World Health Organization

WHO Policy on TB Infection Control in Health-Care Facilities, Congregate Settings and Households

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WHO policy on TB infection control in health-care facilities, congregate settings and households

Stop TB Department

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WHO policy on TB infection control in health-care facilities, congregate settings and households.

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Abbreviations and acronyms

ACH	air changes per hour
ACSM	advocacy, communication and social mobilization
AIDS	acquired immunodeficiency syndrome
CE	Indicates conformity with the essential health and safety requirements set out in European directives
CDC	Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America
DNA	deoxyribonucleic acid
DOT	directly observed therapy
GRADE	Grading of Recommendations Assessment, Development and Evaluation[a]
HEPA	high-efficiency particulate air
HIC	high-income countries
HIV	human immunodeficiency virus
HRD	human resource development
IEC	information, education and communication
IPC	infection prevention and control
IPT	isoniazid preventive therapy
LIC	low-income countries
LMIC	low and middle-income countries
LTBI	latent tuberculosis infection
MDR-TB	multidrug-resistant TB
MIC	middle-income countries
NIOSH	National Institute for Occupational Safety and Health, CDC, USA
NTP	national TB programme
TB	tuberculosis
TST	tuberculin skin test
UNAIDS	The United Nations Joint Programme on HIV/AIDS
UVGI	ultraviolet germicidal irradiation
XDR-TB	extensively drug-resistant TB
WHO	World Health Organization

a. http://www.gradeworkinggroup.org

Executive summary

This document is an evidence-based policy for the implementation of sound tuberculosis (TB) infection control by all stakeholders.

TB infection control is a combination of measures aimed at minimizing the risk of TB transmission within populations. The foundation of infection control is early and rapid diagnosis, and proper management of TB patients.

TB infection control requires and complements implementation of core activities in TB control, HIV control and health-systems strengthening. It should be part of national infection prevention and control policies because it complements such policies – in particular, those that target airborne infections.

The evidence base for the policy was established through a systematic literature review. The review highlighted some areas where evidence supports interventions that add value to TB infection control. A number of recommendations were developed, based on this evidence and on additional factors, such as feasibility, programmatic implementation and anticipated cost.

Set of control measures

TB infection control requires action at national and subnational level to provide managerial direction, and at health facility level to implement TB infection control measures. The recommended set of activities for national and subnational TB infection control is necessary to facilitate implementation of TB infection control in health-care facilities, congregate settings and households, as shown in Box 1. These activities should be integrated within existing national and subnational management structures for general infection prevention and control, if such structures exist. Recommendations on TB infection control in health-care facilities are shown in Box 2.

In contrast to previous WHO guidelines (*1, 2*), which were aimed at health facilities, this document provides guidance to WHO Member States on what to do and how to prioritize TB infection control measures at national level.

The recommended set of measures are needed because TB infection control is at an early stage of development in most countries, based on reports to WHO from Member States in 2008. No country provided information or data on implementation of measures, although 66% (131/199) of countries stated that they had a policy on TB infection control (*3*).

Box 1 Set of activities for national and subnational TB infection control

The national and subnational managerial activities listed below provide the managerial framework for the implementation of TB infection control in health-care facilities, congregate settings and households.

1. Identify and strengthen a coordinating body for TB infection control, and develop a comprehensive budgeted plan that includes human resource requirements for implementation of TB infection control at all levels.
2. Ensure that health facility design, construction, renovation and use are appropriate.
3. Conduct surveillance of TB disease among health workers, and conduct assessment at all levels of the health system and in congregate settings.
4. Address TB infection control advocacy, communication and social mobilization (ACSM), including engagement of civil society.
5. Monitor and evaluate the set of TB infection control measures.
6. Enable and conduct operational research.

In the past, TB infection control in health-care facilities and congregate settings was largely neglected in the policy and practice of TB control. However, recent outbreaks of multidrug-resistant tuberculosis (MDR-TB) and extensively drug-resistant tuberculosis (XDR-TB) with high mortality – in particular in high HIV-prevalent settings – have led to a stronger focus on TB infection control in such settings. This document includes recommendations on TB infection control in health-care facilities,

as shown in Box 2, below, as well as in congregate settings, as described in Chapter 4. It also provides guidance on how to reduce TB transmission in households, as shown in Chapter 5.

Box 2 Set of measures for facility-level TB infection control

The measures listed below are specific to health-care facilities. More details on congregate settings and households are given in Chapters 4 and 5, respectively.

Facility-level measures

7. Implement the set of facility-level managerial activities:
   a) Identify and strengthen local coordinating bodies for TB infection control, and develop a facility plan (including human resources, and policies and procedures to ensure proper implementation of the controls listed below) for implementation.
   b) Rethink the use of available spaces and consider renovation of existing facilities or construction of new ones to optimize implementation of controls.
   c) Conduct on-site surveillance of TB disease among health workers and assess the facility.
   d) Address advocacy, communication and social mobilization (ACSM) for health workers, patients and visitors.
   e) Monitor and evaluate the set of TB infection control measures.
   f) Participate in research efforts.

Administrative controls [a]

8. Promptly identify people with TB symptoms (triage), separate infectious patients, control the spread of pathogens (cough etiquette and respiratory hygiene) and minimize time spent in health-care facilities.
9. Provide a package of prevention and care interventions for health workers, including HIV prevention, antiretroviral therapy and isoniazid preventive therapy (IPT) for HIV-positive health workers.

Environmental controls

10. Use ventilation systems.
11. Use ultraviolet germicidal irradiation (UVGI) fixtures, at least when adequate ventilation cannot be achieved.

Personal protective equipment

12. Use particulate respirators.

[a] The administrative controls include (in addition to the items listed above) reduction of diagnostic delays, use of rapid diagnostic tests, reduction of turnaround time for sputum testing and culture, and prompt initiation of treatment.

Implementing control measures

All health-care facilities, public and private, caring for TB patients or persons suspected of having TB should implement the measures described in this policy. The measures selected will depend on the infection control assessment (Activity 3 in Box 1, above), which is based on the local epidemiological, climatic and socioeconomic conditions, as well as the burden of TB, HIV, MDR-TB and XDR-TB.

Health-care facilities

The literature review suggests that implementation of controls as a combination of measures reduces transmission of TB in health-care facilities. However, administrative controls should be implemented as the first priority because they have been shown to reduce transmission of TB in health-care facilities. Administrative controls are needed to ensure that people with TB symptoms can be rapidly identified and, if infectious, can be separated into an appropriate environment and treated

promptly. Potential exposure to people who are infectious can be minimized by reducing or avoiding hospitalization where possible, reducing the number of outpatient visits, avoiding overcrowding in wards and waiting areas, and prioritizing community-care approaches for TB management.

The administrative controls should be complemented by the environmental controls and personal protective equipment, because evidence shows that these measures also contribute to a further reduction of transmission of TB.

The environmental controls implemented will depend on building design, construction, renovation and use, which in turn must be tailored to local climatic and socioeconomic conditions. However, installation of ventilation systems should be a priority, because ventilation reduces the number of infectious particles in the air. Natural ventilation, mixed-mode and mechanical ventilation systems can be used, supplemented with ultraviolet germicidal irradiation (UVGI) in areas where adequate ventilation is difficult to achieve.

Personal protective equipment (particulate respirators) should be used with administrative and environmental controls in situations where there is an increased risk of transmission.

Congregate settings

Congregate settings range from correctional facilities and military barracks, to homeless shelters, refugee camps, dormitories and nursing homes. In such settings, there is a need for coordination with policy makers responsible for such settings beyond the purview of ministries of health. Reduction of overcrowding in any congregate setting, and in particular in correctional services, is one of the most important measures to decrease TB transmission in such settings.

Households

To reduce the transmission of TB in households, any information, education and communication activity for prevention and management of TB should include behaviour and social change campaigns. Such campaigns should focus on how communities and, in particular, family members of smear-positive TB patients and health service providers can minimize the exposure of non-infected individuals to those who are infectious. This will ultimately translate into healthier behaviour of the entire community in relation to prevention and management of TB.

Changes in focus of current policy

In addition to recommendations for national managerial activities and a focus on health-care facilities and congregate settings, as well as households, this policy differs from previous guidelines on TB infection control in having a greater focus on:

- design of buildings and use of space
- the role of communities, which have a right to be able to attend a clinic or hospital without fear of contracting TB, and for health workers to work in safer environments (this policy includes provision of a package of HIV prevention, treatment and care measures for health workers)
- the need for health workers to undergo TB diagnostic investigation if they have symptoms or signs suggestive of TB, and to be given appropriate information and encouraged to undergo HIV testing and counselling
- the need for health workers found to be HIV-positive to be given support, and for measures to be implemented to reduce their exposure to TB (particularly MDR-TB and XDR-TB)
- awareness-raising activities in the community to garner social support for decreasing TB transmission in the community, to contribute to sustainable change toward healthy behaviour, and to minimize the associated stigma through community education
- the role of advocacy for improved TB infection control, through the removal of obstacles that impede wide implementation of TB infection control activities
- minimizing time spent in health facilities, including clinics, and prioritizing models of community-based approaches in a context of proper case management and a patient-centred approach.

This document does not cover recommendations for laboratory biosafety, because these are being addressed elsewhere (*4*).

Next steps

The literature review undertaken for this policy:

- identified major knowledge gaps in terms of the efficacy and effectiveness of infection control measures
- showed the need for TB infection control research to be scaled up and to be considered a crucial component of TB, HIV and general infection control research efforts.

The success of this policy depends on its rapid implementation. For this to happen, costs for the implementation of all the elements of the policy will need to be defined and adequate resources will need to be identified. In addition, scale-up of TB infection control will require simple indicators to monitor success in working towards safer health services for all.

CHAPTER 1

Introduction

This document is an evidence-based policy for the implementation of sound tuberculosis (TB) infection control by all stakeholders.

TB infection control is a combination of measures aimed at minimizing the risk of TB transmission within populations. The foundation of such infection control is early and rapid diagnosis, and proper management of TB patients. TB infection control is:

- a subcomponent of the WHO's updated Stop TB strategy (*5*), contributing to strengthening of health systems
- one element of the 12 collaborative activities for control of TB and HIV recommended by the WHO (*6*)
- one of the "I"s in the WHO's "Three I's for HIV/TB" (the other two being isoniazid preventive therapy [IPT] and intensified case finding) (*7*)
- an essential part of sound HIV control programmes in countries with a high prevalence of HIV.

TB infection control requires and complements the implementation of core interventions in TB control, HIV control and strengthening of health systems. In addition, countries should include TB infection control in their national infection prevention and control policies, and should maximize synergies between programmes that deal with infection prevention and control, and those focusing on TB and HIV control.

TB infection control cuts across disciplines. The measures taken to control infection – even those that are TB specific – strengthen the health services because, in their design and implementation, they draw from different areas of expertise, and they improve collaboration between disciplines. Once established, a sound infection control framework can provide a basis from which other programmes can benefit. Successful implementation of TB infection control requires:

- sound technical guidance
- coordinated efforts from ministries of health, finance, justice, labour, public works and environment
- coordination between different national disease-specific programmes
- coordination between health authorities at national and subnational level
- contributions from technical partners and civil society
- major advocacy mobilization to remove obstacles that impede wide implementation of activities.
- adequate funding at all levels.

1.1 Rationale

TB infection control is growing in importance because of the association of TB with HIV and the emergence of multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB). This document was developed in response to demand from countries for guidance on what to do, and how to prioritize TB infection control measures at the national level. Based on reports to WHO from Member States in 2008, it is clear that TB infection control is at an early stage of development in most countries. No country provided information or data on implementation of measures, although 66% (131/199) of those reporting stated that they had a policy on TB infection control (*3*).

This policy document focuses on providing guidance on TB infection control in health-care facilities, because people working in such settings have a higher incidence of TB than the general population (Annex 1). Incidence of TB among people living or working in congregate settings (e.g. correctional facilities or nursing homes) and among household contacts of TB patients also exceeds the incidence found in the general population (Annex 1). Therefore, this document also provides guidance on preventing TB transmission in congregate settings and households.

1.2 Objective

The aim of the policy is to provide Member States with guidance on how to reduce the risk of TB transmission in health-care facilities, congregate settings and households, and how to prioritize TB infection control measures.

1.3 Target audience

The document is aimed at national and subnational policy makers, including health-system managers of programmes covering TB, HIV/AIDS, infection prevention and control, hospital services, control and quality assurance programmes, and occupational health.

1.4 Scope

The policy describes a set of elements that will help to reduce transmission of TB in health-care facilities, congregate settings, and in households.

In contrast to previous guidelines, which focused on facilities (*1, 2*), this WHO-recommended policy on TB infection control provides guidance to WHO Member States on what to do and how to prioritize TB infection control measures at national level, and includes recommendations for national managerial activities.

Previous guidelines from the WHO and the Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, United States of America (USA) provide the framework for managerial activities at facility level, and can be used as a reference guide for implementing TB infection control at this level (*1, 2, 8*). The current document updates specific control measures described in previous WHO guidelines.

In contrast to previous guidelines, managerial activities at facility level are considered here as a separate element, rather than being included in administrative controls. Managerial activities at facility level need to be in line with and complement national managerial activities.

This document also updates or places new or increased emphasis on the particular administrative and environmental controls that need to be implemented, and on personal protective equipment. Although the main focus is on health-care facilities, guidance is also provided on TB infection control in households and congregate settings.

Other new areas in this policy include:

- a special focus on design of buildings and use of space
- increased emphasis on particular activities such as
  - integration with other health-system efforts
  - greater involvement of civil society in the design, development, implementation, and monitoring and evaluation of TB infection control
  - greater emphasis on selective administrative controls (e.g. reduction of time spent in health-care facilities)
  - provision of a package of HIV prevention, treatment and care measures for health workers.

This policy complements the following:

- *General infection control efforts* – these include the standard precautions (e.g. hand hygiene,[a] cough etiquette and respiratory hygiene and personal protective equipment) that apply to all health-care facilities, as well as core interventions in TB, HIV and health systems (*9*).
- *Airborne infection control efforts* – these include airborne precautions (e.g. patient placement, use of adequately ventilated areas and use of particulate respirators) that apply to all health-care facilities caring for patients with, or suspected of having, airborne infections; such precautions are important because *Mycobacterium tuberculosis* – the bacterium that causes TB – is spread almost exclusively through droplet nuclei via the air (*9*).

a. Hand hygiene does not directly decrease TB transmission, but implementation of TB infection control should happen in the context of general infection control interventions, and hand hygiene is an essential element of good infection control practices.

As discussed later in the document, studies show that implementation of the administrative and environmental controls and personal protective equipment described here reduces transmission of TB in health-care facilities. Thus, all facilities – public and private – caring for TB patients or persons suspected of having TB should implement the measures described in this policy as a matter of urgency. The combination of measures selected for implementation will be based on the infection control assessment and will be informed by local programmatic, climatic and socioeconomic conditions.

This policy also describes how to prioritize TB infection control measures, depending on the burden of TB, HIV and MDR-TB. However, it does not cover recommendations for laboratory biosafety, because these are addressed elsewhere (*4*),

The set of TB infection control measures given in this policy is intended to minimize the risk of TB transmission in health-care facilities and congregate settings. The community has a right to safe health care and to be able to attend a clinic or hospital without fear of contracting TB; also, health workers have a right to a safe working environment. The measures should be delivered as part of a patient-centred approach (*10*).

