TUBERCULOSIS *and* AIR TRAVEL

GUIDELINES FOR PREVENTION AND CONTROL

THIRD EDITION

World Health Organization

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Tuberculosis and air travel

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Preface

Air travel is now widely accessible, with a resulting increase in the numbers of international air travellers and a consequently greater risk of communicable diseases being spread by infectious travellers. The transmission of airborne infections between people in confined spaces such as aircraft cabins is of particular concern to health officials and the general public.

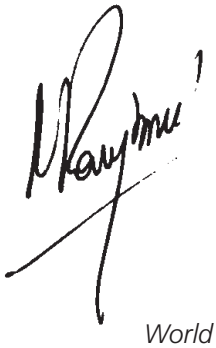
In the early 1990s, several reports concerning the transmission of tuberculosis (TB) infection including its then most dangerous form, multidrug-resistant TB (MDR-TB), from infectious travellers to other passengers and crew during long flights, caused anxiety among travellers and serious concern among public health officials and airline companies. The World Health Organization (WHO) published guidelines in 1998 defining the extent of the problem and the potential risks, and providing recommendations for travellers, physicians, health authorities and airline companies. The recommendations were based on the limited evidence available at the time: investigations involving seven contagious TB patients and some 2600 potentially exposed air travellers. A second edition of the guidelines was published in 2006.

The emergence of MDR-TB and extensively drug-resistant TB (XDR-TB) has raised special concerns in relation to the international spread of particularly dangerous strains of *Mycobacterium tuberculosis*. Since the 2006 edition was published, several incidents have occurred involving air travel and potential transmission of TB. The revision of the International Health Regulations (IHR), which entered into force in June 2007, provides for the introduction of new measures that might potentially apply to international events involving TB. The IHR provide a legal framework for a more effective and coordinated international response to public health emergencies and risks, including those caused by outbreaks of communicable diseases. Several IHR provisions are relevant to the detection and control of TB during air travel, strengthening the role of WHO and of national public health authorities in this domain.

Following these important recent developments, WHO has prepared this third edition to address current public health risks that may arise from

the potential transmission of TB during air travel, and new approaches to international collaboration. This edition builds upon the 2006 edition and adds to it in providing: (i) greater clarity in the definition of infectious index cases; (ii) procedures for the follow-up of contacts of infectious cases; and (iii) a more detailed definition of the roles and responsibilities of the agencies involved. The recommendations recognize that the response needs to be proportional to the risk, so that public confidence is preserved and unnecessary restrictions are avoided.

The guidelines were developed with the collaboration of public health authorities and international experts in the prevention and control of TB, travel medicine and air travel. Implementing the recommendations will help to reduce the international spread of TB and decrease the risk of infection among individual travellers. Although the role of air travel-related transmission of TB is minimal compared with the overall transmission of TB worldwide, these guidelines may nevertheless be useful for national authorities, especially in countries with a low TB burden, and for the airline industry, to facilitate procedures involving multiple actors.



Mario Raviglione
Director
Stop TB Department
World Health Organization

Acknowledgements

This third edition of *Tuberculosis and air travel: guidelines for prevention and control* was prepared by WHO in collaboration with experts from leading national and international public health authorities, and with the International Civil Aviation Organization, the International Air Transport Association, international experts in the prevention and control of tuberculosis, international authorities in travel medicine, and representatives from the European Commission and the European Centre for Disease Prevention and Control.

The following experts participated in the guideline working group and provided input to the preparation and review of the guidelines. Their contributions are gratefully acknowledged.

