Guidelines for Tuberculosis Control in New Zealand 2010
Chapter 12: Infection Control and Occupational Health in Tuberculosis Disease

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Summary

Exposure to tuberculosis in the health care setting
Tuberculosis (TB) is a communicable disease that is a risk to health care workers. The greatest risk to health care workers is from a patient who is not suspected of having TB. Patients receiving treatment for TB may continue to be smear-positive for prolonged periods but have significantly reduced infectivity.

Infectivity of children
Children aged under 12 years are rarely infectious. However, if children are sputum smear-positive, they need to be treated with the same precautions with which adults are treated.

Isolation of patients with infectious tuberculosis
Isolation of patients with infectious TB is an important public health intervention and may take place in hospital or the community.
If infectious patients are sufficiently unwell to require hospital admission or cannot comply with community infection control precautions, they should be isolated in hospital.
For infectious patients who are not acutely ill, home isolation and treatment is often preferred. Patients with smear-positive pulmonary TB may be removed from isolation, if:
- they have had a minimum of two weeks’ effective chemotherapy
- their cough has resolved
- at least two sputum specimens have been smear-negative.
Many patients will have ceased to produce sputum after two weeks’ treatment. They are unlikely to be infectious.

Infection control within health care settings
Administrative controls
- All health care facilities should have in place administrative measures to reduce the exposure to patients with TB.
- Infection control policies and procedures.
- Laboratory diagnostic capabilities.
- Proper cleaning and sterilisation or disinfection of medical equipment.
- Staff education and training programmes to ensure prompt detection, airborne precautions, and treatment of persons who have suspected or confirmed TB.
- Linkage with public health services.
Hospital engineering controls
People should be isolated in airborne infection isolation rooms if pulmonary TB has been diagnosed or is suspected.
Personal protective equipment
Health care workers providing care for adult patients with known or suspected infectious pulmonary TB must wear particulate respirators (N95) that have been approved by the National Institute for Occupational Safety and Health, USA.

Staff screening
Pre-employment screening
Health care staff and students should be screened for TB infection using a risk-assessment questionnaire and either a Mantoux test or interferon gamma release assay (IGRA) before they start employment. If the test is positive or the person is at very high risk of TB infection, a chest X-ray (CXR) is indicated. A CXR is also indicated for health care workers with previous positive test results.

Universal use of the Bacille Calmette-Guérin (BCG) vaccination for staff and students is not advised in New Zealand for three reasons:
- The risk of occupationally acquired TB for most workers is relatively low.
- BCG has low efficacy in adults.
- BCG affects Mantoux reactions, so causes problems when the Mantoux test is subsequently used as a diagnostic tool. This is less of a concern if HCW screening is performed using IGRA.

Surveillance during employment
Staff at high risk of TB exposure should complete an annual questionnaire about TB symptoms and exposure, and a Mantoux test or IGRA (if they previously tested negative).

Conversion of the Mantoux test or IGRA is an indication for a CXR. People with abnormal CXRs should be investigated by a respiratory physician. If the CXR is normal, treatment of latent TB infection should be considered.

Staff working in lower-risk areas should complete periodic questionnaires during their employment and be asked to report symptoms consistent with TB, especially if they are working with immune-suppressed patients.

Routine, periodic CXR screening is not recommended for health care workers.

Infection control in non-health care facilities
Correctional facilities
Higher rates of TB occur among current or recent prisoners. The key activities required to prevent transmission of TB in correctional facilities are:
- screening to find persons with active disease
- containment to prevent transmission of TB
- supervision of the persons treatment
- maintenance of uninterrupted care prior to release into the community.

Other occupational group
The risk is difficult to define in other non-health-related occupational groups but does not appear to pose a significant risk for occupational acquisition.
Introduction

Health care workers face unavoidable hazards, including exposure to patients with infectious tuberculosis (TB). The risks posed by this hazard cannot be eliminated, but they can be reduced.

An infection control programme should formalise and document the policies, procedures and practices necessary to minimise the risk of acquiring TB from the work environment. The policy and procedures for infection control and prevention should take into account the particular characteristics and infection risks of the individual facility. The Health and Safety in Employment Act 1992 and the Health and Safety in Employment Regulations 1995 outline the legislative requirements for both employers and employees to minimise harm in the work place.