Awareness-raising activities in the community garner social support for decreasing TB transmission in the community. Such activities also help to increase sustainable behaviour and social change, and to minimize the stigma inherently associated with identifying potentially infectious individuals and placing them in safe, separate environments. Communities also have an important role and responsibility in preventing TB transmission in congregate settings and households. All these measures create a supportive environment for detection of new cases and provision of care.

This policy makes clear that sustained political, institutional and financial commitment are needed, as is the involvement of all disciplines that can promote implementation of adequate TB infection control measures in the context of general infection prevention and control programmes.

1.5 Policy formulation process

Participants at three WHO meetings informed the scope of this policy (*7, 11*). The meetings also contributed to the development of the questions used in a systematic literature review that was undertaken by the systematic review panel, to provide the evidence base for the policy.

The review considered the efficacy and effectiveness of selected elements of the set of TB infection control measures. The findings of the review were used to formulate recommendations (given in Chapters 3 and 7). The recommendations take into account additional factors such as feasibility, programmatic implementation and anticipated cost.

This policy was drafted in September 2008, in collaboration with various departments of WHO – the Department for Epidemic and Pandemic Alert and Response, the HIV/AIDS Department and the Patient Safety Programme. The draft was circulated to the members of the systematic review and policy panel, WHO regional offices (including TB, HIV/AIDS and infection control focal points), members of the core team of the TB infection control subgroup of the TB/HIV working group, chairs of the implementation working groups of the Stop TB partnership, partner organizations and additional reviewers. Geographical, technical, end-user and gender representation were reflected in the constituency of the panels.

1.6 Dissemination process

The full results of the systematic review (Annexes 1–7, available in a CD-ROM) will be published in a peer-reviewed journal. The document will be circulated through WHO channels and the working groups of the Stop TB partnership (including partners, professional associations and institutions) for adaptation and implementation at country level. It will also be translated and disseminated. A feedback mechanism will be established to inform future revision. The policy recommendations given in this document are expected to remain valid until 2013. The Stop TB Department at WHO Headquarters in Geneva will be responsible for initiating a review process of this policy at that time.

1.7 Structure

This chapter provides the context for the development of the TB infection control policy. The remaining six chapters of the document cover:

- the chief elements of TB infection control, including recommendations on what should be done and why, based on the literature review and expert opinion
  - at national and subnational level (Chapter 2)
  - at health-care facility level (Chapter 3)
  - in congregate settings (Chapter 4)
- guidance for preventing transmission of TB (including MDR-TB) in the household (Chapter 5)
- how the elements should be prioritized and what the global targets for TB infection control should be (Chapter 6)
- the factors that inform the strength of the public health recommendations set out in Chapter 3 (Chapter 7).

The six annexes provide the evidence for Recommendations 8a–8d, 10, 11 and 12. The annexes will be made available in a CD-ROM.

1.8 Evidence levels

Coordinated action could not happen without a managerial framework that facilitates the implementation of TB infection control. To date, no one has compared different managerial structures. Thus, evidence for managerial activities is not readily available, and no level of evidence is given for these activities. However, those implementing this policy should evaluate such activities to better inform their role in the implementation of TB infection control measures.

For the recommended administrative controls, environmental controls and personal protective equipment, this policy gives a level of evidence that relates to the strength of the public health recommendation. No literature review was conducted for selected administrative controls aimed at minimising diagnostic delays, such as early diagnosis, use of rapid diagnostic tests, reducing sputum and culture turnaround time, and prompt initiation of treatment. This is because these measures are also the basis of sound TB control, and justification for their implementation is being addressed elsewhere (*5*).Nevertheless, these measures are still listed here as essential administrative controls to be implemented.

For the provision of isoniazid preventive therapy (IPT) (Control 9), systematic reviews were available that determined the efficacy of this measure in preventing TB (*12, 13*). The impact of antiretroviral therapy on reduction of TB incidence in HIV-positive patients had also already been documented (*14, 15*). Its provision should be considered as part of a package of prevention and care for health workers, in the context of universal access to services for HIV prevention, treatment and care. This policy does not cover recommendations on high-efficiency particulate air (HEPA) filters, but acknowledges their use for selected situations (described in previous publications (*1, 16*)). Further information on HEPA filtration units can be found in selected readings (*8*).

The strength of the public health recommendation is also informed by expert opinion, and based on climatic, cultural, cost and programmatic factors. Recommendations are either 'strong' (i.e. the desirable effects outweigh the undesirable effects) or 'conditional' (i.e. the desirable effects probably outweigh those that are undesirable). The Glossary has more information on the different types of recommendation. Chapter 7 gives details of the recommendations, which are supported by the findings of the literature review.

CHAPTER 2

National and subnational activities to reduce transmission of TB

This chapter describes the six national and subnational managerial activities that provide the managerial framework for the implementation of TB infection control in health-care facilities, congregate settings and households.

Facility-level managerial activities (Activity 7), administrative controls, environmental controls and personal protective equipment (Controls 8–12), are discussed in Chapter 3. TB infection control measures specific to congregate settings are described in Chapter 4, and guidance for TB infection control in the household is given in Chapter 5.

2.1 Set of control activities – national and subnational

The set of national and subnational level managerial activities is given in Box 1 and described in detail below. At this level, activities 1–6 are all managerial; they provide policy makers at national and subnational level with a comprehensive framework that can support and facilitate the implementation, operation and maintenance of TB infection control in health-care facilities, congregate settings and households. This managerial framework should be based within existing national or subnational infection control management structures, where such structures exist.

Box 1 Set of activities for national and subnational TB infection control

The national and subnational managerial activities listed below provide the managerial framework for the implementation of TB infection control in health-care facilities, congregate settings and households.

1. Identify and strengthen a coordinating body for TB infection control, and develop a comprehensive budgeted plan that includes human resource requirements for implementation of TB infection control at all levels.
2. Ensure that health facility design, construction, renovation and use are appropriate.
3. Conduct surveillance of TB disease among health workers, and conduct assessment at all levels of the health system and in congregate settings.
4. Address TB infection control advocacy, communication and social mobilization (ACSM), including engagement of civil society.
5. Monitor and evaluate the set of TB infection control measures.
6. Enable and conduct operational research.

2.2 Specific national and subnational activities

2.2.1 Activity 1 – Identify and strengthen a coordinating body for infection control, and develop a comprehensive budgeted plan that includes human resource requirements for implementation of TB infection control at all levels

Activity 1a – Adopt a national policy

National health authorities should adopt a national policy that includes a legal framework conducive to the implementation of the plan for national TB infection control. To develop such a plan, TB, HIV, occupational health, correctional services programmes and civil society should all be invited to coordinate with existing national infection prevention and control programmes. In settings where there is no national infection prevention and control programme, such a programme should be created. As part of national infection prevention and control programmes, specific TB infection control bodies should be established at national and subnational level, and clear leadership and accountability of the different stakeholders should be defined. TB infection control should also be reflected in TB and HIV policies.

Activity 1b – Conduct comprehensive planning and budgeting

Implementation of a TB infection control plan requires comprehensive planning and integration with other national infection control efforts at all levels. Resources required for each element of TB infection control should be accurately costed, and necessary resources identified. Planning and financing the design, construction, renovation and optimal use of buildings, and evaluation of the choice of environmental controls to be implemented, is essential. These activities should be based on infection control assessment of the facilities and informed by socioeconomic considerations. The roles and responsibilities of each stakeholder in implementing and monitoring each element of TB infection control must be clearly defined.

> ***Remarks***
> *These activities emphasize the multidisciplinary aspects of implementing TB infection control as part of a country's overall infection control efforts. They acknowledge the importance of building on and integrating with general infection prevention and control programmes.*

Activity 1c – Develop human resources and build capacity

Human resource development for TB infection control requires specific planning by the main national stakeholders. Such planning should ensure that:

- health workers at the different levels of the health system have the professional competence necessary to successfully implement TB infection control measures
- there are sufficient numbers of the relevant categories of health workers, including those with architectural and engineering expertise. In particular, the plan should quantify human resource needs, including staff numbers, required for each relevant category
- the necessary support systems are in place to enable and motivate staff to use their competencies according to their job descriptions.

National stakeholders need to develop and include a human resource development plan for TB infection control. This plan should be reflected in the human resource development plan for TB and HIV. The TB infection control plan should be part of the national human resource development plan.

> ***Remarks***
> *Implementation of some controls will require less investment in human resources than others (see Chapter 7). However, in general, lack of a workforce competent in TB infection control is one of the major barriers to developing and implementing sound policy and practice. Coordinated planning by representatives from programmes in TB, HIV, correctional services, general infection prevention and control and occupational health is required to identify gaps and develop a national human resource plan that will increase capacity within the health system.*

2.2.2 Activity 2 – Ensure that health facility design, construction, renovation and use are appropriate

Crucial to TB infection control are appropriate design, construction, renovation and optimal use of health facilities. Crowded wards or narrow corridors with no ventilation being used as waiting areas; and overcrowded, poorly ventilated spaces being occupied by potentially infectious patients are all conducive to transmission of TB. Such situations also represent major obstacles to the implementation of effective administrative and environmental controls.

TB infection control considerations should be reflected in new constructions and renovations. It may be necessary to rethink the use of available spaces to optimize the implementation of infection control measures. High-risk areas for TB transmission include:

- TB and medical wards, including emergency rooms
- outpatient departments to which infectious TB patients and people suspected of having infectious TB are referred
- spaces reserved for high-risk aerosol generating procedures; for example, sputum collection areas (for more information on biosafety issues relating to sample handling and transportation, see WHO 2009 (*4*)), bronchoscopy rooms and areas where autopsy or lung surgery with high-speed devices is conducted.

Design and use of any high-risk areas must ensure adequate ventilation and organize patient flow in a way that minimizes the exposure of non-infectious patients to infectious patients. Lower risk areas include surgery, orthopaedic and administrative areas.

Remarks

This activity acknowledges that inadequate design of health facilities and use of space contribute to transmission of TB in health-care facilities. It also acknowledges the importance of planning to maximize the ease with which the basic components of TB infection control can be implemented in spaces designated for potentially infectious patients. Unsuspected TB cases on general medical and specialty wards and in clinics contribute to TB transmission because they are not being treated and may go unsuspected for days or weeks. Because the signs and symptoms of TB are nonspecific, TB may not be considered and available diagnostic tests may not be used; in addition, proper TB infection control measures might not be in place. In acknowledgement of this situation, designs for hospitals and clinics should incorporate features that help to reduce TB transmission; for example, features that reduce crowding, facilitate flow of patients and provide adequate ventilation.

2.2.3 Activity 3 – Conduct surveillance of TB disease among health workers, and conduct assessment at all levels of the health system and in congregate settings

The national TB infection control body should take responsibility for the assessment of health-care facilities in the country, to determine the risk for TB transmission, and to monitor the status of implementation of control measures.

In high HIV-prevalent settings, special emphasis should be placed on the infection control assessments of health-care facilities that provide chronic HIV care.

The national TB infection control body should facilitate and define responsibilities for surveillance of TB disease among health workers. This will require regular reporting of cases of TB among staff from all facilities, and of the overall number of staff working at that facility. It may be useful to collect data in a health worker TB registry. The national TB programme and other relevant programmes (e.g. HIV and occupational health) should determine the modalities for data collection.

In congregate settings, setting up surveillance activities among workers and populations of such settings should be considered.

Remarks

Surveillance of TB disease among staff, and assessment of the magnitude of the burden of TB, MDR-TB and HIV in different settings and geographical areas will provide national data that are essential for informing the implementation of TB infection control measures. Results from surveillance will also provide a basis for setting targets and prioritizing more intense action.

2.2.4 Activity 4 – Address TB infection control advocacy, communication and social mobilization (ACSM), including engagement of civil society

Civil society, communities and relevant decision-makers must be included in the design, development, implementation, and monitoring and evaluation of policies on TB infection control, to obtain the support of all involved.

Civil society and communities can create demand for TB infection control and help to implement it. Literacy efforts in TB, HIV and general infection control should popularize information on TB infection control, as an evidence-based set of measures in each health-care facility. Behaviour-change campaigns should aim to minimize the stigma that patients feel as a result of triage and separation, and the use of particulate respirators by their health-service providers. Individuals should also be encouraged to rapidly seek care if they have symptoms suggestive of TB and given information about the right to safe health care.

Implementation plans should include campaigns for behaviour change for multiple target audiences (including policy makers, patients, health workers, family members and communities). The approach to implementing TB infection control should be patient-centred, and community-based approaches should be prioritized where possible. The approach should consider

human rights and the dignity of the patient (*10*) and health workers, and should balance the interests of individuals and public health. Civil society should mobilize to advocate for resources for implementation of TB infection control measures.

Remarks

Involvement of stakeholders beyond the health sector is increasingly recognized as an essential component of modern public health programmes. Involvement of affected communities is particularly important for measures such as TB infection control, which can occasionally produce conflicts between societal needs and the rights of individual patients. Best practice from other public health interventions has shown that advocacy generated through involvement of civil society and communities is feasible and brings the benefits of ownership, a sense of urgency to overcome problems and greater sustainability. Creating demand for TB infection control is likely to expedite implementation of all country-level activities and help to maintain standards at facility level.

2.2.5 Activity 5 – Monitor and evaluate the set of TB infection control measures

Establishing the system for monitoring and evaluation, including supervision activities, of the set of TB infection control measures should involve collaboration and sharing of indicators between programmes (e.g. programmes related to TB, HIV, occupational health, quality control and quality assurance, and infection prevention and control) and the general health system.

Countries should agree on a core set of simple indicators and data collection tools, and decide on responsibilities for data collection and monitoring, and for evaluation of the different elements of TB infection control. Selected WHO indicators for TB infection control should be used as a basis for standardising country-specific monitoring and evaluation activities (*17*).

Remarks

Different national programmes involved in infection control need to collaborate, agree on and implement a monitoring system for TB infection control. Such collaboration will help to provide the means to monitor and improve programme performance.

2.2.6 Activity 6 – Enable and conduct research

Research is essential to adapt general recommendations to the needs of individual countries, help evaluate effectiveness and rapidly correct inefficiencies. It is therefore recommended as an integral component of TB infection control. Developing and implementing research priorities specifically aimed at informing policy will make it easier to scale up activities.

Remarks

Suggested topics of research informed by the evidence gap emerged from the systematic reviews, as discussed in Chapter 7 and the annexes (available on CD-ROM). However, a comprehensive research agenda on TB infection control should be developed. Budgeting to fill the research gaps is essential, and advocating for additional resources to conduct more research aimed at improving TB infection control is needed.

CHAPTER 3

Reducing transmission of TB in health-care facilities

This chapter describes the various elements that can be combined to achieve TB infection control at facility level. It provides guidance on which TB infection control elements to emphasize, based on infection control assessment and informed by climatic, cultural, cost and programmatic factors. It first discusses managerial activities at this level, and then describes the different types of control available to facilities. This chapter focuses on health-care facilities, but the controls discussed can also be applied to congregate settings, as discussed in Chapter 4.