- Dr Ibrahim Abubakar, Consultant Epidemiologist/Head of Tuberculosis Section, Respiratory Diseases Department, Centre for Infections, Health Protection Agency, London, United Kingdom
- Dr Francisco Averhoff, CAPT, US Public Health Service, Quarantine and Border Health Services Branch, Division of Global Migration and Quarantine, National Center for Preparedness, Detection and Control of Infectious Diseases, Centers for Disease Control and Prevention (CDC), Atlanta, United States of America
- Dr Ann Buff, Epidemic Intelligence Service Officer, Outbreak Investigation Team, Surveillance, Epidemiology and Outbreak Investigations Branch, Division of Tuberculosis Elimination, National Center for STD, HIV/AIDS, Viral Hepatitis and TB Prevention, Coordinating Center for Infectious Diseases, Centers for Disease Control and Prevention (CDC), Atlanta, United States of America
- Dr Jacques Chemardin, Unité alertes et réponses, Département des urgences sanitaires, Direction générale de la santé, Paris, France
- Dr Nigel Dowdall, Head of Health Services, British Airways, Waterside (HMAG), Harmondsworth, United Kingdom *and Member of IATA Medical Advisory Group*
- Dr Edward Ellis, Manager, Tuberculosis Prevention and Control, Public Health Agency of Canada, Ottawa, Canada

- Dr Anthony Evans, Chief, Aviation Medicine Section, International Civil Aviation Organization (ICAO), Montreal, Canada
- Dr Karoline Fernandez de la Hoz, Tuberculosis Coordinator, European Centre for Disease Prevention and Control (ECDC), Stockholm, Sweden
- Dr José Figueroa, Deputy Director of Public Health, Health Improvement Directorate, City and Hackney Teaching PCT, London, United Kingdom
- Dr Paolo Guglielmetti, Administrator, European Commission (EC), DG SANCO C3 – Health Threats Unit, Luxembourg
- Dr Peter Helbling, Federal Office of Public Health (FOPH), Bern, Switzerland
- Dr Vincent Houdry, Seconded National Expert, European Commission (EC), DG SANCO C3 – Health Threats Unit, Luxembourg
- Dr Jean-Paul Klein, Sektion III, Fachexperte (HIV/AIDS, TBC, Impfwesen), Bundesministerium für Gesundheit, Familie und Jugend, Vienna, Austria
- Dr Henry Kong, Chief Port Health Officer, Port Health Office, Department of Health, China, Hong Kong SAR
- Dr Katrin Leitmeyer, Seconded National Expert, Preparedness and Response Unit, European Centre for Disease Prevention and Control (ECDC), Stockholm, Sweden
- Dr Philip LoBue, Associate Director for Science, Division of Tuberculosis Elimination, National Center for STD, HIV/AIDS, Viral Hepatitis and TB Prevention, Coordinating Center for Infectious Diseases, Centers for Disease Control and Prevention (CDC), Atlanta, United States of America
- Dr Karen Marienau, Quarantine and Border Health Services Branch, Division of Global Migration and Quarantine, National Center for Preparedness, Detection and Control of Infectious Diseases, Centers for Disease Control and Prevention (CDC), Atlanta, United States of America
- Dr Marie-Claire Paty, Bureau risque infectieux et politique vaccinale, Sous-direction prévention des risques infectieux, Direction générale de la santé, Ministère de la santé, de la jeunesse et des sports, Paris, France
- Mr Derek Scholten, Senior Epidemiologist, Tuberculosis Prevention and Control, Public Health Agency of Canada, Ottawa, Canada
- Prof. Robert Steffen, Director, WHO Collaborating Centre for Travellers' Health, University of Zurich Institute of Social and Preventive Medicine, Zurich, Switzerland
- Dr Claude Thibeault, Medical Advisor, International Air Transport Association (IATA), Montreal, Canada *and Chairman, IATA Medical Advisory Group*

- Dr Stéphane Veyrat, Responsable unité alertes et réponses, Département des urgences sanitaires, Direction générale de la santé, Ministère de la santé, de la jeunesse et des sports, Paris, France
- Dr Jane Zuckerman, Director, WHO Collaborating Centre for Travel Medicine, Royal Free and University College Medical School, London, United Kingdom

WHO secretariat

Dr Léopold Blanc, Dr Pierpaolo de Colombani, Dr Max Hardiman, Dr Ernesto Jaramillo, Ms Riikka Koskenmaki, Dr Ota Masaka, Dr Daniel Menucci, Dr Paul Nunn, Dr Salah Ottmani, Mr Bruce Plotkin, Dr Mario Raviglione, Dr Kathrin Thomas, Dr Pieter Van Maaren, Dr Risards Zaleskis.