The employer responsibilities are to provide all staff in the health care facility with adequate protection against acquiring TB and to provide a safe working environment. Safe work procedures should be developed within the framework of hazards identification, assessment and control. These include screening at baseline for previous exposure, staff access to appropriate testing, vaccination and counselling programmes, procedures for monitoring employee health, a procedure for employees to report exposures and staff education and training in the principles, polices and procedures of infection control.

The employee has the responsibility to take all practicable steps to protect their health and the health of others by following the policies and procedures of the infection control and prevention programme at the facility.

The infection control aspects of tuberculosis in the health care setting include:

- administrative controls:
  - infection prevention and control policy and procedures, including staff screening for active tuberculosis, and latent tuberculosis
  - strengthen diagnostic capabilities of the laboratory
  - proper cleaning and sterilisation or disinfection of medical equipment
  - training and education of HCW regarding TB to ensure prompt identification of people with TB symptoms and adherence to policies for the prevention of transmission of TB
  - close liaison with public health services

- engineering controls

- use of protective personal equipment.

Although there are occupational TB screening programmes in hospitals, there are few published accounts of the epidemiology of latent TB infection and TB disease among New Zealand health care workers.¹
Information for this chapter was obtained from the following international guidelines:

- NICE (2006) Clinical diagnosis and management of tuberculosis, and measures for its prevention and control.\(^2\)

- Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health care settings (2005) Centers for Disease Control and Prevention.\(^3\)

- Guidelines for Australian Mycobacteriology Laboratories (2006) National Tuberculosis Advisory Committee.\(^4\)

- The BCG vaccine: information and recommendations for use in Australia (2006) National Tuberculosis Advisory Committee.\(^5\)

- WHO Policy on TB Infection Control in Health-Care Facilities, Congregate Settings and Households (2009) World Health Organization.\(^6\)
1 Infectivity of Patients with Tuberculosis

1.1 Change in sputum status with treatment

Analysis of smear and culture results from the mycobacteriology laboratory at Auckland Hospital showed that:

- at least 95% of (pre-treatment) specimens with $\geq 0–1$ acid-fast bacilli (AFB) per high-power field (HPF) on microscopy were culture-positive
- cultures from patients with smear-negative pulmonary TB take an average 14 days to become culture-positive
- cultures from patients with 10 or more AFB/HPF before TB treatment take an average four days to become culture-positive
- cultures from patients with 10 or more AFB/HPF who have received at least 14 days’ treatment take an average 10 days to become culture-positive.

The Auckland data suggest that the time it takes for sputum specimens to become culture-positive may have potential as an indicator of the quantity of viable organisms, and therefore of patient infectivity. It may prove to be a more valid predictor of infectivity than the sputum smear result alone. This finding will need to be confirmed by others before it can be included in practical guidelines for the release of smear-positive patients from isolation.

Studies have also been conducted overseas. Telzak et al identified cavitatory disease, numerous AFB on the initial smear and no prior history of tuberculosis as independent predictors of a longer time to sputum smear and culture conversion. Al-Moamary et al looked at patients who remained smear positive 20 weeks after starting treatment. Only seven out of 30 patients (23%) remained culture-positive. This group of patients was more likely to have localised disease on a chest X-ray (CXR), had less radiologic improvement on follow-up, had a higher prevalence of drug resistance, and was less compliant with medication than patients with persistently positive smear results and negative culture results.

For compliant patients with fully susceptible TB, it is likely that they are rendered non-infectious in a matter of weeks, see section 3.3.

1.2 Infectivity of patients who remain smear-positive on treatment

Patients on treatment may continue to be smear-positive for prolonged periods. The infectivity of these patients is unclear. Most evidence suggests patients have significantly reduced infectivity on appropriate treatment, even if they continue to be smear-positive.

Experimental exposure of guinea pigs to sputum smear-positive patients has demonstrated that the infectiousness of untreated patients was much greater than that of patients on chemotherapy. Some patients were markedly more infectious than others. Patients became non-infectious for guinea pigs after two weeks' chemotherapy.
1.3 Infectivity of children

Children under 12 years are rarely infectious. They usually have primary rather than post-primary TB and do not usually have laryngeal or bronchial disease. Generally, they do not have a cough of adequate strength to expel significant numbers of TB bacilli. However, some children such as those with endobronchial disease and older children whose disease may more closely resemble adult TB may be infectious. Sputum smear-positive children need to be managed with the same precautions as adults.
2 Isolation of Patients with Infectious Tuberculosis (sputum smear-positive tuberculosis)

Isolation of infectious TB is an important public health protection measure and may occur in hospital or the community.