3.1 Set of control measures – facility level

The set of TB infection control measures that apply at facility level are listed in Box 2 and described in detail below. Implementation of the national and subnational managerial activities described in Chapter 2 facilitate the implementation of measures described in this chapter and should therefore be implemented as a set.

3.1.1 Facility-level managerial activities

Facility-level managerial activities constitute the framework for setting up and implementing the other controls at facility level. The managerial activities should ensure political commitment and leadership at facility level as well as at national level.

3.1.2 Other types of control

The measures at this level also include administrative and environmental controls, and personal protective equipment, each of which is discussed below. These types of control should be implemented together because they complement one another.

Administrative controls

Administrative controls should be implemented as a first priority because they have been shown to reduce transmission of TB in health-care facilities. Such controls are a vital part of sound infection control practices, which require people with TB symptoms to be promptly identified, separated and treated. As discussed in Chapter 2, the physical separation of TB patients or people suspected of having TB requires rational design, construction or renovation, and use of buildings.

Environmental controls

Environmental controls include methods to reduce the concentration of infectious respiratory aerosols (i.e. droplet nuclei) in the air, and methods to control the direction of infectious air. The choice of environmental controls is intimately related to building design, construction, renovation and use, which in turn must be tailored to local climatic and socioeconomic conditions.

Personal protective equipment

Personal protective equipment (particulate respirators) should be used together with administrative and environmental controls in situations where there is an increased risk of transmission.

Box 2 Set of measures for facility-level TB infection control [a]

The measures listed below are specific to health-care facilities. More details on congregate settings and households are given in Chapters 4 and 5, respectively.

Facility-level measures

7. Implement the set of facility-level managerial activities:
   a) Identify and strengthen local coordinating bodies for TB infection control, and develop a facility plan (including human resources, and policies and procedures to ensure proper implementation of the controls listed below) for implementation.
   b) Rethink the use of available spaces and consider renovation of existing facilities or construction of new ones to optimize implementation of controls.
   c) Conduct on-site surveillance of TB disease among health workers and assess the facility.
   d) Address advocacy, communication and social mobilization (ACSM) for health workers, patients and visitors.
   e) Monitor and evaluate the set of TB infection control measures.
   f) Participate in research efforts.

Administrative controls [b]

8. Promptly identify people with TB symptoms (triage), separate infectious patients, control the spread of pathogens (cough etiquette and respiratory hygiene) and minimize time spent in health-care facilities.
9. Provide a package of prevention and care interventions for health workers, including HIV prevention, antiretroviral therapy and isoniazid preventive therapy (IPT) for HIV-positive health workers.

Environmental controls

10. Use ventilation systems.
11. Use ultraviolet germicidal irradiation (UVGI) fixtures, at least when adequate ventilation cannot be achieved.

Personal protective equipment

12. Use particulate respirators.

[a] Note: measures 1–6 are given in Box 1, in Chapter 2.

[b] The administrative controls include (in addition to the items listed above) reduction of diagnostic delays, use of rapid diagnostic tests, reduction of turnaround time for sputum testing and culture, and prompt initiation of treatment. These are discussed in the text below.

3.2 Specific facility-level activities – managerial

3.2.1 Control 7 – Implement the set of facility-level managerial activities

Facility-level managerial activities include identification and strengthening of local coordinating bodies and development of a facility plan (including human resources) for implementation of TB infection control. The plan should also include policies and procedures to ensure proper implementation of the administrative controls, environmental controls and use of particulate respirators. Rethinking the use of available spaces to optimize the implementation of infection control measures is also crucial. Other facility-level managerial activities include on-site surveillance of TB disease among health workers and assessment of facility, ACSM (for patients, staff and visitors), monitoring and evaluation, and participation in research efforts, in line with the national research agenda.

Remarks

Previous guidelines contain samples of infection control plans, monitoring tools and training materials for staff, and further details on the activities described above (1, 2). Facility-level managerial activities should be in line with and complement the national managerial activities described in Chapter 2, and are intended to support and facilitate the implementation of the controls described below at facility level.

3.3 Specific facility-level controls – administrative

3.3.1 Control 8 – Promptly identify people with TB symptoms (triage), separate infectious patients, control the spread of pathogens (cough etiquette and respiratory hygiene) and minimize time spent in health-care facilities

Control 8a – Promptly identify people with TB symptoms (triage)

Prompt identification of people with TB symptoms (i.e. triage) is crucial. The specific criteria for triaging patients will depend on the local settings and patient population. However, in general, people suspected of having TB must be separated from other patients, placed in adequately ventilated areas, educated on cough etiquette and respiratory hygiene, and be diagnosed as a matter of priority (i.e. fast tracked).

Strong recommendations, low-quality evidence (see Annex 2 and Chapter 7 – Recommendation 8a)

Control 8b – Separate infectious patients

It is also crucial to separate infectious patients after triage. The specific criteria (e.g. smear and culture status) for separating patients will depend on the local settings and patient population. In particular, patients living with HIV or with strong clinical evidence of HIV infection, or with other forms of immunosuppression, should be physically separated from those with suspected or confirmed infectious TB. Patients with culture-positive drug-resistant TB – especially MDR and XDR-TB – or people suspected of having drug-resistant TB should be separated (preferably according to the drug resistance profile) or isolated from other patients, including other TB patients.

Strong recommendations, low-quality evidence (see Annex 2 and Chapter 7 – Recommendation 8b)

Remarks

Triage and separation should be implemented in ways that improve patient flow. They are essential for controlling respiratory infections and are likely to help in controlling TB infection. In high-income countries, combined controls that include triage and separation have been used to successfully control TB outbreaks and reduce TB transmission to health workers. These controls are necessary to minimize the exposure of non-infected patients (in particular, those who are immunocompromised) to infectious patients. The controls should be implemented, irrespective of the likely or known drug susceptibility pattern.

Control 8c – Control the spread of pathogens (cough etiquette and respiratory hygiene)

To minimize the spread of droplet nuclei, any coughing patient with a respiratory infection – in particular, patients with or suspected of having TB – should be educated in cough etiquette and respiratory hygiene; that is, in the need to cover their nose and mouth when sneezing and or coughing. Cough etiquette also reduces transmission of larger droplets, hence contributing to control of other respiratory infections. Such etiquette also applies to health workers, visitors and families. Physical barriers can include a piece of cloth, a tissue or a surgical mask; and such items should be properly disposed of as part of respiratory hygiene practice (*9*). If such physical barriers are not available, best practice suggests that the mouth and nose should be covered with the bend of the elbow or hands, which must then be cleaned immediately. There should be a strong focus on behaviour-change campaigns for this recommendation.

Little is known about whether surgical masks placed on coughing patients affect transmission of TB, or whether masks are better than the barrier interventions described above at minimizing the spread of droplet nuclei. There is a strong theoretical basis for use of masks, particularly when infectious patients are moving through areas housing susceptible individuals. Surgical masks may be useful for patients who are unable to cover their mouth for any reason.

Strong recommendations, low-quality evidence for TB (see Annex 3 and Chapter 7 – Recommendation 8c)

Remarks

As for triage and separation, few studies have considered cough etiquette alone, but successful measures have included it alongside other TB infection control components. Therefore, this recommendation is based on current understanding of the way in which TB is transmitted, with cough etiquette having a high potential benefit because it reduces spread of droplet nuclei.

Control 8d – Minimize time spent in health-care facilities

Hospital stay is generally not recommended for the evaluation of people suspected of having TB or for the management of patients with drug-susceptible TB, except in cases that are complicated or have concomitant medical conditions that require hospitalization. If hospitalized, patients with TB symptoms should not be placed in the same area as susceptible patients or infectious TB patients. To avoid nosocomial (i.e. hospital or health-care acquired) transmission of TB, as little time as possible should be spent in health-care facilities, including clinics; this can be achieved by, for example, reducing diagnostic delays. Community-based approaches for management of TB patients should be prioritized, and should be complemented by education of household members and other close contacts on TB infection control (see Chapter 5). Health workers should ensure that quality clinical care is provided to infectious patients, and minimize the time spent with such patients in areas that are overcrowded or poorly ventilated (*18*). For management of TB (including MDR-TB), national TB programmes (NTPs) are encouraged to incorporate approaches based on community care.

Strong recommendation, low-quality evidence (see Annex 4 and Chapter 7 – Recommendation 8d)

Remarks

Community-based approaches for management of TB appear to be more cost effective than hospitalization and, if proper TB infection control measures are in place, the risk of TB transmission in the household should be minimal. Therefore, the recommendation that patients should be managed as outpatients where possible remains (see Chapter 5).

3.3.2 Control 9 – Provide a package of prevention and care interventions for health workers including HIV prevention, antiretroviral therapy and isoniazid preventive therapy for HIV-positive health workers

All health workers should be given appropriate information and encouraged to undergo TB diagnostic investigation if they have signs and symptoms suggestive of TB (*19*). Similarly, all health workers should be given appropriate information and encouraged to undergo HIV testing and counselling. If diagnosed with HIV, they should be offered a package of prevention, treatment and care that includes regular screening for active TB and access to antiretroviral therapy. Based on the evaluation, health workers should be put on either isoniazid preventive therapy (IPT) or a full regimen of anti-TB treatment, should they be diagnosed with active TB. HIV-positive health workers should not be working with patients with known or suspected TB (in particular, they should not be working with patients with MDR-TB and XDR-TB), and they should be relocated from positions where exposure to untreated TB is high to a lower risk area.

Strong recommendation in settings with a high prevalence of HIV

Conditional recommendations in settings with a low prevalence of HIV (see Chapter 7 – Recommendation 9)

Remarks

IPT is effective in people living with HIV because it reduces the risk of developing active TB. Incidence of TB also decreases in HIV-positive cohorts on antiretroviral therapy. Health workers are more exposed to TB than the general population; thus, HIV-positive health workers are a priority group for IPT.

3.3.3 Additional administrative controls

Certain administrative controls should be implemented in addition to those described above. Diagnostic delays should be minimized:

- through use of rapid diagnostics
- by reducing the turnaround time for sputum testing and culture
- by carrying out investigations in parallel rather than in sequence
- by using smear-negative algorithms.

For individuals with diagnosed TB, it is crucial to promptly initiate adequate treatment and education, support adherence and ensure completion of treatment. Patients with TB symptoms who access the health system should have the knowledge and ability to access prompt diagnostic evaluation and adequate treatment if needed (*10*).

3.4 Specific facility-level controls – environmental

3.4.1 Control 10 – Use ventilation systems

Adequate ventilation in health-care facilities is essential for preventing transmission of airborne infections, and is strongly recommended for controlling spread of TB. The choice of ventilation system will be based on assessment of the facility and informed by local programmatic, climatic and socioeconomic conditions (see Controls 10a and 10b). Any ventilation system must be monitored and maintained on a regular schedule. Adequate resources (budget and staffing) for maintenance are critical.

Strong recommendation, low-quality evidence (see Annex 5 and Chapter 7 – Recommendation 10)

Remarks

The threshold for ventilation requirements may vary according to the type of ventilation (e.g. recirculated air versus fresh air). There are two ways to measure ventilation rate: one uses the volume of the space (i.e. air changes per hour or ACH) while the other takes into account the number of people in a space (i.e. litres/second/person). Occupancy-based measurement of ventilation rates takes into account the fact that each person in a space should have a certain supply of fresh air. Evidence shows that for non- isolation rooms, ventilation rates lower than 2 ACH are associated with higher TST conversion rates among staff. A higher ventilation rate is able to provide a higher dilution of airborne pathogens and consequently reduces the risk of airborne infections. The current WHO recommendation for an airborne precaution room is at least 12 ACH.[b] This is equivalent to 80 l/s/patient for a room of 24 m^3. WHO is updating specific guidelines on requirements for ventilation rates for different spaces (e.g. general wards, outpatient facilities, corridors); details will be provided in upcoming publications.

There have been several reports of TB transmission in health facilities with faulty or no ventilation systems. The evidence for ventilation is weak and indirect, but consistent, and it favours use of ventilation in TB infection control.

In choosing a ventilation system (i.e. natural, mixed-mode or mechanical) for health-care facilities, it is important to consider local conditions, such as building structure, climate, regulations, culture, cost and outdoor air quality. For ventilated health-care facilities, it is important to use airflow direction to minimise the risk of transmission to those susceptible to infection, although directional airflow may not be achievable with most simple natural ventilation designs. Therefore, where infectious sources are likely to be present, facility design and operation should seek to achieve airflow patterns from the source of potential contamination to the air exhaust points, or to areas where there are conditions for sufficient dilution.

b. http://www.who.int/csr/resources/publications/WHO_CDS_EPR_2007_6c.pdf

Control 10a – Natural ventilation

In existing health-care facilities that have natural ventilation, when possible, effective ventilation should be achieved by proper operation and maintenance on a regular schedule. Simple natural ventilation may be optimized by maximizing the size of the opening of windows and locating them on opposing walls.

Conditional recommendations, low-quality evidence (see Annex 5 and Chapter 7 – Recommendation 10a)

Remarks

In existing health-care facilities with natural ventilation, where possible, the use of natural ventilation should be maximized before considering other ventilation systems. However, this depends on climatic conditions being favourable to use of such a ventilation system.

Control 10b – Mechanical ventilation

Well-designed, maintained and operated fans (mixed-mode ventilation) can help to obtain adequate dilution when natural ventilation alone cannot provide sufficient ventilation rates.

In some settings, mechanical ventilation (with or without climate control) will be needed. This may be the case, for example, where natural or mixed-mode ventilation systems cannot be implemented effectively, or where such systems are inadequate given local conditions (e.g. building structure, climate, regulations, culture, cost and outdoor air quality).

Conditional recommendation, low-quality evidence (see Annex 5 and Chapter 7 – Recommendation 10b)

Remarks

Particular attention should be paid to the maintenance costs for the operation of mechanical ventilation system.

3.4.2 Control 11 – Use of upper room or shielded ultraviolet germicidal irradiation fixtures

Priority should be given to achieving adequate ACH using ventilation systems. However, in some settings it is not possible to achieve adequate ventilation; for example, because of climatic changes (e.g. in winter or during the night) or building structure, or because transmission of TB would pose a high risk of morbidity and mortality (e.g. in MDR-TB wards). In such cases, a complementary option is to use upper room or shielded ultraviolet germicidal irradiation (UVGI) devices. This environmental control does not provide fresh air or directional airflow.

Conditional recommendation, low-quality evidence (see Annex 6 and Chapter 7 – Recommendation 11)

Remarks

UVGI devices do not replace ventilation systems; rather, they should be considered as a complementary intervention. Several studies have shown that a well-designed UVGI upper room system can disinfect mycobacteria or surrogate test organisms in a test room that is equal to 10–20 equivalent air changes. Upper UVGI devices are potentially hazardous if improperly designed or installed. In well-designed systems, the principal hazard is inadvertent eye exposure by workers climbing up into the high-UV zone for tasks such as painting, cleaning and maintenance. As with any engineering control, a UVGI device needs proper design, installation, operation and maintenance.

3.5 Specific facility-level controls – personal protective equipment

3.5.1 Control 12 – Use of particulate respirators

Health workers may gain additional protection from TB through the use of particulate respirators that meet or exceed the N95 standards set by the United States Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH) or the FFP2 standards that are CE certified.