Managing editor

Dr Lindsay Martinez

Methodology

1. Selection of the guideline working group participants

A small steering group of WHO staff defined the scope of the need for revision of the 2006 guidelines and selected the participants in the guideline working group. The participants were selected to include, with as broad a geographical representation as feasible: (a) national public health authorities, including those with experience in the investigation and follow-up of incidents involving TB in travellers; (b) WHO experts in the prevention and control of TB; (c) representatives from the International Civil Aviation Organization (ICAO) on regulatory aspects of air travel and from the International Air Transport Association (IATA) on current conditions, procedures and practices followed by airline companies; (d) international experts in travel medicine; (e) representatives of the EC and the ECDC; and (f) staff from the WHO International Health Regulations Coordination Programme. The working group provided input in the preparation and review of the text and development of the recommendations. The participants in the working group and their affiliations are listed in the *Acknowledgements* section of this document.

2. Guideline review process

Several members of the working group had identified issues that needed clarification or updating during the initial definition of the scope of the revision. On the basis of these issues, a draft text was produced and circulated to the working group for consideration and comment. All comments received were circulated to the group. The draft text was amended to incorporate all agreed corrections and additions. Issues identified during the review process requiring additional information and/or discussion were placed on the agenda of a technical consultation, held on 5–6 February 2008. During this consultation, consensus was reached on all the outstanding issues related to the recommendations, and the conclusions of the discussions were incorporated into a revised draft text of the guidelines, which was circulated to the working group for final confirmation of accuracy. All comments received during the review process were kept on record.

3. Conflict of interest

All participants in the guideline working group completed a Declaration of Interests. The following interests were declared by participants:

- Dr Nigel Dowdall declared an interest as Head of Health Services, British Airways, and Member of the IATA Medical Advisory Group.
- Dr Robert Steffen declared that he provides medical advice on request on an ad hoc basis to Swiss International Airlines, without remuneration.
- Dr Claude Thibeault declared an interest as a Private Consultant acting as Medical Adviser to IATA on a fee-for-service basis.

4. Identification of evidence

Evidence obtained for the first and second editions of these guidelines included reviews of published literature on TB related to air travel, on transmission of other infectious diseases during air travel, and on the quality of aircraft cabin air. This evidence was used and updated for the third edition through the following procedures: (1) a review of published literature carried out to identify cases of TB in air travellers, following the search strategy detailed in *Appendix 1*; (2) a request for data on TB in air travellers from national public health authorities represented in the guideline working group, and from ICAO and IATA; (3) expert opinion provided by the guideline working group participants. There was no formal assessment of the quality of the evidence.

5. Development of recommendations

During the initial process to define the scope of the revision, the recommendations included in the 2006 edition of these guidelines were modified as necessary and gaps were identified. New recommendations were developed and added. The final recommendations contained in this document were each discussed and all were agreed by consensus at the technical consultation held at WHO, Geneva, on 5–6 February 2008. There was no formal grading of the recommendations.

6. Proposed review date for the guidelines

The recommendations of this third edition are expected to remain valid for a period of five years. It is expected that the document will be considered for possible revision in 2012. In the intervening period, any updated information and guidance will be provided as necessary on the WHO web site: www.who.int/tb.

Summary

International travel has become increasingly easy and readily available. Ever greater numbers of people are using international air travel for many reasons including business, tourism, immigration, asylum seeking and humanitarian activities. Exposure to serious communicable diseases during air travel is of concern for passengers, crew and public health officials, since there is a potential risk of transmission of tuberculosis (TB) infection and some other airborne or droplet-spread diseases on board commercial aircraft, particularly during long flights.

Reported episodes of potential transmission of TB infection on board aircraft, the outbreak of severe acute respiratory syndrome (SARS) in 2003, and the increasing incidence of MDR-TB and emergence of XDR-TB have raised considerable anxiety among travellers, health authorities, airline companies and the media. There is evidence that transmission of mycobacteria of the *M. tuberculosis* complex may occur during long flights from an infectious source (a passenger or crew member with infectious pulmonary or laryngeal TB) to other passengers or crew. However, as yet no case of clinical or bacteriologically-confirmed TB disease associated with exposure during air travel has been identified.