2.1 Isolation of infectious cases in hospital

Infectious patients should be admitted to hospital and isolated, if they are:

- sufficiently unwell to require admission to hospital
- unable to comply with the community infection control precautions.

Patients should be cared for using Airborne Precautions, in addition to Standard Precautions, which are designed to reduce the risk of airborne transmission of infectious agents. The patient should be placed in an airborne infection isolation (AII) room. An AII room is required to have monitored negative air pressure in relation to the surrounding areas, six to 12 air changes per hour and appropriate discharge of air outdoors or monitored high-efficiency filtration of room air before the air is circulated to other areas in the hospital. All individuals entering the room must wear respiratory protection (N95 respirator) when entering the room.

2.2 Isolation of infectious cases at home

It is possible to initiate anti-TB therapy at home. If the patient is not acutely ill, home isolation and treatment is often the preferred option. Home isolation and treatment minimises the possibility of previously unexposed people being exposed to TB, which might happen in a hospital. The management of these patients will be shared by the District Health Board Respiratory Service and Regional Public Health Communicable Team.

A public health nurse experienced in TB control should visit the home of the isolated patient within 24 hours of diagnosis and discuss isolation requirements with the patient and their family. The nurse must explain that:

- the patient should stay at home and not go to places where there will be previously unexposed or casually exposed people
- the family must minimise the duration and number of visits by previously unexposed or casually exposed people (this is especially important if visitors are children – all visiting by children from outside of the family should be strongly discouraged until the patient is smear-negative)
- where possible the patient should minimise contact with children less than five years of age
- previously unexposed people should not come to live with the family until sputum converts to negative
- the patient must wear a surgical mask when previously unexposed or casually exposed people (including visiting public health nurses) visit the house
- the patient must cover their mouth when sneezing or coughing
- the patient needs to adhere to the schedule of medication and side-effect monitoring.

The nurse must also educate the family about disease transmission and disease control.

2.3 Criteria for ending isolation

Patients with smear-positive pulmonary TB may be considered for removal from isolation, if all of the following have been met.

- The patient has had a minimum of two weeks’ effective chemotherapy.
- The patient has stopped coughing.
- The patient is infected with a fully susceptible strain of *Mycobacterium tuberculosis*.
- The patient is responding well to treatment.
- At least two of the patient’s sputum specimens are smear-negative or the patient remains smear-positive but is culture-negative.13

Many patients will have ceased to produce sputum after two weeks’ treatment and are unlikely to be infectious. If spontaneous sputum specimens cannot be obtained, supervising nursing staff must be sure the patient is no longer coughing before the decision is made to end isolation.
3 Administrative Measures for Infection Control

All health care facilities should have in place administrative measures to reduce the exposure to patients with TB.

3.1 Infection control policy

Important measures must be implemented when a person with suspected or confirmed infectious TB is admitted to hospital. These measures should be clearly documented in a written Infection Control Policy. The purpose of this policy is to ensure prompt detection of infectious cases and the proper placement of patients in Airborne Precautions.

- In addition to Standard Precautions, Airborne Precautions must be used when providing clinical care for patients if pulmonary TB is suspected or has been diagnosed.
- The patient should be placed in an airborne infection isolation (AII) room which must have modern, negative-pressure ventilation systems (see section 12.5.2).
- Aerosol-generating procedures such as bronchoscopy and sputum induction on patients with TB (and some other infections) should be carried out in respiratory isolation conditions even when TB is only remotely possible; particulate respirators must be worn.
- Patients with human immunodeficiency virus (HIV), regardless of whether they have TB or not, should be nursed in separate wards from non-HIV infected TB patients. Nosocomial TB outbreaks have been documented overseas in HIV-infected people.
- Infectious TB patients must wear surgical masks when they leave the isolation room for investigations in other parts of the hospital.
- Standard Precautions will protect against the unlikely possibility of cutaneous transmission of TB from body substances containing \textit{M. tuberculosis}.
- Particulate respirators and gloves are required for TB wound care.