In addition to implementation of administrative and environmental controls, use of particulate respirators is recommended for health workers when caring for patients or those suspected of having infectious TB.[c] Visitors should also wear particulate respirators when in enclosed space with infectious cases. Considering the risk of stigma that the use of particulate respirators may generate, there should be a strong focus on behaviour-change campaigns for health workers, patients and communities. Particulate respirators should not be used by patients or people suspected of having infectious TB; rather, surgical masks are appropriate in such cases, to ensure proper cough etiquette.

In particular, health workers should use particulate respirators:

- during high-risk aerosol-generating procedures associated with high risk of TB transmission (e.g. bronchoscopy, intubation, sputum induction procedures, aspiration of respiratory secretions, and autopsy or lung surgery with high-speed devices)
- when providing care to infectious MDR-TB and XDR-TB patients or people suspected of having infectious MDR-TB and XDR-TB.

A comprehensive programme for training health workers in the use of particulate respirators should be implemented, because correct and continuous use of respirators involves significant behaviour change on the part of the health worker. Consideration should be given to including fit testing of respirators.

Strong recommendation, low-quality evidence (see Annex 7 and Chapter 7 – Recommendation 12)

Remarks

This recommendation is based on current understanding of the way in which TB is transmitted, with particulate respirators having a high potential benefit because they provide protection for health workers, in particular in the absence of other controls. In addition, this control is justified by the high morbidity and mortality caused by MDR-TB and XDR-TB.

c. To date, few studies have looked at whether particulate respirators are of value when providing routine care to patients if administrative and environment controls are in place.

CHAPTER 4

Infection control for congregate settings

This chapter discusses managerial activities, administrative controls, environmental controls and personal protective equipment in relation to congregate settings. The recommendations for congregate settings are less specific than those for health-care facilities, because congregate settings are so diverse. They include a mix of settings that range from correctional facilities and military barracks, to homeless shelters, refugee camps, dormitories and nursing homes. Each facility differs in the type of population it contains and the duration of stay of dwellers; in turn, this affects the dynamics of TB transmission.

For the purpose of this policy, congregate settings are divided into two categories – long term (e.g. prisons) and short term (e.g. jails and homeless shelters) – to reflect the different duration of stay of the inhabitants. This chapter focuses particularly on prisons because evidence from such settings is readily available; however, the recommendations also apply to other congregate settings. As more evidence becomes available, the guidance will be updated to better reflect the specific needs of particular settings. Any health-care facility (e.g. medical or infirmary) within a congregate setting should be considered as a health-care facility; therefore, the set of TB infection control measures should be implemented, as in any health-care facility within the same geographical area or having the same epidemiological characteristics.

The incidence of TB infection and TB disease among individuals in congregate settings exceeds the incidence among the general population; this is particularly the case among inmates of prisons in high-income countries (see Annex 1).

The association of HIV and the emergence of MDR-TB and XDR-TB increase the need to give urgent and appropriate attention to implementation of TB infection control in congregate settings, and to prioritize some elements, as discussed in this chapter.

4.1 Managerial activities in congregate settings

The full set of national and subnational managerial activities described in Chapter 2 should also apply to congregate settings. As a first step, policy makers responsible for congregate settings should be made part of the coordinating system for planning and implementing interventions to control TB infection. In particular, the medical service of the ministry of justice and correctional facilities should be fully engaged and encouraged to implement TB infection control. In any congregate setting, overcrowding should be avoided because it can lead to non-infected individuals being exposed to TB.

Congregate settings should be part of the country surveillance activities, and should be included in facility assessment for TB infection control. Such assessment will be useful in determining the level of risk of the facility or building.

Any advocacy and information, education and communication material should include a specific focus on congregate settings, as should monitoring and evaluation of TB infection control measures.

Facility-level managerial activities should also apply with some adaptation to congregate settings. These activities will facilitate the implementation of the different types of controls described below.[d]

4.2 Administrative controls in congregate settings

To decrease TB transmission in congregate settings, cough etiquette and respiratory hygiene, and early identification, followed by separation and proper treatment of infectious cases should be implemented (Controls 8a–8c, Chapter 3). In particular, all inmates of long-term stay facilities and inhabitants of other congregate settings should be screened for TB before entry into the facility. All staff should be given appropriate information and encouraged to undergo TB diagnostic investigation if they have signs and symptoms suggestive of TB. People suspected of having TB should be diagnosed as quickly as possible. People suspected of having TB and infectious patients should always be separated and, if possible, isolated in

d. Facility-level managerial activities will require adaptation because they were originally developed only for health-care facilities.

an adequately ventilated area, until sputum smear conversion. Directly observed therapy (DOT) while a patient is on treatment is also recommended. In short-term stay congregate settings, such as jails and shelters, a referral system for proper case management of cases should be established.

In congregate settings with a high prevalence of HIV (in particular in correctional services), patients living with HIV and other forms of immunosuppression should be separated from those with suspected or confirmed infectious TB. All staff and persons residing in the setting should be given information and encouraged to undergo HIV testing and counselling. If diagnosed with HIV, they should be offered a package of prevention and care that includes regular screening for active TB. Additional measures for groups at high risk – such as injecting and other drug users – should be ensured (*20*).

In congregate settings with patients having, or suspected of having, drug-resistant TB, such patients should be separated from other patients (including other TB patients), and referral for proper treatment should be established.

4.3 Environmental controls in congregate settings

Buildings in congregate settings should comply with national norms and regulations for ventilation in public buildings,[e] and specific norms and regulations for prisons, where these exist. In congregate settings in which there is a high risk of TB transmission and where adequate ventilation cannot be achieved – for example because of design constraints (e.g. in correctional facilities) – use of UVGI could be considered. If UVGI is used, fixtures should be designed to prevent injury from improper use or tampering with the device.

4.4 Personal protective equipment in congregate settings

When a person residing in a long-term stay congregate setting is suspected or diagnosed as having TB and is physically separated, the same recommendations on infection control apply as for health-care facilities. In short-term stay congregate settings, appropriate referral should be organized.

e. The requirements for ventilation in public buildings are for the comfort of the user rather than for minimizing the risk of TB transmission.

CHAPTER 5

Reducing transmission of TB in households

This chapter discusses the various actions needed to reduce transmission of TB in households. Such actions are necessary because household members of persons with infectious TB are at high risk of becoming infected with TB and consequently developing the disease (Annex 1).

Pivotal studies from India in the 1950s, appear to show that the major risks for infection are through close contact (exposure) to the infectious case before diagnosis (*21, 22*). Whether the patient subsequently remains at home or moves to a sanatorium appears to have little impact on household transmission, provided the patient is treated effectively.

Early case detection remains one of the most important interventions for reducing the risk of TB transmission in the household. TB contact investigation should be undertaken in line with the standards defined in the national TB control policies. In addition, basic infection control behaviour-change campaigns should be part of any community information, education and communication messages. The infection control messages need to promote the importance of early identification of cases, adherence to treatment and implementation of proper TB infection control measures (e.g. cough etiquette and respiratory hygiene) in the household, before and after diagnosis of TB.

Behaviour-change campaigns for family members of smear-positive TB patients and health service providers should aim to minimize stigma and the exposure of non-infected patients to those who are infected. To reduce exposure in households:

- houses should be adequately ventilated, particularly rooms where people with infectious TB spend considerable time (natural ventilation may be sufficient to provide adequate ventilation)
- anyone who coughs should be educated on cough etiquette and respiratory hygiene, and should follow such practices at all times
- while smear positive, TB patients should
  - spend as much time as possible outdoors
  - sleep alone in a separate, adequately ventilated room, if possible
  - spend as little time as possible in congregate settings or in public transport.

It is not fully known how different drug-susceptibility patterns and HIV status affect the risk of TB transmission (Annex 1). Patients with MDR-TB usually sputum convert later than those with drug-susceptible TB. This is probably due to the limited efficacy of second line drug armamentarium. For this reason, patients with drug-resistant TB remain infectious for much longer, even if treatment is initiated. This may prolong the risk of transmission in the household. MDR-TB increases the risk of morbidity and mortality, particularly in people living with HIV. Additional infection control measures should therefore be implemented for the management of MDR-TB patients at home.[f]

Awareness of infection control in the community should be promoted, irrespective of the drug susceptibility profile of the TB diagnosis, because most MDR-TB is undiagnosed but is nevertheless transmitted in the community.[g]

In households with culture-positive MDR-TB patients, the following guidance should be observed, in addition to the measures given above:

f. Early in the history of treatment of drug-resistant TB, strict hospitalization of patients was considered necessary. However, today, community-based approaches for management of patients with MDR-TB provided by trained lay and community health workers can achieve comparable results and, in theory, may decrease nosocomial transmission of TB.

g. Particular attention should be given to the quality of information, education and communication messages, to avoid any unintended increase of stigma. In general, awareness of infection control in the community – even if well conducted – does not eliminate stigma attached to having TB. Therefore, such awareness needs to be balanced with the benefits that community education can bring, in terms of garnering social support for decreasing TB transmission in the community and helping to contribute to sustainable change toward healthy behaviour.

- While culture positive, MDR-TB patients who cough should always practice cough etiquette (including use of masks) and respiratory hygiene when in contact with people. Ideally, health service providers should wear particulate respirators when attending patients in enclosed spaces.
- Ideally, family members living with HIV, or family members with strong clinical evidence of HIV infection, should not provide care for patients with culture-positive MDR-TB. If there is no alternative, HIV-positive family members should wear respirators, if available.
- Children below five years of age should spend as little time as possible in the same living spaces as culture-positive MDR-TB patients. Such children should be followed up regularly with TB screening and, if positive, drug-susceptibility testing and treatment.
- While culture positive, XDR-TB patients should be isolated at all times, and any person in contact with a culture-positive XDR-TB patient should wear a particulate respirator. If at all possible, HIV-positive family members, or family members with a strong clinical evidence of HIV infection, should not share a household with culture positive XDR-TB patients.
- If possible, potential renovation of the patient's home should be considered, to improve ventilation (e.g. building of a separate bedroom, or installation of a window or wind catcher, or both).

CHAPTER 6

Prioritizing measures and setting targets for TB infection control

This chapter discusses TB infection control in terms of prioritizing measures for health-care facilities and setting targets. The association of HIV with TB, and the emergence of MDR-TB and XDR-TB, increase the urgency of the need to implement TB infection control and prioritize some elements in all settings. A national and subnational managerial framework (Box 1 in Chapter 2, activities 1–6) needs to be in place to facilitate the implementation of the facility-level TB infection control measures described below.

6.1 Prioritization of TB infection control measures

For TB infection control, the first priority for all health-care facilities caring for TB patients or people with TB symptoms is to implement the set of TB infection control measures described in Box 2 (in Chapter 3). TB infection control builds on the implementation of general infection control efforts and those aimed at controlling airborne infection. This may also help to de-stigmatize TB infection, because the focus of the public health interventions is on providing universal access for patients with symptoms of communicable diseases (in particular, respiratory infections, rather than TB only).

The assessment (Box 1, Activity 3) will provide the basis for the selection of the best combination of administrative controls, environmental controls and personal protective equipment. The selection will also be informed by local epidemiological, climatic and socioeconomic conditions.

To avoid nosocomial transmission of TB, time spent in health-care facilities (including clinics) should be minimized, and community-based approaches to the management of TB patients should be prioritized.

In HIV-prevalent settings, the focus in health-care facilities should be on:

- separating patients living with HIV and other forms of immunosuppression from those with suspected or confirmed infectious TB
- the provision of a package of prevention and care for HIV-positive health workers
- possible job relocation to lower risk areas in the case of HIV-positive health workers.

This focus by health-care facilities in HIV-prevalent settings should be in the context of implementing the set of TB infection control measures described in Box 2 (in Chapter 3).

In any country, all health-care facilities caring for MDR-TB should introduce the set of TB infection controls described in Box 2. In particular, in the MDR-TB priority countries (described below), it is important to focus on separating culture-positive drug-resistant TB patients or people suspected of having drug-resistant TB from other patients, including other TB patients. Another important aspect is ensuring a safe working environment for health workers caring for patients with, or suspected of having, MDR-TB and XDR-TB.

Within-country variation of the burden of TB (including MDR-TB and XDR-TB) and HIV should also be considered when deciding how to prioritize the different elements of TB infection control in health facilities within the country.

MDR-TB priority countries

The MDR-TB priority countries are those where the estimated MDR-TB burden is more than 10% of the total number of TB cases, or countries with more than 4000 estimated MDR-TB cases emerging every year. These countries account for 86% of the total estimated number of new MDR-TB cases worldwide (*3*).

6.2 Targets for TB infection control

The findings of the literature review indicate that:

- lack of TB infection control measures in health-care facilities contributes to TB transmission
- implementation of the TB infection control measures described in Chapters 2 and 3 reduces transmission.

However, it is not clear to what extent implementing TB infection control measures will contribute to reaching the internationally recommended targets for TB and HIV (*23, 24*).

Research and further implementation of TB infection control will improve understanding of the contribution of TB infection control to meeting international targets. However, there is also a need for global and country targets to accelerate country-level implementation of TB infection control. Therefore, the targets shown in Table 6.1, below, are suggested for global-level implementation of the set of TB infection control measures. Countries are encouraged to develop their own targets in line with the global ones.

Table 6.1 Suggested targets for global-level implementation of the TB infection control

Date	Targets
By 2012	50% of countries should have: • developed a national TB infection control plan • set up national surveillance of TB disease among health workers • assessed major health-care facilities and congregate settings for TB infection control • reported on the implementation of TB infection control
By 2013	All countries should have: • developed a national TB infection control plan • set up national surveillance of TB disease among health workers • assessed major health-care facilities and congregate settings for TB infection control • reported on the implementation of TB infection control.

CHAPTER 7

Strength of the public health recommendations

This chapter contains a table for each of the key recommendations in Chapter 3. The tables:

- summarize the quality of evidence available (full evidence profiles are given in the annexes) for selected administrative and environmental controls and personal protective equipment
- describe the factors that inform the strength of the recommendation, including the quality of the evidence and issues such as feasibility, programmatic implementation and anticipated costing
- highlight the main research gaps identified.