M. tuberculosis infection is acquired through inhalation of the bacteria in aerosolized respiratory secretions from a contagious person coughing, sneezing, talking or singing. The risk of infection is related to the infectiousness of the person with TB, the susceptibility of those exposed, the duration of exposure, the proximity to the source case, and the efficiency of cabin ventilation. Susceptibility to infection and disease is increased in immunocompromised persons (e.g. HIV-infected persons) and infants and young children (i.e. less than 5 years of age). There is currently little evidence to suggest that any particular strain of *M. tuberculosis* would be transmitted more readily than others. However, the consequences of infection with drug-resistant strains are potentially more complex in terms of treatment, outcomes and cost.

The air quality on board modern commercial aircraft is high, and under normal conditions cabin air is cleaner than the air in most buildings. Avail-

able evidence suggests that the risk of transmission of infection on short flights is minimal. Longer flights, and especially prolonged journeys (i.e. 8 hours or longer), involve increased exposure and therefore an increased risk of transmission of *M. tuberculosis* complex. This risk is likely to be similar to, or less than, that in other circumstances where people are together in confined spaces.

The revised guidelines address the concerns about transmission of TB, including MDR-TB and XDR-TB, during air travel and provide the following: (i) information on the transmission of TB on board commercial aircraft; (ii) suggestions on practical ways to reduce the risk of exposure to TB on board commercial aircraft; (iii) a summary of the practices adopted for the management of travellers with infectious TB associated with air travel and of commonly encountered difficulties; (iv) guidance on procedures and responsibilities when infectious TB is diagnosed in a patient who has a history of recent air travel, including contact identification, information exchange, and screening for possible interventions; and (v) information on the specific roles and responsibilities of WHO and partner organizations for incidents involving the International Health Regulations (IHR). The provisions relevant to TB in the revised IHR, which were adopted by the World Health Assembly in May 2005 and entered into force in June 2007, are outlined in *Annex 1*. A number of key provisions in the IHR are relevant to requirements for reporting to WHO on important public health events, detection and response, and other aspects of TB-related incidents.

The guidelines include specific recommendations for passengers, air crew, physicians, public health authorities and airline companies. The potential role of WHO in the context of TB associated with air travel is outlined.

Glossary and abbreviations

acid-fast bacilli (AFB) Rod-shaped bacteria that do not lose their stain when exposed to acid or acid–alcohol mixture after the staining process, i.e. bacteria of the *Mycobacterium tuberculosis* complex and all non-tuberculous mycobacteria.

air crew Personnel of an airline who are employed for duties on board the aircraft, including:

- cabin crew personnel working in the cabin;
- flight crew personnel working on the flight deck.

airborne infection/transmission The dissemination of microbial aerosols to a suitable portal of entry, usually the respiratory tract. The route of transmission of TB is airborne through droplets containing TB bacilli produced by TB patients when coughing, sneezing, singing or talking. These droplets evaporate and become droplet nuclei which may remain suspended in the air for several hours and may be inhaled by others.

APU Auxiliary power unit.

Bacille Calmette–Guérin (BCG) A live vaccine against TB derived from an attenuated strain of *Mycobacterium bovis*.

close contact A person who has been in close proximity in an enclosed environment for a prolonged period (i.e. 8 hours or longer) with a person with infectious or potentially infectious TB and who is therefore considered to be at risk of infection with *M. tuberculosis*. On an aircraft, a close contact is considered to be a passenger who was seated in the same row or in the two rows in front of or behind the index case, i.e. a total of 5 rows.

contact investigation The process of identification, assessment and follow-up of close contacts of index cases.

EC European Commission.

ECDC European Centre for Disease Prevention and Control.

extensively drug-resistant TB (XDR-TB) Tuberculosis caused by strains of *M. tuberculosis* that are resistant to isoniazid ***and*** rifampicin ***and*** to

any of the fluoroquinolones ***and*** to at least one of the following injectable second-line anti-TB drugs: amikacin, kanamycin, capreomycin.

flight time The total time from the moment an aircraft first moves for the purpose of taking off until the moment it finally comes to rest at the end of the flight.