3.2 Laboratory diagnostics

The results of smear examinations for AFB on respiratory specimens should be available within 24 hours (see Chapter 11, so people in whom infectious TB is not confirmed can be considered for removal from isolation.

There should be processes in place to ensure that the results are promptly reported to the requesting Doctor or Medical Unit and to the Infection Control Service.


3.3 **Proper cleaning and sterilising or disinfection of medical equipment**

Instruments such as bronchoscopes and nebulisers used for patients with TB and other mycobacterial diseases become contaminated. If the cleaning and sterilisation or disinfection of the equipment is inadequate, organisms may be transferred from one patient to another. Contaminated equipment may also transfer viable organisms to specimens from patients who do not have TB disease, giving false-positive smears or cultures (see Chapter 11).

Each District Health Board should have a policy for the microbiological surveillance of endoscopes that is supervised by an infection control committee.

Standards New Zealand has published advice on the cleaning and sterilisation of instruments.\(^1^5\) The 3rd edition’s GENCA ‘Infection Control in Endoscopy’ guideline has recently been released in draft form.\(^1^6\) It recommends monthly testing for routine bacteria and mycobacterial cultures (culturing for rapid growing mycobacteria **not** *M. tuberculosis*) from all bronchoscopes. The water from the automatic endoscope processes should also be cultured for rapid growing mycobacteria.

3.4 **Training and education of HCW regarding tuberculosis**

All HCW should receive education about the symptoms of tuberculosis, the appropriate isolation precautions to be applied when caring for patients suspected or proven to have tuberculosis.

3.5 **Close liaison with public health services**

Tuberculosis disease is notifiable. Early liaison between the public health service and the infection control and occupational health services in the facility is necessary to avoid confusion of roles and responsibilities when inadvertent HCW exposure necessitating contact tracing occurs.
4 Hospital Engineering Controls

4.1 Background

Isolation areas require adequate ventilation with direct engineering controls that dilute airborne droplet nuclei containing TB bacilli.\textsuperscript{3}

The physical isolation of a patient in a well-ventilated room does not reliably prevent airborne transmission unless the room has negative pressure. An open window will change the direction of airflow and may contaminate areas outside the isolation room.

Engineering controls can be thought of as different ways of achieving ‘dilution’ of airborne droplet nuclei that contain TB bacilli. It is expensive for facility designers and maintenance staff to fully implement all the guidelines, and little empirical evidence shows what provides the best results for a certain level of investment.\textsuperscript{17} Some systems, unless very carefully designed and maintained, will not provide the necessary protection.\textsuperscript{18,19} Equipment such as fans deteriorate in performance with age and may be affected by structural alterations to the building or inappropriate maintenance.\textsuperscript{17} There are reports of facilities where the design intention was good, but the function was poor.\textsuperscript{20,21} The system’s performance must be regularly checked, using techniques such as smoke testing.

4.2 Negative-pressure rooms

Negative-pressure ventilation extracts air and lowers the pressure in the isolation room. This ensures contaminated air does not flow from the isolation room to clean areas. However, negative-pressure ventilation does not protect health care workers who enter the room; they must wear appropriate face masks. An anteroom outside the isolation room further reduces the risk of the isolation room contaminating air in the rest of the ward. Air is extracted from the anteroom at a lesser rate than from the isolation room.

In hospitals with air conditioning systems, the ventilation engineer needs to design a system to change the air more than the recommended number of times per hour. The Centers for Disease Control and Prevention recommends more than six air changes per hour in general patient areas such as waiting rooms and over 12 air changes per hour in areas used to nurse TB patients.\textsuperscript{3}

It takes a long time to completely clear a room from the aerosol generated by a cough. As shown in Table 4.1, even at the recommended air change rate (12 air changes per hour) the room will not be completely clear (99.9% clean) for 35 minutes.\textsuperscript{3}

Thus, dilution takes time and further demonstrates the need for personal respiratory protection. The information in Table 4.1 also assumes perfect mixing, which is rare in practice.
### Table 4.1: Time required to remove the aerosol produced by a cough