The tables cover:

- Recommendation 8a – Triage (Table 7.1)
- Recommendation 8b – Physical separation (Table 7.2)
- Recommandation 8c – Cough etiquette and respiratory hygiene (Table 7.3)
- Recommendation 8d – Minimize time spent in health-care facilities (Table 7.4)
- Recommendation 9 – Provision of prevention and care interventions for health workers (Table 7.5)
- Recommendation 10 – Implementation of ventilation systems (Table 7.6)
- Recommendation 10a – Implementation of natural ventilation (Table 7.7)
- Recommendation 10b – Implementation of mechanical ventilation (Table 7.8)
- Recommendation 11 – Use of ultraviolet germicidal irradiation fixtures (Table 7.9)
- Recommendation 12 – Use of particulate respirators (Table 7.10)

Table 7.1 Recommendation 8a – Triage

Recommendation: Triage people with TB symptoms		
Population: Patients accessing health-care facilities and congregate settings		
Intervention: Triage		
Factor	Decision	Explanation
Quality of evidence	Low quality	The quality of the evidence available is low and only assesses the intervention as part of a set of administrative control measures But … Further trial unlikely to be approved; before and after intervention studies in settings where these measures have not yet been extensively put into practice could provide useful data
Benefits (desired effects) and disadvantages (undesired effects)	Strong (benefits outweigh disadvantages)	Benefits • Early diagnosis and initiation of appropriate treatment • Reduction of transmission among individuals attending health-care facilities • Reduction of transmission among health workers and close contacts Disadvantages • Grouping people without TB (including those with HIV) with infectious patients who are not yet diagnosed
Values and preferences	Strong	• Health workers will appreciate measures that reduce their exposure • Patients attending health-care facilities might feel safer in a waiting area with such a policy • Communities will like measures that will make health-care facilities safer But … • Increases workload for health workers • May stigmatize people with chronic cough
Costs	Strong (may range from minimal to significant capital investment in infrastructure)	Reduced by: • averted diagnostic costs of suspected new cases acquired nosocomially • patient able to continue working • less transmission of TB, in that TB cases are averted • break in chain of transmission Increased by: • staff training • infrastructure (separated waiting area, isolation rooms…) • additional AFB and CXR for positive TB triage
Feasibility	Depends on country	• Generally feasible in HIC • Lack of human resources in MIC/LIC • Lack of infrastructures in MIC/LIC • Slow process to diagnose TB (slow turnaround time due to inadequate laboratory capacity in MIC/LIC)
Overall ranking	STRONG RECOMMENDATION	
Research gap	Need to develop specific screening criteria for triaging people with TB symptoms in different settings, based on burden of TB, HIV, MDR-TB and XDR-TB	

AFB, acid-fast bacilli; CXR, chest radiography; HIC, high-income countries; HIV, human immunodeficiency virus; LIC, low-income countries; MDR, multidrug resistant; MIC, medium-income countries; TB, tuberculosis; XDR, extremely drug resistant

Table 7.2 Recommendation 8b – Physical separation

Recommendation: Separate infectious patients		
Population: Patients accessing health-care facilities and congregate settings		
Intervention: Separation of infectious patients		
Factor	Decision	Explanation
Quality of evidence	Low quality	• The quality of the evidence available is low – only one study shows a direct impact of physical separation as an individual intervention on reduction of TB transmission
Benefits (desired effects) and disadvantages (undesired effects)	Strong (benefits outweigh disadvantages)	Benefits • Early diagnosis and initiation of proper treatment • Reduction of transmission among individuals attending health-care facilities • Reduction of transmission among health workers and close contacts Disadvantages • People living with HIV (suspected of having TB) might be separated from other patients but be placed with smear-positive TB patients
Values and preferences	Strong	• Health workers will appreciate measures that reduce their exposure • Communities will like measures that make health-care facilities safer But … • Increases workload for health workers • May stigmatize people with chronic cough
Costs	Strong (may range from minimal to significant capital investment in infrastructure)	Reduced by: • averted diagnostic costs of suspected new cases acquired nosocomially • patient being able to continue working • less transmission of TB, in that TB cases are averted • break in chain of transmission Increased by: • staff training • infrastructure (separated waiting area, isolation rooms…) • additional AFB and CXR for positive TB triage
Feasibility	Depends on country	• Generally feasible in HIC • Lack of human resources in MIC/LIC • Lack of infrastructures in MIC/LIC • Slow process to diagnose TB (slow turnaround time due to inadequate laboratory capacity)
Overall ranking	STRONG RECOMMENDATION	
Research gap	Need to develop and assess different models of physical separation, based on smear, HIV status and suspected or confirmed TB drug-sensibility pattern	

AFB, acid-fast bacilli; CXR, chest radiography; HIC, high-income countries; HIV, human immunodeficiency virus; LIC, low-income countries; MDR, multidrug resistant; MIC, medium-income countries; TB, tuberculosis

Table 7.3 Recommendation 8c – Cough etiquette and respiratory hygiene

Recommendation: Employ cough etiquette and respiratory hygiene		
Population: Patients in health-care facilities and congregate settings		
Intervention: Cough etiquette		
Factor	Decision	Explanation
Quality of evidence	Low quality	• There is no evidence available to quantify the impact of this intervention on TB transmission; although there is a theoretical rationale for the use of cough hygiene, its role needs to be better evaluated
Benefits (desired effects) and disadvantages (undesired effects)	Strong (benefits outweigh disadvantages)	Benefits • Potential reduction of transmission of airborne infection among individuals attending health-care facilities • Can increase patients' awareness of respiratory hygiene Disadvantages • Requires adherence • Need to ensure safe disposal of tissues
Values and preferences	Strong	• Health workers will appreciate measures that reduce their exposure • Patients attending outpatient department would feel more comfortable in a waiting area where cough etiquette is practised But … • Increased workload for health workers (counsellors, infection control nurses, etc) • May stigmatize people with chronic cough
Costs	Strong (costs are minimal and benefits potentially high)	Reduced by: • averted diagnostic costs of suspected new cases acquired nosocomially • decreased admission costs of new TB cases • decreased treatment costs of new TB cases Increased by: • staff training • supplies • patient education activities • educational supports (e.g. posters, demonstrations)
Feasibility	Strong	Generally feasible
Overall ranking	STRONG RECOMMENDATION	
Research gap	Need to investigate impact of cough etiquette and respiratory hygiene on transmission of TB	

TB, tuberculosis

Table 7.4 Recommendation 8d – Minimize time spent in health-care facilities

Recommendation: Minimize time spent in health-care facilities		
Population: Patients with all forms of TB		
Intervention: Minimize time spent in health-care facilities		
Factor	Decision	Explanation
Quality of evidence	Low-quality	• The quality of the evidence available is low. The literature available generally assesses the effectiveness and cost-effectiveness of different care approaches; therefore, the evidence for this recommendation comes from data about contagiousness of patients during treatment, cost evaluations and implementation reports. For drug-susceptible TB, there is good evidence that household transmission occurs before diagnosis and initiation of treatment.
Benefits (desired effects) and disadvantages (undesired effects)	Strong (benefits outweigh disadvantages)	Benefits • Reduction of nosocomial transmission • Increase in quality of life for patients and family members Disadvantages • Potential transmission of TB in households and community until culture conversion (especially in settings with high prevalence of HIV) • Lack of appropriate management of complications and drug-toxicity • Potential risk of patients defaulting or not being followed up
Values and preferences	Strong	• Health workers and communities will appreciate measures that reduce their exposure • Reduction of inpatient workload for health workers • Patients will appreciate their early return in community • Reduction of stigma But … • Increased workload for health workers in outpatient department and community-based services • Households' fear of acquiring the infection • Lack of trust by health workers in patients' abilities to manage unsupervised treatment • Management of patients' noncompliant with IEC messages
Costs	Strong	Reduced by: • lower inpatient admission costs • reduced need for big infrastructure with adequate isolation measures • reduced treatment costs for health workers (reduction of health-care acquired infections among health workers) • capacity of the patient to be productive (in some settings, being at home might be relevant for the family's economy, even if the patient does not work outside the home) Increased by: • community-based service staff training • community-based services costs • TB treatment and diagnosis costs if new infections in the household • travel cost if patients require frequent follow-up visits
Feasibility	Strong	• Generally feasible
Overall ranking	STRONG RECOMMENDATION	
Research gap	Need to determine household transmission of TB (particularly MDR-TB) after treatment is started – this research should be a priority Need to develop new rapid diagnostic tests to make diagnosis faster	

IEC, information, education and communication; HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis

Table 7.5 Recommendation 9 – Provision of prevention and care interventions for health workers

Recommendation: Implement package of interventions including HIV-testing, IPT and access to ART[a]		
Population: HIV-positive health workers and care providers		
Intervention: IPT		
Factor	Decision	Explanation
Quality of evidence	High quality	• Quality of evidence is highly significant for efficacy of IPT in preventing TB; strongly supported by placebo-controlled trials and four meta-analyses • Evidence not specific to health workers
Benefits (desired effects) and disadvantages (undesired effects)	Strong (benefits outweigh disadvantages)	Benefits • Decrease in number of cases of TB • Promotion of the package of TB and HIV interventions through screening diagnosis of more TB cases • Trials have not shown evidence for selection of resistance • Well tolerated • Combining ART and IPT appears safe and effective Disadvantages • No survival benefit in adults • Risk of hepatotoxicity increases with age of more than 35 years • Unclear timing and methodology for screening of health workers • Low to medium IPT uptake and completion • Unclear duration of treatment (lifelong or multiple cycles) • Need to validate screening algorithms
Values and preferences	Strong	• Implications for disclosure of HIV status or stigma But … • Health workers will appreciate measures to reduce risk of transmission of TB • Allows a new focus on reaching and managing health workers
Costs	Strong	• Averted costs of medical care and treatment of TB cases • Minimal incremental cost to add IPT to a package of prevention and care • Reduces health workers leakage • Reduces costs for families (less sick, patient can work and earn income) • Modelling studies show that IPT is a cost-effective intervention But … • Cost-effectiveness limited by the low coverage of HIV testing and low uptake and completion of IPT
Feasibility	Depends on country	• Inclusion of IPT as part of HIV prevention and care • Need to generate more demand from affected community • Establishment of monitoring system • Need for increased human resources and training • Need for strong linkages between TB and HIV clinics • Availability of isoniazid within HIV services and drug supply • Need infrastructure for screening • Need for integration of service delivery for TB and HIV
Overall ranking	STRONG RECOMMENDATION in settings with high prevalence of HIV CONDITIONAL RECOMMENDATION in settings with low prevalence of HIV	
Research gap (25)	Need to evaluate screening methodologies Need to determine duration of preventive therapy	

ART, antiretroviral therapy; HIV, human immunodeficiency virus; IPT, isoniazid preventive therapy; TB, tuberculosis

[a] See TB/HIV collaborative activities for use of ART as an intervention to reduce the burden of TB among HIV

Table 7.6 Recommendation 10 – Implementation of ventilation systems [a]

Recommendation: Implementation of ventilation systems		
Population: Health-care facilities		
Intervention: Ventilation systems		
Factor	Decision	Explanation
Quality of evidence	Low quality	• There is no evidence available to quantify the direct impact of this intervention on TB transmission; available evidence, though weak and indirect, is generally favourable on use of ventilation systems for TB infection control
Benefits (desired effects) and disadvantages (undesired effects)	Strong (benefits outweigh disadvantages)	Benefits • Capable of achieving adequate ACH in health-care facilities • Suitable for all climates if properly designed, installed, maintained and operated (mechanical) • May allow control of direction of airflow and temperature control Disadvantages • Requires expertise • Requires maintenance • Requires electricity (mixed-mode and mechanical) • No easy-to-use tool for measuring ACH
Values and preferences	Strong	• Health workers and patients will appreciate measures that reduce their exposure But … • Reduces comfort of occupants if ventilation not properly designed, installed or maintained (e.g. temperature and humidity problems)
Costs	Low to high, depending on the design of the building and the complexity of the ventilation system	Reduced by: • low capital (if building is designed for natural ventilation), operational and maintenance cost • requirement for strong efforts to ensure that windows and doors are appropriately located for natural ventilation Increased by: • cost of installation and maintenance • cost of temperature control in extreme climates
Feasibility	Depends on country	• Lack of infrastructure • Lack of expertise to install and maintain • Constant natural ventilation only feasible in tropical and possibly subtropical climates
Overall ranking	STRONG RECOMMENDATION	
Research gap	Need to determine: • the effectiveness of the intervention on the reduction of TB transmission • feasibility in different settings (with different weather, designs etc)	

ACH, air changes per hour; TB, tuberculosis

[a] See recommendations 10a and 10b for more details on the ventilation systems

Table 7.7 Recommendation 10a – Implementation of natural ventilation

Recommendation: Implementation of natural ventilation		
Population: Health-care facilities		
Intervention: Natural ventilation		
Factor	Decision	Explanation
Quality of evidence	Low quality	• There is no direct evidence available to quantify the direct impact of this intervention on TB transmission; indirect evidence is generally favourable on use of this intervention for TB infection control
Benefits (desired effects) and disadvantages (undesired effects)	Moderate (benefits sometimes outweigh disadvantages)	Benefits • Capable of achieving ACH above the required minimum of 12 ACH, which results in higher decay of droplet nuclei Disadvantages • Difficult to control (depends on wind and temperature) • No control over direction of airflow • Sufficient permanent openings (e.g. windows and vents) should be guaranteed to maintain adequate ACH • No easy-to-use tool for measuring ACH • Limited applicability (only suitable in a few locations globally)
Values and preferences	Strong	• Health workers and patients will appreciate measures that reduce their exposure But … • Reduces comfort of occupants if ventilation not properly designed, installed or maintained (e.g. temperature and humidity problems), especially if used in climates that are outside normal environmental conditions
Costs	Low (if building was designed for good cross ventilation) High (if need to design a new building or make major renovations)	Reduced by: • low capital (if building is designed for natural ventilation), operational and maintenance cost • need to ensure that windows and doors are appropriately located for natural ventilation Increased by: • buildings requiring modification so that windows can remain open in rain or wind • well-designed natural ventilation system requiring initial capital investment as well as proper maintenance and operation
Feasibility	Depends on country	• Generally feasible • Generally not feasible in extreme climates • Only applicable in few locations for constant implementation
Overall ranking	CONDITIONAL RECOMMENDATION	
Research gap	Need to determine: • the effectiveness of the intervention on the reduction of TB transmission • feasibility in different settings (with different weather, designs, etc) • the impact of airflow on TB transmission • which regions could implement constant natural ventilation in an existing or newly designed facility	

ACH, air changes per hour; TB, tuberculosis

Table 7.8 Recommendation 10b – Implementation of mechanical ventilation

Recommendation: Implementation of mechanical ventilation		
Population: Health-care facilities		
Intervention: Mechanical ventilation		
Factor	Decision	Explanation
Quality of evidence	Low quality	• There is no evidence available to quantify the direct impact of this intervention on TB transmission; weak and indirect evidence available is generally favourable on use of mechanical ventilation for TB infection control
Benefits (desired effects) and disadvantages (undesired effects)	Moderate (benefits do not always outweigh disadvantages)	Benefits • Capable of achieving a minimum of 12 ACH, but additional ACH has minimal additional benefit relative to the costs • Suitable for all climates, if properly designed, installed, maintained and operated • Mechanical ventilation may allow temperature control • Mechanical ventilation allows control of direction of airflow Disadvantages • Requires expertise • Requires maintenance • Requires electricity • No easy-to-use tool for measuring ACH
Values and preferences	Strong	• Health workers and patients will appreciate measures that reduce their exposure But … • Reduces comfort of occupants if not properly designed (e.g. temperature and humidity)
Costs	Low to high, depending on the complexity of the system	Increased by: • cost of installation and maintenance • cost of temperature control in extreme climates
Feasibility	Depends on country	• Lack of infrastructure • Lack of expertise to install and maintain
Overall ranking	CONDITIONAL RECOMMENDATION	
Research gap	Need to determine: • the effectiveness of the intervention on the reduction of TB transmission • feasibility in different settings (with different weather, designs, etc) • the relative effectiveness of mechanical and natural ventilation • the impact of airflow on TB transmission	