- Total flight duration: the period including ground delays after boarding, flight time, and ground delays after landing.

haemoptysis Coughing blood or sputum containing blood.

HEPA filter High-efficiency particulate air filter.

IATA International Air Transport Association.

ICAO International Civil Aviation Organization.

IHR International Health Regulations (2005).

immigrant A person from one country who has travelled to another country with the intention of settling there.

index case (index patient) The first patient in a family or other defined group to come to the attention of the investigator.

interferon-gamma release assay (IGRA) In vitro blood tests for cell-mediated immunity to TB that measure interferon-gamma (IFN-γ) released from peripheral blood T-cells stimulated with synthetic peptides simulating proteins present in *M. tuberculosis*.

IGO Intergovernmental organization.

multidrug-resistant TB (MDR-TB) Tuberculosis caused by strains of mycobacteria of the *M. tuberculosis* complex that are resistant to at least isoniazid ***and*** rifampicin.

Mycobacterium tuberculosis The namesake bacterium of the *M. tuberculosis* complex and the most common causative agent of TB in humans. The *M. tuberculosis* complex also includes *M. bovis* and five other related species.

outbreak The occurrence in a community or region within a defined period of time of cases of an illness clearly in excess of normal expectancy.

PHEIC Public health emergency of international concern, as defined by the WHO Director-General in accordance with the IHR.

preventive therapy For individuals with latent *M. tuberculosis* infection: the treatment of subclinical latent infection with *M. tuberculosis* to prevent progression to active TB disease, usually based on 6–9 months of oral isoniazid.

SARS Severe Acute Respiratory Syndrome.

sputum-smear examination A laboratory technique in which sputum is smeared on glass slides, stained (e.g. carbol-fuchsin or auramine – Ziehl-Neelsen method), and washed with an acid. Slides are subsequently examined by microscopy for the presence of stained acid-fast bacilli (AFB).

traveller[1] A person (passenger or crew member) undertaking an international commercial airline flight.

tuberculin Purified protein derivative (PPD) – a mixture of antigens from a culture filtrate extract of *M. tuberculosis* that is used for skin testing; many of the antigens are not species-specific.

tuberculin skin test (TST) Cutaneous (intradermal) injection of purified protein derivative (PPD) to identify people who have been sensitized to mycobacterial antigens by infection with mycobacteria of the *M. tuberculosis* complex, non-tuberculous mycobacteria, or vaccination with BCG.

tuberculosis (TB) The disease caused by bacteria belonging to the *M. tuberculosis* complex (*M. tuberculosis*, *M. bovis*, *M. africanum*, *M. microti*, *M. canettii*, *M. caprae*, *M. pinnipedii*), manifested by clinical, radiological or laboratory evidence with or without positive TST.

- Active TB: tuberculosis disease associated with symptoms or signs, including findings on physical examination.
- Infectious TB: active tuberculosis of the respiratory tract (pulmonary or laryngeal TB) that is transmissible to others, i.e. contagious, determined by positive sputum smear and culture.
- Laryngeal TB: tuberculosis affecting the larynx.
- Latent TB infection: infection with mycobacteria of the *M. tuberculosis* complex, diagnosed by a positive TST and/or IGRA, without clinical evidence of disease.
- Potentially infectious TB: tuberculosis of the respiratory tract which is sputum smear-negative and culture-positive.
- Pulmonary TB: tuberculosis involving the lung parenchyma.

universal precautions Defined measures intended to prevent or reduce the risk of infectious exposure to blood and other body fluids.

ventilation The process of supplying and removing air.

[1] "Traveller" is defined in the IHR as "a person undertaking an international voyage".

1. Background information

The increasing availability and duration of air travel, and the rising numbers of travellers, increase the possibility of exposure to people with infectious TB.

