuclei generation and spread, particularly in high-prevalence HIV settings where many health-care workers may be HIV-infected. Respiratory protection may be used as an interim measure while selected administrative and/or environmental control measures are awaiting implementation.

Areas that potentially present a higher risk of transmission:

- respiratory isolation rooms
- ambulatory and phthisiology waiting rooms
- thoracic radiology room
- bronchoscopy and sputum induction rooms
- pentamidine nebulization room
- ventilatory assistance areas
- day-hospital
- emergency rooms

- autopsy room
- microbiology/mycobacteria laboratory

Tuberculosis laboratory biosafety

Laboratory biosafety is the process of applying a combination of administrative controls, containment principles, practices and procedures, safety equipment, emergency preparedness, and facilities to enable laboratory staff to work safely with potentially infectious microorganisms; biosafety also aims at preventing unintentional exposure to pathogens or their accidental release.

The main risks in a TB laboratory are related to the aerosols generated during the procedures that could be inhaled by laboratory workers. The risk of aerosolization is associated with the:

- Type of procedure
- Frequency of testing, and the laboratory's workload
- Consistency of the material and its predisposition to aerosolize (for example, viscous liquids versus dry solids)
- Bacillary load of the materials.

TB laboratory facilities can be classified into three main levels of procedural risk, based on the activities being performed and their associated risks:

- low TB risk
- moderate TB risk
- high TB risk (such as a TB-containment laboratory).

The probability of aerosols being generated is a key factor to consider in determining the level of risk and the necessary mitigation or control measures.

Risk precaution levels, associated laboratory activities and risk assessment for TB laboratories

Risk level of TB laboratory	Laboratory activities	Assessment of risk
Low risk	Direct sputum-smear microscopy; preparation of specimens for use in an automated nucleic acid amplification test cartridge.	Low risk of generating infectious aerosols from specimens; low concentration of infectious particles
Moderate risk	Processing and concentration of specimens for inoculation on primary culture media; direct DST (for example, line-probe assays on processed sputum)	Moderate risk of generating infectious aerosols from specimens; low concentration of infectious particles
High risk(TB-containment laboratory)	Culture manipulation for identification; DST or line-probe assays on cultured isolates	High risk of generating infectious aerosols from specimens; high concentration of infectious particles

The international biohazard warning symbol and sign must be displayed on the laboratory door.

Protective laboratory clothing must be worn at all times while staff are working in the laboratory.

The use of engineering controls (for example, biological safety cabinets and room ventilation) and personal respiratory protection (such as respirators) can help prevent laboratory-acquired tuberculosis (TB) infections associated with the inhalation of infectious aerosols. However, the most important consideration in reducing the risk of infection in the laboratory is to minimize the production of aerosols.