ACH, air changes per hour; TB, tuberculosis

Table 7.9 Recommendation 11 – Use of ultraviolet germicidal irradiation

Recommendation: Implementation of ultraviolet germicidal irradiation (UVGI)		
Population: Health-care facilities		
Intervention: UVGI		
Factor	Decision	Explanation
Quality of evidence	Low quality	• One epidemiologic study that looked at TST conversion rates in health workers showed no major additional benefit; however, one well-designed animal model study (in guinea pigs) demonstrated that upper-room UVGI could reduce TB transmission and disease
Benefits (desired effects) and disadvantages (undesired effects)	Moderate (benefits sometimes outweigh disadvantages)	Benefits • May be capable of achieving air disinfection equivalent to 10–20 ACH if system appropriately designed, installed, maintained and operated • Suitable for most climates (relative humidity above 70% reduces its effectiveness) Disadvantages • Requires expertise in design, installation and testing • Requires maintenance and cleaning (not effective if not well maintained) • Requires electricity • Requires air mixing to be effective • Direct exposure or overexposure UVGI results in non-permanent adverse effects (photokeratitis and erythema) • No easy-to-use tool for measuring equivalent ACH
Values and preferences	Uncertain	• Health workers and patients will appreciate measures that reduce their exposure But … • Reduces comfort of occupants if UVGI not properly designed, installed or maintained
Costs	Low to moderate	Increased by: • Capital investment to install and maintain
Feasibility	Depends on country	• Lack of infrastructure (better with higher ceiling and good air mixing) • Lack of expertise to install and maintain
Overall ranking	CONDITIONAL RECOMMENDATION	
Research gap	Need to determine: • effectiveness of the intervention on the reduction of TB transmission • feasibility in different settings (with different weather, designs, etc)	

ACH, air changes per hour; TB, tuberculosis; TST, tuberculin skin test; UVGI, ultraviolet germicidal irradiation

Table 7.10 Recommendation 12 – Use of particulate respirators

Recommendation: Use of particulate respirators		
Population: Health-care facilities		
Intervention: Particulate respirators for health workers		
Factor	Decision	Explanation
Quality of evidence	Low quality	• Theoretical basis • Available evidence, though weak and indirect, is generally favourable on use of particulate respirators for TB infection control
Benefits (desired effects) and disadvantages (undesired effects)	Moderate/ strong (benefits outweigh disadvantages)	Benefits • Provide additional protection to the health workers Disadvantages • Not clear whether additional protection is provided if administrative controls are in place and environment is well ventilated • Requires training • Requires adherence • May affect health worker's performance for some procedures • No clear guidance on how long the same respirator can be used over time
Values and preferences	Moderate	• Health workers will appreciate measures that reduce their exposure But … • Reduces comfort of health workers • May generate stigma if implemented without proper IEC
Costs	Low to moderate	Increased by: • purchase of respirators • training programme
Feasibility	Depends on country	• Lack of expertise • Lack of training • Requires commitment from health workers to wear them • Requires good education and training on their appropriate use
Overall ranking	STRONG RECOMMENDATION (in particular for MDR-TB and high-risk procedures)	
Research gap	Need to determine: • effectiveness of the intervention on the reduction of TB transmission • programmatic role of testing for good fit • re-use guidance	

IEC, information, education and communication; MDR, multidrug resistant; TB, tuberculosis

Glossary

The terms listed below have been defined or adapted for the purpose of this document.

Adequately ventilated room	A room with at least 12 air changes per hour.
Advocacy communication and social mobilization	In the context of TB infection control, the aim of advocacy is to secure financial resources and to change policies, guidelines or procedures by influencing groups such as politicians, decision makers and journalists. The aim of communication is to increase awareness, influence social norms, change behaviour (in individuals or subpopulations) and improve communication and counselling between people with TB, their families and providers. The aim of social mobilization is to change norms, improve services, expand community support and solve social problems, often by bringing groups together to act at the community level (*26*).
Air changes per hour (ACH)	Under ideal conditions – in which droplet nuclei are evenly distributed and room air is uniformly mixed – the proportion of infectious particles eliminated with each air change or one "equivalent air change" is 63%. A second air change removes 63% of what remains, and so on. One air change has occurred when the volume of air entering or exiting a room is equal to the volume of the room. Subsequent increases in air change leads to an exponential reduction in droplet nuclei in the room.
Airborne precautions	Precautions that apply to patients or suspects with airborne infections and are used in addition to standard precautions (see below). They include use of respirators by health workers, patient placement in a separated well-ventilated area and use of a medical mask on patient for transportation outside the patient's isolation area. These precautions, which apply to all airborne infections, contribute to reducing the spread of TB.
Community involvement	In the context of TB infection control, the involvement of people with TB and their communities in the design, implementation, monitoring and evaluation of health promotion, and TB preventive and curative services. Home-based care and community-based approaches for management of TB are part of community involvement in TB control.
Conditional recommendation	A recommendation for which the desirable effects probably outweigh those that are undesirable. Reasons for a conditional recommendation include low-quality evidence and lack of a clear estimate of the potential benefits or harms. A conditional recommendation can still be worth implementing, provided that certain conditions are met (see Chapter 3).
Congregate settings	A mix of institutional settings where people live in close proximity to each other. For the purpose of this policy, congregate settings are divided into two categories – long term (e.g. prisons) and short term (e.g. homeless shelters, jails) – to reflect the different duration of stay of the inhabitants. Health-care facilities are considered separately, even though these are settings where people congregate.

Control	Measures used to minimize the risk of spreading TB within populations
Droplet nuclei	Airborne particles that carry *Mycobacterium tuberculosis*; droplet nuclei are generated after people who have pulmonary or laryngeal TB disease cough, sneeze, shout or sing. The particles are approximately 1–5 μm; normal air currents can keep them airborne for prolonged periods and spread them throughout a room or building. Droplets are generally greater than 5 μm in diameter. Droplets settle faster than droplet nuclei and do not reach the alveoli when inhaled.
GRADE	An approach to the grading of recommendations assessment, development and evaluation that aims to overcome the shortcomings of current grading systems in health care. For further information, see the GRADE website (http://www.gradeworkinggroup.org).
Health-care facility	Any establishment that is engaged in direct patient care on site.
Health workers	All those in public and in private services, in the health sector and other sectors, whose main activities are aimed at improving health. They include health service providers – for example, doctors, nurses, pharmacists and laboratory technicians – and health management and support workers – for example, financial officers, cooks, drivers and cleaners. (http://www.who.int/mediacentre/factsheets/fs302/en/index.html)
Infection control assessment	An assessment of the implementation of managerial activities (including risk assessment), administrative controls, environmental controls, and respiratory protective equipment in a setting, in the context of local epidemiological, climatic and socioeconomic conditions.
Infectious case	Smear-positive cases are the most infectious and most likely to transmit TB. Smear-negative but culture-positive cases can also transmit TB.
Laboratory biosafety	Infection control measures related specifically to the laboratory environment, based on the relative risk of exposure to biological agents, hazardous chemicals and laboratory procedures.
Measures	These include the set of managerial activities, administrative controls, environmental controls and personal protective equipment for TB control.
Mechanical ventilation	Ventilation created using an air supply or an exhaust fan to force air exchange and to drive airflow. Such ventilation works by generating negative or positive pressure in the room to drive air changes. To be effective, all doors and windows must be kept closed, with controlled air leakage into or out of the room.
Mixed-mode ventilation	A ventilation system that combines both mechanical and natural ventilation. It provides the opportunity to choose the most appropriate ventilation mode based on the circumstances.
Natural ventilation	Ventilation created by the use of external natural forces such as wind and temperature. Control of airflow direction cannot be achieved by simple natural ventilation – it depends on sufficient wind speed or direction, or temperature differential.

Nosocomial infection	An infection occurring in a patient in a hospital or other health-care facility in whom the infection was not present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge, and also occupational infections acquired by staff as a result of working at the facility (*27*).
Particulate respirators	Special type of closely fitted face mask with the capacity to filter particles to protect against inhaling infectious droplet nuclei. The N95 respirator has a filter efficiency level of 95% or more against particulate aerosols free of oil when tested against 0.3 μm particles. The "N"denotes that the mask is not resistant to oil; the "95" refers to a 95% filter efficiency. The FFP2 respirator has a filter efficiency level of 94% or more against 0.4 μm particles and is tested against both an oil and a non-oil aerosol.
Risk assessment	Includes analysis, collection and review of surveillance data and in-depth description of a facility.
Separation	Placing patients infected or colonized with the same known pathogen in a designated unit (i.e. one that has the same space and staff), to which patients without the pathogens are not admitted.
Settings with a high prevalence of HIV	Countries, subnational administration units (e.g. districts, counties) or selected facilities (e.g. referral hospitals, drug rehabilitation centres) where the adult HIV prevalence rate among pregnant women is more than or equal to 1%, or where HIV prevalence among tuberculosis patients is more than or equal to 5%.
Stakeholders	Include national authorities such as ministries of health, other relevant ministries and government agencies. National stakeholders are also non-governmental organizations, faith based organizations, civil societies, technical partners, international organisations, and communities living with HIV/AIDS involved in any aspect of design, implementation and evaluation of TB infection control.
Standard precautions	The basic infection control precautions in health care that are intended to minimize spread of infection associated with patient's blood, body fluids, secretions and non-intact skin. Examples of such precautions include hand hygiene (possibly by hand rubbing with alcohol-based formulations or hand washing using soaps and clean water), respiratory hygiene, cleaning and disinfection, waste management and – based on infection control assessment – use of personal protective equipment (e.g. gloves, facial protection, gowns). Details on standard precautions are available from WHO (*9*).
Strength of a public health recommendation	Depends on the quality of the evidence and on issues related to feasibility, programmatic implementation and anticipated costing.
Strong recommendation	A recommendation for which the desirable effects outweigh the undesirable effects.
Triage	In the context of TB infection control, a system for identifying people with TB symptoms based on cough. Triage is used in fast-tracked TB diagnosis and further separation, when necessary.

Ultraviolet germicidal irradiation (UVGI)	Radiation at 254 nm, produced within the UV-C region of the electromagnetic spectrum. UVGI prevents microbial replication by inactivating both bacterial and viral deoxyribonucleic acid (DNA). The most practical and effective application uses wall or ceiling-mounted UVGI fixtures to create an upper room air disinfection zone. Good mixing of air between the upper and lower room is required to allow effective disinfection of air in the lower part of the room where people breathe (the lower breathing zone).

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4376 DESIGN DIRECTION

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WHO policy on TB infection control in health-care facilities, congregate settings and households

Annexes (CD-ROM)

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Introduction

The evidence given in these annexes was derived from systematic reviews and literature searches related to TB infection control measures. The main questions that were considered were:

1) How much TB transmission is there in different settings?

2) What is the effectiveness of triage, separation, cough etiquette and reduction of stay in health-care facilities?

3) What is the effectiveness of ventilation?

4) What is the effectiveness of ultraviolet germicidal irradiation (UVGI)?

5) What is the effectiveness of particulate respirators?

Each evidence profile contains the question in an adapted "PICOT" (population, intervention; comparison, outcome and time) format, the study selection process and a summary of the main results. The outcome that was considered for each question was the decrease in TB incidence (both drug-susceptible and drug-resistant TB), where:

- *TB incidence* was specified as the incidence of TB cases (new and recurrent) or TB infection, measured with cutaneous test or gamma interferon assays, or TB prevalence derived measures
- *decrease in TB incidence* was measured in patients (differentiating between HIV and non-HIV infected) and health workers (differentiating between HIV and non-HIV infected).

The GRADE system[a] was used to determine the quality of the collected evidence. This system considers factors such as study design, quality, consistency, directness and precision.

a. http://www.gradeworkinggroup.org/

ANNEX 1

Quantification of TB transmission in selected settings

A1.1 Question

Table A1.1

Question or intervention	Outcome	Setting	Population
Quantification of TB transmission in selected settings	TB incidence	Any ward TB ward MDR ward Outpatient Household Congregate[a]	Patients (HIV positive and all patients) HWs (HIV positive and all HWs)

HW, health worker; HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis

[a] Congregate settings include prisons, homeless shelters, army barracks and nursing homes.

A1.2 Study selection process

- Health workers
  - TB infection incidence in low- and middle-income countries (LMICs – using the World Bank ranking) (10 studies, 7 from 1 systematic review (*1*) [see Section 1.5.1] and 3 independent reviews)
  - TB infection incidence in high-income countries (HICs –World Bank ranking) (35 studies, 33 from 2 systematic reviews (*2*,*3*) [see Section 1.5.1] and 2 independent reviews)
  - TB incidence in LMICs (22 studies, 20 from 1 systematic review (*1*) [see Section 1.5.1] and 2 independent reviews)
  - TB incidence in HICs (14 studies, 12 from 1 systematic review (*3*) [see Section 1.5.1] and 2 independent reviews)
- Inpatients in health-care facilities
  - TB infection and TB incidence (10 studies independent review, data only from HICs)
- Congregate settings contacts
  - TB infection incidence (9 studies independent review, data only from HICs)
  - TB incidence (17 studies independent review, data only from HICs)
- Household contacts
  - TB infection or TB incidence in HICs (14 studies independent review)

A1.3 Summary of evidence

Table A1.2 shows that the incidence of latent TB infection (LTBI) and TB disease among health workers in health-care facilities exceeds the incidence among the general population or among health workers not exposed to health-care facilities. Likewise, the incidence of LTBI and TB among individuals in congregate settings, such as prisons (for which evidence was readily available), and incidence of LTBI and TB among contacts in household settings, exceed the incidence among the general population.

Table A1.2 Pooled estimates (reference general population)

Population	Outcome	Settings	Risk ratio[a]
Health workers	LTBI	High income	10.06
	LTBI	Low income	5.77
	TB	Low income	5.71
	TB	High income	1.99
Congregate (mostly prisons)	LTBI	High income	2.74
	TB	High income	21.41
Household	LTBI and TB	High income	3.19

LTBI, latent TB infection; TB, tuberculosis

[a] Estimates were computed from studies reported in the GRADE profiles tables

A1.4 GRADE profiles

Table A1.3 Health-care facilities – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
LTBI incidence among HWs in high-income countries							
32	Observa-tional study	No seri-ous limita-tions	No serious in-consist-ency	No serious indirect-ness	No serious imprecision	Very strong as-sociation[a]	HIGH
LTBI incidence among HWs in low to middle-income countries							
10	Observa-tional study	No seri-ous limita-tions	No serious in-consist-ency	No serious indirect-ness	No serious imprecision	Very strong as-sociation	HIGH
TB incidence among HWs in high-income countries							
14	Observa-tional study	No seri-ous limita-tions	No serious in-consist-ency	No serious indirect-ness	No serious imprecision	Very strong as-sociation[b]	HIGH
TB incidence among HWs in low to middle-income countries							
22	Observa-tional study	No seri-ous limita-tions	No serious in-consist-ency	No serious indirect-ness	No serious imprecision	Very strong as-sociation[c]	HIGH

HW, health worker; LTBI, latent TB infection; IRR, incidence rate ratio.