Tuberculosis occurs worldwide and remains a leading cause of death. In 2005, 5 million new and relapse TB cases were reported to WHO, of which 2.3 million were sputum smear-positive pulmonary cases. However, it is estimated that nearly 9 million cases may have occurred worldwide, more than 95% in developing countries (*1*). International air travel has become widely accessible and the International Civil Aviation Organization (ICAO) has forecast that there will be more than 2.5 billion air passengers per year by 2015 (*2*). The ease, availability and duration of air travel, with large numbers of people travelling internationally, increase the possibility of exposure to people with infectious TB. The increasing public health importance of MDR-TB in many countries (*3*) and the emergence of XDR-TB call for increased vigilance to minimize the potential risk of international spread of particularly dangerous TB strains.

Several industrialized countries require medical examinations including TB screening for immigrants, refugees and asylum seekers. Some countries also require medical examination for entering students, people on temporary work visas and visitors intending to stay for periods longer than three months. The timing and specific requirements of the medical examination vary from country to country. Several countries require TB screening to be done in the country of origin, while some others require medical examination both in the country of origin and on arrival in the destination country. Since these medical clearances may be valid for some time, a person could develop infectious TB during the period elapsing between the medical examination and the time of travel. Some countries screen immigrants from countries with a high TB incidence and/or asylum seekers on arrival in the country. Thus, people with infectious TB would often be identified as having infectious TB only after they have travelled.

While screening for TB is often mandatory for immigrants and refugees, it is not required by countries for the overwhelming majority of passengers flying on commercial aircraft.

2. Tuberculosis on aircraft

Available evidence indicates that the risk of transmission of *M. tuberculosis* on board aircraft is low and limited to persons in close contact with an infectious case for 8 hours or longer.

Research has shown that the risk of any communicable disease being transmitted on board aircraft is low (*4*). However, transmission probably occurs more frequently than reported because most diseases have an incubation period longer than the duration of air travel. Airborne and droplet-borne diseases that are potentially transmissible on board aircraft include TB, influenza, meningococcal disease, measles and SARS (*5*).

TB is an infectious disease, caused by mycobacteria of the *M. tuberculosis* complex and transmitted by exposure to tubercle bacilli in airborne droplet nuclei produced by a person with infectious TB during coughing, sneezing, singing or talking. When TB develops in the human body, it does so in two stages: firstly, the individual exposed to *M. tuberculosis* becomes infected and secondly, the infected individual develops the disease (active TB). However, only a small minority (<10%) of infected individuals will subsequently develop active disease and most of them will do so within five years. While the risk of progression to active TB disease is greatest within the first two years after infection, latent infection may persist for life.

No cases of TB disease have so far been reported among those known to have been infected with *M. tuberculosis* during air travel. From 1992 to 1994, the United States Centers for Disease Control and Prevention (CDC), together with state and local health departments, conducted contact investigations for seven index cases, involving one cabin-crew member and six passengers with infectious TB disease who had flown during this period. The concern was that the closed aircraft cabin environment may have facilitated transmission of *M. tuberculosis* (*6–11*). The total number of potentially exposed passengers and cabin crew exceeded 2600 on 191 flights involving nine different types of aircraft.

All index cases were identified as highly infectious, i.e. smears from spontaneous sputum specimens from all index cases were grossly positive for acid-fast bacilli (AFB) and all were culture-positive and had evidence of extensive pulmonary disease on chest radiography. In addition, one patient had biopsy- and culture-confirmed laryngeal TB, the most infectious form of TB.

Strains of *M. tuberculosis* resistant to isoniazid and rifampicin, i.e. multidrug-resistant TB (MDR-TB), were isolated in two of these episodes (*6*, *10*). Organisms isolated from the other index cases were sensitive to all anti-TB drugs. Two passengers, who were flying to the United States for medical care, knew that they had active TB disease at the time of their flights but did not inform the airline of their status. In the other five instances, TB was diagnosed after the flights.