<table>
<thead>
<tr>
<th>Air change rate per hour</th>
<th>Percentage aerosol removed</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90%</td>
<td>99%</td>
<td>99.9%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>28 minutes</td>
<td>55 minutes</td>
<td>83 minutes</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12 minutes</td>
<td>23 minutes</td>
<td>35 minutes</td>
<td></td>
</tr>
</tbody>
</table>

### 4.3 Filtration

A TB isolation room does not need special inlet filtration to improve the incoming air quality since the contaminant is introduced within the room. However, filtration of re-circulated air within the room can be viewed as a method of increasing the effective dilution without increasing the number of air changes per hour. If air in a TB isolation room is re-circulated, filtration by high-efficiency particulate attenuation (HEPA) filters built into the ceiling space is required.

Self-contained portable HEPA filtration units are available and claim cost-effective performance, but they are prone to short-circuiting the air flow and are not recommended if built-in systems are available.\(^{22}\)

### 4.4 Ultra-violet germicidal irradiation

There is increasing evidence about the effectiveness of ultra-violet germicidal irradiation (UVGI) on the TB aerosol. Upper-room UVGI systems are have evaluated to see how effective they are at killing or inactivating airborne mycobacteria. Currently it has been established that appropriately designed and maintained upper-room UVGI systems may kill or inactivate airborne mycobacteria and increase the protection afforded to HCW while maintaining a safe level of UVGI in the occupied lower portion of the room.\(^{23}\)

Additional research needs to be done to better plan effective upper-room UVGI fixture installations in the health care setting taking into account variables such as air mixing and measurement of UV fluence levels in the upper room.

### 4.5 Monitoring the effectiveness of engineering controls

A programme of regular testing is required to ensure engineering controls of air quality are effective. Testing should include:

- monthly smoke tests to ensure air-flow direction is as intended
- checks that negative-pressure gauges are functioning correctly
- regular review and replacement of HEPA filters.
5 Personal Protective Equipment

Health care workers providing care for adult patients with known or suspected infectious pulmonary TB must wear particulate respirators (N95) that have been approved by the National Institute for Occupational Safety and Health, USA.

There are a number of approved particulate respirators available in New Zealand; the most commonly used ones in health care are the 3M n95 1860, 1860s and1870.

The following are important requirements.

- Training should be given in the use of particulate respirators and the need to check for satisfactory facial fit; periodic fit checks should be made.

- N95 particulate respirators are intended to be disposable or single use. The manufacturers advise that they be discarded when the user leaves the isolation room. Some New Zealand facilities re-use these respirators because of their high cost. If re-use occurs, careful labelling of the mask and placement of it in a suitable container, such as a biohazard bag used for clinical specimens, between uses is needed. The respirator should be discarded at the end of a working shift.

- Reusable or multi-use particulate respirators must be labelled for a single staff member’s use and maintained according to the manufacturer’s instructions.

- Some staff, such as those with beards, may need alternative protection. Obtain advice from the Infection Control Service.
6 Staff Screening

The magnitude of the risk of occupational transmission of tuberculosis in any health care setting varies by setting, occupational group, prevalence of TB in the community, patient population and effectiveness of infection control procedures. In general the risk of TB is elevated in HCW who work in wards with patients with TB, nurses in hospitals in general, nurses attending HIV-infected or drug-addicted patients, pathology and laboratory workers, respiratory therapists and physiotherapists, physicians in internal medicine, anaesthetists, surgeons and psychiatrists. It is also elevated in non-clinical staff such as cleaners and orderlies.²⁴

A recent review of the prevalence and incidence of TB infection and disease among HCW in countries categorised by income reported that the median prevalence of latent TB infection in HCW from low–median income countries (LMIC) was 63% (range 33–79%) compared to 24% (range 4-46%) in HCW from high income countries (HIC).²⁵ Among HCW from LMIC latent TB infection was consistently associated with markers of occupational exposure but in HIC it was associated with non-occupational factors. The median annual incidence of TB infection attributable to health care work was 5.8% (range 0–11%) in LMIC and 1.1% (range 0.2–12%) in HIC. Rates of active TB in HCW were consistently higher than the general population in all countries. Administrative controls were identified as important in all countries for controlling occupationally-acquired TB. Administrative controls were also seen as the cheapest and easiest measure to implement.²⁵

Internationally recommendations about staff screening are similar. Baseline screening in the form of a risk assessment questionnaire and either a Mantoux test or interferon gamma release assay (IGRA) are recommended. The purpose of the baseline screening is to provide a basis for comparison in the event of a potential or known exposure to tuberculosis and to facilitate the detection and treatment of new employees with latent or active TB infection. However, the response to screening outcomes (Mantoux or IGRA results) differs. The difference mainly relates to BCG vaccination being recommended by some guidelines for those employees found to have negative results.