[a] Thirteen studies, IRR >5; thirty three studies, IRR >2

[b] Two studies, IRR >5; six studies, IRR >2

[c] Seventeen studies, IRR >5; twenty one studies, IRR >2

Table A1.4 Health-care facilities (patients) – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
Nosocomial transmission of TB or LTBI incidence (patient population)							
10	Observa-tional study	No seri-ous limi-tations	No serious in-consistency	No seri-ous indi-rectness	No seri-ous im-precision	Very strong association[a]	HIGH

LTBI, latent TB infection; IRR, incidence rate ratio.
[a] One study, IRR>5;three studies, IRR>2

Table A1.5 Congregate settings – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
LTBI incidence among individual in congregate settings							
9	Observa-tional study	No seri-ous limi-tations	No serious inconsistency	No seri-ous indi-rectness	No seri-ous im-precision	Very strong association[a]	HIGH
TB incidence among individuals in congregate settings							
17	Observa-tional study	No seri-ous limi-tations	No serious inconsistency	No seri-ous indi-rectness	No seri-ous im-precision	Very strong association[b]	HIGH

LTBI, latent TB infection; IRR, incidence rate ratio.
[a] One study, IRR>5; three studies, IRR>2
[b] Thirteen studies, IRR>5; fourteen studies, IRR>2

Table A1.6 Household settings – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
Household transmission of TB or LTBI incidence in high income countries							
14	Observa-tional study	No seri-ous limi-tations	No serious inconsistency	No serious indirect-ness	No seri-ous im-precision	Very strong association [a]	HIGH

LTBI, latent TB infection; IRR, incidence rate ratio
[a] Four studies, IRR>5; nine studies, IRR>2

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■ ANNEX 2

Triage of people with TB symptoms and separation of infectious cases (Recommendations 8a and 8b)

A2.1 Question

Question or intervention	Outcome	Settings	Population
Triage with and without separa-tion versus no in-tervention	Reduction in TB incidence	Outpatient settings Any ward TB ward MDR ward Congregate settings[a]	Patients (HIV-positive and all patients) HWs (HIV-positive and all HWs)

HW, health worker; HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis

[a] Congregate settings include prisons, homeless shelters, army barracks and nursing homes.

A2.2 Study selection process

BCG, Bacille Calmette Guerin; Mtb, *Mycobacterium tuberculosis*; TB, tuberculosis

A2.3 Summary of evidence

In total, 15 studies, including 3 (*1–3*) from LMICs, have been reviewed. The reviewed studies, including three that contained qualitative data only (*4–6*), support the implementation of triage and physical separation within a set of TB infection control measures. All the studies (*1–3*) from LMICs reported reduction of TB infection among health workers within a year of introduction of multiple infection control measures. In particular, in two studies (*2*, *3*), the decrease in LTBI incidence was statistically significant; the third study (*1*) showed a decrease of TB disease among health workers, but this decrease was not statistically significant.

In all studies conducted in HICs (*7–15*), indicators of nosocomial transmission rapidly declined following the implementation of recommended infection control measures.

Two studies (*11*, *14*) showed that the implementation of the full set of administrative measures reduces transmission of TB to health workers in nosocomial settings. One study showed that reduction of incidence of TB infection among health workers happened after introducing an expanded isolation policy (*7*). Four studies (*11*, *13–15*) addressed the issue of nosocomial transmission of multidrug-resistant TB (MDR-TB) following introduction of outbreak and administrative control measures. In one study within the HIV ward setting, the exclusive implementation of administrative controls resulted in the complete elimination of MDR-TB transmission among patients (*14*). However, identification of the key interventions responsible for the decrease in transmission is difficult, because many measures were introduced simultaneously in most facilities.

Overall, the limited evidence available suggests that risk of TB infection can be reduced with simple administrative controls, but this needs to be evaluated in larger, better controlled studies.

A2.4 GRADE profiles

Table A2. 1 Triage of people with TB symptoms and separation of infectious cases – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness[a]	Imprecision	Quality
Triage						
12 (*1–3, 7–15*)	Observa-tional studies	No serious limitations	No serious inconsistency	Serious indirectness	No serious imprecision	LOW
Physical separation						
12 (*1–3, 7–15*)	Observa-tional studies	No serious limitation	No serious inconsistency	Serious indirectness	No serious imprecision	LOW

[a] Indirect intervention – the studies available assess the outcome for several administrative measures implemented concurrently.

A2.5 References

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ANNEX 3

Cough etiquette and respiratory hygiene (Recommendation 8c)

A3.1 Question

Table A3.1

Question or intervention	Outcome	Settings	Population
Source control interventions (masks, tissues, cough etiquette and respiratory hygiene) versus no intervention	Reduction in TB incidence	Any ward TB ward MDR ward Outpatient Congregate[a]	Patients (HIV positive and all patients) HWs (HIV positive and all HWs)

HW, health worker, HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis
[a] Congregate settings include prisons, homeless shelters, army barracks and nursing homes.

A3.2 Study selection process

BCG, Bacille Calmette Guerin; Mtb, *Mycobacterium tuberculosis*; TB, tuberculosis

A3.3 Summary of evidence

Two observational studies (*1*, *2*) clearly mention respiratory hygiene among the administrative measures contained in the packages implemented. However, some articles addressed the impact of respiratory hygiene on the reduction of transmission of influenza and pertussis, diseases with transmission dynamics that differ from those of TB (*3–6*). The few data available from these studies support the implementation of cough etiquette to reduce the transmission of influenza and pertussis. These findings, although not TB related, are used to inform the public health recommendation for the role of cough etiquette for TB infection control.

A3.4 GRADE profile

Table A3.2 Cough etiquette and respiratory hygiene – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Quality
2 [a]	Observational studies	Serious limitations	No serious inconsistency	No serious indirectness	No serious imprecision	LOW

[a] Table generated based on the TB-related papers only (*1,2*)

A3.5 References

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■ ANNEX 4

Minimizing time spent in health-care facilities (Recommendation 8d)

A4.1 Question

Table A4.1

Question or intervention	Outcome	Setting	Population
Minimise time spent in health-care facilities versus no intervention	Reduction in TB incidence	Any ward TB ward MDR ward	Patients (HIV positive and all patients) HWs (HIV positive and all HWs)

HW, health worker; HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis

A4.2 Summary of evidence

No studies were found that directly assess the contribution of hospital stay to nosocomial TB transmission. Therefore, a GRADE table cannot be generated. There are several studies on cost-effectiveness of ambulatory management versus hospitalization.

A4.3 References

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ANNEX 5

Ventilation system: Natural, mixed-mode and mechanical ventilation (Recommendations 10, 10a and 10b)

A5.1 Question

Table A5.1

Question or intervention	Outcome	Setting	Population
Ventilation versus no interventions Mechanical ventilation versus no intervention Natural or mixed-mode ventilation versus mechanical Single occupancy versus ventilation or mechanical	Reduction in TB incidence Change in ACH Cost or cost–effectiveness	Any ward TB ward MDR ward Outpatient Congregate[a]	Patients (HIV-positive and all patients) HWs (HIV-positive and all HWs

ACH, air change per hour; HW, health worker; HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis
[a] Congregate settings include prisons, homeless shelters, army barracks and nursing homes.

A5.2 Study selection process

4537 articles excluded after screening titles and abstracts

BCG, Bacille Calmette Guerin; Mtb, *Mycobacterium tuberculosis*; TB, tuberculosis

A5.3 Summary of evidence

Of the nine included articles (*1, 9*), three were epidemiologic studies (cohort or cross-sectional designs) (*3–5*) that looked at tuberculin skin test (TST) conversion rates in health workers; four were modelling studies (*1, 6–8*) and two described the costs of ventilation interventions (*2, 9*). No randomized controlled trials studying the effectiveness of ventilation measures were found. One study focused on natural ventilation only (*7*), the other studies assessed mechanical ventilation. The three epidemiological studies showed a link between ventilation and TST conversion rates: the lower the ventilation, the higher the TST conversion rate in health workers. The factors studied in the nine included articles vary widely.

In general, even if the evidence for ventilation is of low quality, studies suggest that these interventions are useful for TB infection control.

A5.4 GRADE profiles

Table A5.2 Natural, mixed-mode and mechanical ventilation for TB infection control – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Quality
9	Observational, modelling, environmental, animal, and cost studies	Serious limitations	Serious	Serious	Serious	LOW

Table A5.3 Key findings from the systematic review on natural and mechanical ventilation

Country, type of study, years and reference	Setting and subjects	Type of ventilation	Comparison type	Data without ventilation	Data with ventilation	Notes
South Africa Model-ling study (*1*)	Hospital HWs and patients	Mechanical and natural	Cases of XDR-TB prevent-ed	Mechanical ventilation pre-vents 12% of XDR-TB cases (range 10–20%)	Improvements to natural ventilation could prevent aver-age of 33% of XDR-TB cases (range 8–35% due to wind patterns)	Mechani-cal venti-lation and HEPA fil-ters can reduce extra 10% of XDR-TB cases (range 20–35%)
USA 1989–1994 Cost study (*2*)	5 hospi-tals, 4 with MDR-TB outbreaks			Nonrecirculat-ed air: $30,000–132,900	Room exhaust fans: $3,500–9,800	

Country, type of study, years and reference	Setting and subjects	Type of ventilation	Comparison type	Data without ventilation	Data with ventilation	Notes
USA Prospective cohort study part of screening program 1993–1996 (*3*)	ED Hospital staff	Intervention included: 4 isolation rooms (as per CDC standards), 100% nonrecirculated air in trauma area, improved ventilation with at least 25% fresh air in ED, laminar flow of air, Plexiglas droplet shields	TST conversion rates over 6-month intervals (10 mm cutoff, 5 TU)	(Baseline) Cycle 1: 451/4547 (8.1%) in other departments, 8/88 (9.1%) in Emergency dept. Cycle 2: 6/50 (12%) for ED, 51/2514 (2%) for OD	Cycle 3 after implementation of all measures: 0/64 (0%) for ED and 36/3000 (1.2%) for OD	Annual incidence of TB disease was 22.1/100,000
Canada Cross-sectional survey 1992–1995 (*4*)	17 acute-care hospitals in 4 cities Nurses, physiotherapists, respiratory therapist, aides, orderlies, housekeepers, clerks nonclinical personnel		TST conversion groups (Mantoux, 10 mm cutoff, 5TU)	Inadequate ventilation of nonisolation rooms significantly associated with TST conversion among nursing, housekeeping and respiratory therapy personnel (p<0.001). inadequate ventilation of bronchoscopy rooms also significantly associated with conversion among respiratory therapists	In multi proportional hazards regression, earlier time to conversion significantly associated with ventilation <2ACH in nonisolation rooms (hazards ratio 3.4 (2.1–5.8)) but not with ventilation in respiratory isolation rooms (<6ACH vs >6ACH) 1.02 (0.8–1.3)	Ventilation measured by Smoke tubes and CO_2 release measured by infrared direct reading monitor

Country, type of study, years and reference	Setting and subjects	Type of ventilation	Comparison type	Data without ventilation	Data with ventilation	Notes
Canada Cross-sectional study (5)	17 acute care hospitals in 4 cities Nurses, pathology and microbiology technicians physiotherapists, respiratory therapist, nonclinical personnel as reference		TST conversion groups (Mantoux, 10 mm cut-off, 5TU)	In converted group, ACH averaged 16.7 In nonconverted group, ACH averaged 32.5 TST conversion significantly associated with lower ventilation (<0.001)	In multivariate analysis, ratio of actual ventilation to minimum recommended (comparing half vs equal) gave OR 1.3 though not significant (CI: 0.9, 1.9)	
USA Modelling study using Wells-Riley model (6)	Holding facility Deputy sheriffs		TST conversion rates (Mantoux, 5TU)	At measured ventilation (1763 CFM), 4/37 sheriffs infected; at designed ventilation (4954 CFM), only 1.5/37	62.5% reduction in infection by increasing ventilation by 64%	Annual incidence of TB disease ranged 3–7.3/100,000
Peru Mathematical modelling using Wells-Riley model (7)	8 hospitals including TB wards and clinics (5 built before 1950 and 3 built 1970–1990) ; susceptible individuals who are exposed	Natural and mechanical ventilation	Median risk of TB transmission (% of individuals infected)	Median risk was 97% for natural-ventilation facilities with windows/doors closed, 33% for natural-ventilation facilities in modern hospitals and 11% in pre-1950 hospitals with windows/doors opened	39% for mechanical-ventilated negative-pressure isolation rooms at 12 ACH	ACH measured using tracer gas concentration decay technique, CO_2 concentrations measured using infrared gas analyzer

Country, type of study, years and reference	Setting and subjects	Type of ventilation	Comparison type	Data without ventilation	Data with ventilation	Notes
USA Mathematical modelling based on contact investigation (*8*)	Office building Workers		TST conversion (Mantoux, 10 mm cut-off, 5TU) 4 month intervals	Baseline conversion:27/67 (40%) Decrease in ventilation by 10 CFM would double infection rate (52/67 or 78%)	Increase of 10cfm would reduce rate by 26.9% (18/67) Increase 20 CFM would reduce to13/67 (19%)	Further increases in outdoor air ventilation predicted to result in progressively smaller reductions in infection
USA Life cycle cost analysis for 25 years in 3 cities (*9*)				Waiting room recirculation: Los Angeles (LA)–$1,707,409 New York (NY)–$1,387,717 Atlanta–$1,718,853	100% exhaust in waiting room: LA–$1,753,471 NY–$1,437,056 Atl–$1,770,116	100% exhaust for entire building: LA–$1,783,945 NY–$1,492,515 Atl–$1,847,992

ACH, air changes per hour; CDC, Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America; CFM, cubic feet per minute; ED, emergency department; HEPA, high-efficiency particulate air, HW, health worker, LA, Los Angeles; MDR, multidrug resistant; NY, New York; OD, outpatient department; TST, tuberculin skin test; TU, tuberculin unit; XDR extensively drug resistant

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ANNEX 6

Use of ultraviolet germicidal irradiation fixtures (Recommendation 11)

A6.1 Question

Table A6.1

Questions/interventions	Outcome	Setting	Population
• UVGI lights versus no intervention • UVGI lights versus UV lights plus other interventions	• Reduction in TB incidence • Cost or cost–effectiveness • Adverse outcomes	• Any ward • TB ward • MDR ward • Outpatient • Congregate[a]	• Patients (HIV-positive and all patients) • HWs (HIV-positive and all HWs)

HW, health worker, HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis; UVGI, ultraviolet germicidal irradiation

[a] Congregate settings include prisons, homeless shelters, army barracks and nursing homes.

A6.2 Study selection process

BCG, Bacille Calmette Guerin; Mtb, *Mycobacterium tuberculosis*; TB, tuberculosis; UVGI, ultraviolet germicidal irradiation

A6.3 Summary of evidence

There is wide variation in the factors studied in the 11 included articles (*1–11*). Only one is an epidemiologic study that looked at TST conversion rates in health workers showing no major additional benefit (*2*). However, one well designed animal model study demonstrated that UVGI could reduce TB transmission and disease in guinea pigs (*1*). All the three laboratory experiments studies showed reduction in bacteria concentration, and absence of tubercles in animals exposed to UVGI (*8*, *9*, *11*).

Two are modelling studies (*3*, *5*), another looks at adverse effects (*7*), and one article describes the costs of the UVGI intervention (*4*). There are no randomized controlled trials studying the effectiveness of UVGI. However, given the ethical consideration for the conduction of a randomized controlled trial in humans to determine the efficacy of UVGI, results from the animal model study represent the closest proxy to a randomized controlled trial.

There is little evidence on the effectiveness of UVGI as an intervention. However, the available evidence, though weak and indirect, is generally favourable on its use for TB infection control.

A6.4 GRADE profiles

Table A6.2 UVGI for TB infection control – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Quality
11	Observational, modelling, environmental, animal and cost studies	Serious limitations	Serious	Serious	Serious	LOW

Table A6.3 Key findings from the systematic reviews of ultraviolet germicidal irradiation (UVGI) fixtures

Country, type of study, years and reference	Setting and subjects	Type of UVGI	Comparison type	Data without UVGI	Data with UVGI	Notes
Peru Animal study (*1*)	Three wards Guinea pigs	Upper room	TST conversion and detection of TB disease	106 tuberculin-positives in the control group, 43 in the group protected by ionizers, and 29 in the group only exposed to ward air when UV lights were switched on (*P* <0.0001). Tuberculosis transmission was reduced by 58% by ionizers (log-rank 27; *P* <0.0001) and by 72% by UV lights (log-rank 46; *P* <0.0001).	There was autopsy or organ culture evidence of tuberculosis disease in 26 control group animals, compared with 11 in those protected by ionizers (log-rank 3.7; *P* = 0.055) and 11 in those protected by UV lights (log-rank 5.4; *P* = 0.02).	
USA Cross-sectional survey 1991–93 (*2*)	Hospital HWs, hospital employees	Upper room	TST conversion rates	30/145 (20.7%) baseline conversion rate with several IC measures	Starting from 7/219 (3.2%); changed to 14/227 (6.2%) for first 6 months, then to 4% for next 6 months	TST with 10 mm cut off at 6-month intervals

Country, type of study, years and reference	Setting and subjects	Type of UVGI	Comparison type	Data without UVGI	Data with UVGI	Notes
Italy Prediction modelling (*3*)	Hospital, HIV wards HWs, hospital employees	N/A	TST conversion rates for 4 types of high-risk procedure	GV: 34.3–99.9% GV+SM: 22.3–98.1% GV+DMR: 5.9–61.5% GV+HM: 1.3–17.9%	GV+UV: 5.8–90% GV+SM+UV: 3.5–42.8% GV+DMR+UV: 0.9–12.6% GV+HM+UV: 0.2–2.8%	
USA Cost study 1989–94 (*4*)	5 hospitals, 4 with MDR-TB outbreaks	Upper room, in ventilation duct	Cost	Wall mounted: $84,000 for 12 fixtures, $93,000 for 8 fixtures at another hospital	In ventilation system: $61,400 for 12 fixtures	
USA Risk analysis Hypothetical modelling (*5*)	Hospital	Upper room	TB risk, mean annual new infection rate, cost effectiveness	UVGI reduced TB risk by 1.6-fold in low-risk setting UVGI reduced mean infection rate from 2.2 to 1.3 per year at low irradiance	UVGI reduced TB risk by 4.1-fold in high-risk setting; UVGI reduced mean infection rate from 2.2 to 0.6 per year at high irradiance	Mean cost effectiveness ranged from $133 per TST conversion saved in high-risk setting to $1017 per TST conversion saved in low-risk setting
Canada cross-sectional survey 1997–98 (*6*)	Hospital	Upper room, portable device	ACH measured by proxy, not directly	2.0 w/o UV 3.1 for upper-room UV 2.2 for UV + unmixed air	4.0 with UV 7.7 for portable UV 4.5 for UV + mixed air	All $P<.05$ Measured other bacteria in air, did not include Mtb
USA Double-blind, placebo-controlled field trial, not randomized 1997–2004 (*7*)	Homeless shelter Shelter staff	Upper room	Adverse effects	223/3611(6%) interviews reported skin or eye symptoms	95 cases entirely during active UV period, 36 during placebo, 36 uncertain (Chi-square $P = 0.4$)	

Country, type of study, years and reference	Setting and subjects	Type of UVGI	Comparison type	Data without UVGI	Data with UVGI	Notes
USA Laboratory study (*8*)	Dental clinic in TB hospital	Upper room	Reduction of TB bacteria on culture plates after UV exposure for 24 hours	Count range 150–350	Count range 15–30	9-fold reduction in TB bacteria on plates
USA Laboratory study 1974–75 (*9*)	Laboratory room	Upper room	ACH	ACH when UV off: 2–4	ACH for 1 UV fixture: 12 ACH for 2 UV fixtures: 21–37 difference in ACH: range 10–33	Ratio of disappearance of BCG for UV versus no UV was 9:1
USA Animal study 1995 (*10*)	Six-room pilot ward	Upper room	Presence of tubercles in 12 rabbits exposed to BCG	Tubercles ranged from 2 to 10	No rabbits had tubercles	Used BCG
USA Laboratory study (*11*)	Laboratory room	Upper room	Culturable bacteria count concentration (CFU/m^3)	First time: 7.67×10^4 Repeat: 3.71×10^4	First time: 5.51×10^3 Repeat: 1.01×10^3	UV lamps reduced average room BCG concentration between 96–97% at 50% relative humidity

ACH, air changes per hour; BCG, Bacille Calmette Guerin; CFU, colony forming unit; DMR, dust-mite respirator; GV, general ventilation; HEPA, high-efficiency particulate air; HIV, human immunodeficiency virus; HM, HEPA mask; HW, health worker; MDR, multidrug resistant; Mtb, *Mycobacterium tuberculosis*; N/A, not applicable; SM, surgical masks; TB, tuberculosis; TST, tuberculin skin test; UV, ultraviolet; UVGI, ultraviolet germicidal irradiation

A6.5 References

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ANNEX 7

Use of particulate respirators for health workers (Recommendation 12)

A7.1 Question

Table A7.1

Question/interventions	Outcome	Settings	Population	Special situations
Respirators (N95 or equivalent) versus no intervention	Reduction in TB incidence	Any ward TB ward MDR ward Outpatient	HWs (HIV-positive and all HWs)	Procedures involving aerosol versus other procedures
Fit test versus fit check and/or training	Proper use of the respirator	Any ward TB ward MDR ward Outpatient	HWs (HIV-positive and all HWs)	

HW, health worker; HIV, human immunodeficiency virus; MDR, multidrug resistant; TB, tuberculosis

A7.2 Study selection process

BCG, Bacille Calmette Guerin; Mtb, *Mycobacterium tuberculosis*

A7.3 Summary of evidence

Of the 13 relevant studies included in the review (*1–13*), 3 epidemiologic studies (cross-sectional surveys) evaluated TST conversion rates in health workers and showed a decrease in TST conversion in health workers following the introduction of respirators (*6*, *7*, *10*). Four articles were modelling studies (*2*, *3*, *7*, *12*), and four studies described the cost/cost-effectiveness of respirators (*2,9,11,13*). One study showed low compliance with use of respirators by HWs even if proper training is ensured (*4*). One study demonstrated that user seal check should not be used as a surrogate for respirator fit testing (*5*).

A majority of the cost studies determined respirators are expensive and not very cost-effective. There is little evidence on the effectiveness of respirators as an infection control intervention by themselves. However, the available evidence, though weak and indirect, is generally favourable on its use for TB infection control.

A7.4 GRADE profile

Table A7.2 Respirators for TB infection control – quality assessment

No. studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Quality
13	Observational, modelling, environmental, animal and cost studies	Serious limitations	Serious	Serious	Serious	LOW

Table A7.3 Key findings from systematic review on respirators

Country, type of study, years and reference	Setting and subjects	Type of mask or respirator	Comparison type	Data with or without mask or respirator	Data with mask or respirator	Notes
USA Cost study (*1*)	Tertiary case hospital HWs	Various	Cost	Simple isolation mask: $1,833 DMR: $1866–28,106 Disposable HEPA respirator: $15,396–114,715 Respirator with replaceable HEPA: $18,614–138,697	Estimated cost of preventing one case of occupational TB Disposable HEPA respirator $631,236 Respirator with replaceable HEPA filter: $5,686,577 Fit testing: $312,422 Fit training: $268,086	Fit testing for 350 new employees per year: $6,124 ($312,422 over 41-year period) Fit training for new employees in year: $5,256 ($268,086 for 41 years)
USA Modelling study (*2*)	Hospital HWs	Various	Risk reduction and person-hours to TST conversion	Protection rate versus no respiratory protect (reduce risk fold) • surgical mask 2.4 • disposable dust-mite or dust-fume respirator or disposable HEPA respirator 17.5 • negative pressure cartridge HEPA respirator 45.5 • powered air-purifying respirator 238	Under no UVGI and 6 ACH, 2560 person-hours required for skin-test conversion for no respirator protection, increases to 6100 hours for surgical mask, 44900 hours for DF/DM mask or disposable HEPA, 116000 hours for negative pressure cartridge HEPA respirator, and 610,000 for powered air-purifying respirator	
South Africa Modelling study (*3*)	Hospital HWs and patients	N95 respirators for staff and mask s for patients	Cases of XDR-TB prevented	Respirator mask use would prevent 2% of XDR cases and 2/3 in staff. 5% of XDR infections averted if patients provided with surgical masks	Enforcement of adherence would increase number of XDR cases averted by average of 1% (range 0–2%)	Mask use more effective when combined with other strategies (reducing length of stay, improved natural ventilation, MODS, voluntary testing and counselling with anti-retroviral therapy, isolation with 5 patients)
Brazil Cross-sectional 2000–01 (*4*)	Hospital HWs	N95 respirators	Compliance	During high-risk procedures: 20% of patient encounters had HW wear N95 versus 27.6% in non-high-risk procedures (OR = 1.53, *P* = 0.367)	In TB isolation room: 39.5% of patient encounters had HW wear N95 versus 8.7% when patient not isolated (OR = 6.85, p<0.001)	39% of HWs found to have facial-seal leakage (i.e. masks not worn properly); 25.5% of patient encounters had HW wear N95

Country, type of study, years and reference	Setting and subjects	Type of mask or respirator	Comparison type	Data with or without mask or respirator	Data with mask or respirator	Notes
Hong Kong Retro-spec-tive (5)	Hospital Nurses	N95 and N100	User fit check versus fit test-ing with Porta-Count reading of 100 as the criterion for a cor-rectly fit-ted mask	The user seal check wrongly indicated that the mask fitted on 18–31% of occa-sions	User seal check wrongly indicated that it did not fit on 21–40% of occasions	Results indicate that user seal check should not be used as a surrogate fit test
USA 1991–1993 cross-sec-tional (6)	Hospital HWs, hospital employ-ees	Vari-ous	TST conver-sion rates (several IC mea-sures to-gether, includ-ing neg-ative-pres-sure rooms and UV lights)	30/145 (20.7%) baseline conver-sion rate with Technol shield	Conversion rate at 3.2 then 6.2 (with UV) then 4.0 for particulate respi-rators 5.8 for dust-mist-fume respirators	TST with 10 mm cut-off at 6-month inter-vals
USA Mod-elling study with modi-fied Wells-Riley (7)		Vari-ous	Risk of infection	Risk under mod-erate exposure category with disposable respi-rator (leakage 0.2), ACH 6 = 0.042	Risk goes down to 0.021 with a elastomeric half-face respirator (w/leak-age of 0.1)	Risk of infection de-creases exponentially with increasing per-sonal respirator pro-tection; relative efficacy of such pro-tection decreases with increased venti-lation

Country, type of study, years and reference	Setting and subjects	Type of mask or respirator	Comparison type	Data with or without mask or respirator	Data with mask or respirator	Notes
USA Cross-sectional survey 1992–95 (8)	Hospital HWs	Various	TST conversion rates	For hospitals reporting > 6 patients in 1992: submicron respirator protection (submicron surgical masks, NIOSH-approved disposable particulate respirators: dust mist, DFM and HEPA-filter respirators): TST conversion rate 289/29376 (0.98%) Surgical masks: 497/52648 (0.94%) *P* = 0.98	For hospitals reporting > 6 patients in 1992 among high-risk HWs (including bronchoscopists and respiratory therapists): Submicron respirator protection: TST conversion rate was 15/750 (1.9%) Surgical masks: 19/1183 (1.6%) *P* = 0.50	Similar analysis for hospitals reporting <6 TB patients/year, no significant differences in HW TST conversion rate between hospital compliant or not compliant with TB infection control measures
USA Cost study 1994 (9)	Five hospitals HWs	Various	Cost	Total program cost of HW respirator fit-testing program: $8,736–$26,175	Estimate of N95 respirator program cost, assuming single use: $270–422,526	These findings, in contrast to other studies, suggest cost of respirator protection program at most hospitals not excessive
Brazil Cross-sectional study 1997–99 (*10*)	Hospital Nurses	Various	TST conversion rates	In relation to use of Technol PFR95 masks, 31/68(68.9%) who reported using them did not convert, as compared to only 2/8 (25%) who showed tuberculin conversion (RR = 0.3, *P* = 0.03 CI:0.09–1.01)	In relation to use of surgical masks, 28/68(62.2%) who reported using them did not convert, as compared to 6/8 (75%) who showed tuberculin conversion (p = 0.7)	TST testing Mantoux 2TU with 10 mm cut-off
USA Cost-effectiveness study (11)	159 veteran affairs hospitals HWs	HEPA respirators	Cost effectiveness	Using HEPA respirators in HWs: Would cost $7 million to prevent 1 case of TB in HW	Using HEPA respirators in HWs: Would cost $100 million to save one life	

Country, type of study, years and reference	Setting and subjects	Type of mask or respirator	Comparison type	Data with or without mask or respirator	Data with mask or respirator	Notes
USA Modelling study (*12*)		Various	Cumulative risk of infection	10-year cumulative risk for low-risk scenario: 0.15 (no respirator), 0.067 (surgical mask), 0.0094 (disposable DMF respirator), 0.0033 (elastomeric half-mask HEPA respirator), 0.00064 (HEPA PAPR) Of 1000 HWs, number of expected cases after 10 years: 150, 67, 9, 3, 1 (same order as above)	10-year cumulative risk for high-risk scenario: 0.48 (no respirator), 0.24 (surgical mask), 0.037 (disposable DMF respirator), 0.013 (elastomeric half-mask HEPA respirator), 0.0026 (HEPA PAPR); of 1000 HWs, number of expected cases after 10 years: 480, 240, 37, 13, 3 (same order as above)	
USA Cost study 1992–95 (*13*)	Hospital HWs	Various	Cost of personal protective equipment program	Tecnol fluid-shield: $80,600 in 1992 to $41,067 in 1995 Moldex 2200 particulate respirator $25,239 in 1992 to $5,550 in 1995	3M dust-mist-fume 9220: $990 in 1992 to $21,450 in 1993 American threshold fluid-resistant: $19,443 in 1995	3M HEPA 9920: $66,960 in 1994 to $16,000 in 1995

ACH, air changes per hour; CDC, Centers for Disease Control and Prevention; CI, confidence interval; DF, dust/fume; DM, dust/mist; DMF, dus/mist/fume; DMR, dust/mist respirator; HEPA, high-efficiency particulate air; HW, health worker; IC, infection control; MODS, microscopic-observation drug-susceptibility; NIOSH, National Institute for Occupational Safety and Health; OR, odds ratio; PAPR, powered air purifying respirator; RR, relative risk; TB, tuberculosis; TST, tuberculin skin test; UV, ultraviolet; UVGI, ultraviolet germicidal irradiation; XDR, extremely drug resistant

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