In the UK² it is recommended that all staff new to the National Health Service (NHS) who will be working with patients or clinical specimens undergo a TB check. This includes completing a questionnaire that assesses personal and family history of TB, determines the presence of signs and symptoms suggestive of active TB infection and provides evidence for previous assessment for TB risk by screening with a Mantoux or IGRA in the last five years. Employees new to the NHS from a country of high TB incidence, or who have contact with patients in settings with a high TB prevalence, should have a Mantoux or IGRA.² If the result is negative they should be risk assessed for HIV infection and offered BCG vaccination. If positive they should be referred to a TB clinical service. If a new employee is from a low incidence setting without prior BCG vaccination and has a positive Mantoux or IGRA then they should have a medical assessment and a chest X-ray.² They should be referred to a TB clinical service for further consideration of TB treatment if the chest X-ray is abnormal, or for consideration of treatment for latent TB if the chest X-ray is normal.
In the USA all paid and unpaid persons working in health care settings who have the potential for exposure to TB through air space shared with persons with infectious TB disease should be included in a TB screening programme. The screening programme involves a questionnaire to assess risk factors and baseline testing for TB infection. If a Mantoux or IGRA has not been performed in that last 12 months then testing should be performed. If the result of the TST in the last 12 months was negative another Mantoux should be done.

For all employees with negative Mantoux or IGRA it is up to the institution to decide whether to perform serial testing or not. This decision will be based on a risk assessment for the setting. Serial screening for signs and symptoms of TB infection may be performed in high risk settings such as staff involved in aerosol-generating or aerosol-producing procedures (bronchoscopy, sputum induction and administration of aerosolised medications) and those participating in suspected or confirmed \textit{M. tuberculosis} specimen processing and culturing of \textit{M. tuberculosis}. TB training and education is also recognized as an important aspect of new staff induction.

In Australia the BCG strategy is no longer recommended as the primary means of HCW protection. The preferred strategy is appropriate infection control measures including staff education and Mantoux testing program that identifies and treats the at-risk infected HCW. The Australian guidelines for screening of personnel working in a mycobacteriology laboratory require all new staff to have a two-step Mantoux perform. Any positive results should be followed up by a CXR and medical assessment. Staff with negative TST should have an annual test and any staff with TST conversion will need further assessment.

6.1 Pre-employment screening

In New Zealand health care staff who have contact with patients or infectious materials must undergo pre-employment screening. This screening aims to:

- detect applicants who may have TB disease, and hence avoid the possibility that this may be transmitted to patients
- identify those with latent TB infection so that they can be counselled and offered treatment where appropriate
- obtain baseline data about Mantoux or IGRA status for comparison with data obtained during routine surveillance or after exposure to TB.

Similar screening by educational institutions is required for students of nursing, medicine and allied health. This screening must be included in the agreements between hospitals and educational institutions (universities and polytechnics). When hospitals employ agency (bureau) staff, the contract must specify similar screening for the agency workers. Larger hospitals should have an in-house occupational health unit to facilitate co-operation with other services such as infection control and public health.
Pre-employment screening to prevent staff exposure to patients with tuberculosis infection in rest homes is unnecessary. Among 288 cases aged over 70 years who were notified in 1995–99, only 15 (9%) were recorded as residing in a rest home or retirement village. This approximates the proportion of the elderly population living in such settings and indicates no excess risk. However, if the new staff member is from a country of high TB incidence, or has had contact with patients in settings with a high TB prevalence, then consideration should be given to have the new staff member undergo pre-employment screening. Advice should be sought from the local District Health Board Infection Control Service or Public Health Unit.

Pre-employment screening consists of a:
- pre-employment questionnaire
- IGRA (recommended) or two-step Manotux
- CXR, if appropriate.

6.1.1 Pre-employment questionnaire
The pre-employment questionnaire should cover:
- birth, residence, and extended travel in countries of high TB prevalence
- previous TB
- previous Mantoux or IGRA results
- known TB exposure from family or work
- previous occupations
- proposed new occupation
- health problems that would increase the risk of developing TB disease.

6.1.2 Two-step TST or interferon gamma release assay
A number of District Health Boards are shifting away from using the Mantoux due the logistics of delivering the test and are now using the QuantiFERON Gold assay for pre-employment screening.

If the Mantoux is used for pre-employment screening then the two-step Mantoux is essential, if the person is not known to be positive. Failure to use the two-step test may later lead to an incorrect diagnosis of a Mantoux conversion and to unnecessary investigation or treatment. If a Mantoux has been done in the last 12 months and was negative then only a single Mantoux needs to be performed.

A full discussion of the two-step Mantoux test is in Chapter 8.

6.1.3 Chest X-ray
A CXR should be offered to those with a positive Mantoux reaction or IGRA or if concerns have been raised as a result of the questionnaire or there has been a previously positive Mantoux or IGRA.
Abnormal CXRs should be discussed with a respiratory physician, who may need to examine the person.

6.1.4 Pre-employment Bacille Calmette-Guérin vaccination

The place of Bacille Calmette-Guérin (BCG) vaccination for health care workers is controversial.\textsuperscript{2,3} Universal use of BCG for staff and students is not indicated in New Zealand or Australia, because most workers are at comparatively low risk of occupationally acquired TB. BCG has been shown to reduce the occurrence of severe forms of TB disease in children and overall might reduce the risk of progression from latent TB to TB disease but it is not thought to prevent TB infection. It has a low efficacy in adults and makes the further use of the Mantoux as a diagnostic tool more difficult.

6.2 Surveillance during employment

Surveillance during employment is a controversial issue and different countries have taken different approaches. The United States requires individual institutions to perform risk assessment in their setting to determine if serial screening is required.\textsuperscript{9} In the UK serial screening is not recommended.\textsuperscript{2} In New Zealand it is up to individual District Health Boards to determine the need for serial surveillance.

Surveillance can include regular:
- TB symptom questionnaires
- Mantoux or IGRA
- CXR, if applicable.

In general staff working in TB, or general respiratory wards, are at high risk of TB exposure, as are staff in bronchoscopy or induced-sputum rooms, TB laboratories, and post-mortem examination rooms. These staff should complete an annual questionnaire about TB symptoms and recent exposure and have a Mantoux or IGRA (if they previously tested negative).

Staff working in areas of lower risk should be informed of their duty to report signs and symptoms suggestive of TB as part of responsibility to protect patients. Serial screening is not required.

Staff with Mantoux or IGRA conversion should have a CXR, and those with abnormal CXRs should be examined by a respiratory physician. If TB disease is excluded by a normal CXR, treatment of latent TB infection may be considered.

6.3 Staff exposed to patients with infectious tuberculosis

Staff exposed to an infectious TB case are managed in the same way as other contacts are managed (see Chapter 7).
7 Infection Control in Non-Health Care Settings

7.1 Infection control in correctional facilities

High rates of TB occur in correctional and detention facilities. In New Zealand, from 1997 to 2001 the TB rate among current or recent prisoners was approximately six times higher than the average national TB rate. Incarcerated persons are at high risk for TB for many reasons; most come from groups at higher risk of TB within the community. They may not have had access to primary care before incarceration and standards of health care within correctional facilities do not match those available in the community. The physical structure of the facilities contributes to disease transmission, as facilities often provide close living quarters with inadequate ventilation and are often overcrowded. Further compounding this is the movement of inmates into and out of overcrowded and inadequately ventilated facilities making transmission of TB more likely and hindering TB-control measures.

The key activities required to prevent transmission of TB in correctional facilities are:

- screening – finding persons with active disease
- containment – preventing transmission of TB and treating the person with TB
- supervision of the persons TB treatment
- maintenance of uninterrupted care by liaising with public health services before release into the community.

New prisoners may, during their screening process on admission to a correctional facility, give a history of being on current treatment for active TB disease (diagnosed in the community), past treatment for active TB disease or treatment for LTBI, or past diagnosis of LTBI without treatment. Infectious TB may also be suspected and diagnosed for the first time in a prisoner already being held in a correctional facility. It is important to raise awareness of signs and symptoms in prisoners, prison staff and health care workers working in these settings.

An infectious case should be immediately transferred to a hospital and placed in an airborne infection isolation room until they have completed at least two weeks of appropriate anti-TB treatment.

All staff in correctional facilities should be familiar with the infection control policy for that institution. This policy should include how to access N95 particulate respirators if the possibility of infectious TB in an inmate arises.

When an infectious TB case is discovered or managed in prison:

- the clinician should alert Department of Corrections and public health teams about the infectious potential and treatment
- written communication should continue throughout the period of treatment and follow-up
• public health staff must be available to conduct education and contact investigation among prison staff
• liaison between prison services and public health will allow identification and education of families at risk for TB exposure.

The management of inmates with TB should be in accordance with *Tuberculosis Case Management in Prisoners: Joint Protocol for Corrections Facilities and TB Treatment Supervising Services (Regional Public Health Services and/or Clinical TB Services) in New Zealand* (date of publication (online): April 2010).

7.2 Screening for health care workers in correctional facilities

The high incidence of TB cases in correctional facilities is associated with an increased rate of TB transmission to prison workers as well as other inmates in some studies. However, a recent study looking at the risk factors for occupational infection among health care workers in correctional facilities in the USA reported that the risk factors were predominantly demographic rather than occupational.

Health care workers working in correctional facilities should undergo the same screening processes as HCW in health care settings (see section 7).
8 Occupational Risk for Persons Working in Occupations with Risk of Exposure to Tuberculosis

8.1 Silica workers
Silica workers have a high incidence of TB, particularly when silicosis has developed, but this is rarely an issue in New Zealand.\[^{33}\]

8.2 Abattoir workers
In New Zealand, bovine TB (\textit{M. bovis}) is an important disease of livestock and has been documented in cattle, deer, sheep, pigs and goats. A high incidence of TB has been noted in New Zealand abattoir and freezing workers, with 21 cases notified from 1995 to 2000. However, in at least 12 of these cases the organism was identified as \textit{M. tuberculosis}, implying that the source of infection was not the animal carcasses.

8.3 Veterinarians
Because of their exposure to livestock and domestic animals, veterinarians are at risk of infection by zoonotic pathogens. As well as farm animals, domestic pets, including cats and dogs, may be infected by \textit{M. bovis}. Surprisingly, there has been no report of TB transmitted from a diseased animal to a veterinarian in New Zealand.

8.4 Farm and animal workers
Farm and animal workers have the potential for extensive contact with zoonotic pathogens.

8.5 Possum hunters
In New Zealand, possums are reservoir hosts for \textit{M. bovis} and are responsible for the spread of infection in wild animals and domestic stock.\[^{34}\] It is estimated that around 15–20\% of possums in an endemic area become infected. Transmission from possums to cattle and deer is probably also by the respiratory route, although some ingestion also occurs when domestic stock are attracted to terminally ill possums.\[^{34}\]

There has been no recorded case of human infection with \textit{M. bovis} occurring in possum hunters, but there is a theoretical risk of this. Infection might occur by the respiratory route from live possums or when gutting infected lymph glands and other organs.

8.6 Armed forces
There is no recent evidence of increased risk of TB in the New Zealand armed forces. Recommendations for armed forces personnel working in high-incidence countries are the same as for travellers to these countries.
8.7 Miscellaneous occupations

Analysis of data from the United States National Occupational Mortality Surveillance database identified disproportionately high numbers of deaths from TB in funeral directors, food service and preparation workers, and machine operators, as well as health care workers and occupations with silica exposure.\textsuperscript{35,36} TB in food service and preparation workers and machine operators may be ascribed to confounding risk factors associated with their low socioeconomic status, but funeral directors may have a true risk of exposure from cadavers.\textsuperscript{37,38} This would also be consistent with the findings of higher rates in pathologists and mortuary workers.

There is no evidence of increased risk of TB in New Zealand for teachers; despite the fact about 167 children of school age were identified with TB between 1996 and 2000. Children have a low risk of transmission of TB.

There is no evidence of increased risk of TB in New Zealand for early childhood workers, police, and conservation or ambulance workers.
References


**Further reading**