Investigation of close contacts found evidence of transmission of *M. tuberculosis* infection during a flight in only two of the seven episodes. In one event, transmission from a cabin flight attendant was detected in 2 of 212 crew members who had worked in close proximity with the index case during a 6-month period; both of those infected were exposed to the infectious source for at least 12 hours. In the other event, there was probable transmission from an infectious case to 4 passengers (seated in close proximity to the index case in the same cabin section), out of a total of 257 passengers tested on a flight longer than 8 hours (*6*, *10*). These results suggest that the risk of infection with *M. tuberculosis* during air travel is similar to that associated with exposure during other activities in which prolonged contact with potentially infectious individuals may occur (e.g. train or bus travel, any gathering in enclosed spaces).

The average lifetime risk of untreated latent TB infection progressing to active disease at some time during life is <10% and not all persons infected as a result of exposure during air travel may receive effective preventive antibiotic treatment. Therefore, although no cases of TB disease have yet been reported among the infected contacts in the seven studies carried out by CDC, the possibility that future cases of TB disease due to TB infection acquired during air travel may occur cannot be excluded.

Subsequent published case reports of other instances of infectious TB in passengers on long-haul flights (*12–16*), reviewed in 2005 (*17*) and with a further case presently under investigation (*18*), have also suggested that the risk of transmission of infection on board appears to be low. According to an international airline analysis of in-flight TB on long-haul flights, 34 cases of infectious TB were notified to the airlines during a five-year period

(2000–2004), giving an overall notification rate of 0.05 per 100 000 long-haul passengers (*19*).

There is currently little evidence concerning the transmissibility of drug-resistant strains of TB during air travel. However, in other settings, drug-resistant TB has not been found to be more transmissible than drug-sensitive strains, although the patients may remain infectious for longer (*20–22*). While the risk of acquiring infection may not differ, the consequences are significant in terms of complexity of treatment, outcomes and cost.

***Further information is needed on the outcome of contact investigations*.**

The available evidence on the risk of transmission of TB during air travel and outcome data from passenger-contact investigations are limited. In order to strengthen the evidence base for operational decision-making and policy development, a coordinated international approach to research, data collection, analysis and dissemination is needed.

3. Aircraft ventilation

In case of ground delays of more than 30 minutes with passengers on board, provision should be made to ensure adequate cabin ventilation.

While an aircraft is parked at the gate with the engines off, passenger cabin ventilation is normally supplied by one of the following means:

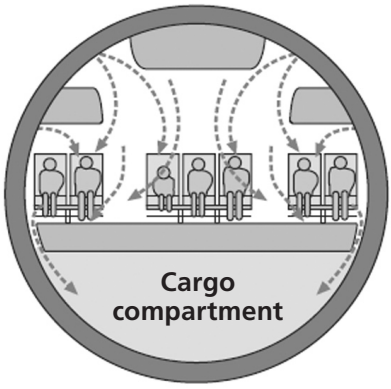
(i) an air-conditioning unit (preconditioned air source) connected to the aircraft ventilation system;
(ii) a ground pneumatic source providing the air required to operate the aircraft environmental control system;
(iii) the auxiliary power unit (APU) of the aircraft running the aircraft ventilation system;
(iv) natural airflow through the aircraft's open door(s), usually for short periods and only when no other source of ventilation is available.

Once the aircraft has left the gate and the engines have been started, the APU is usually shut down and, in most current aircraft, the air supply to the cabin is then drawn from compressor stages of the engines (i.e. bleed air). Aircraft manufacturers are exploring other options for aircraft ventilation, e.g. in some future models, air will be drawn in through a specific electric compressor and not through the aircraft engines. The bleed air supply in current aircraft is at high pressure and temperature (ranging from 150 °C to 280 °C, depending on the stage of flight) and the environmental system cools and conditions the air to comfortable levels before introducing it into the passenger cabin.

Air is distributed evenly throughout the passenger cabin via ducts running the entire length of the aircraft. Air enters the cabin from overhead distribution outlets and flows downwards in a circular pattern towards the outflow grills along both side walls of the cabin near the floor (*Fig. 1*). Air enters and leaves the cabin at approximately the same seat row, and airflow in forwards and backwards directions is minimal. Movement of passengers and crew in the cabin has little impact on the intended airflow patterns.

When the aircraft is delayed on the ground and the doors are closed, the ventilation system should be in operation. An influenza outbreak on an aircraft was greatly facilitated by a ground delay lasting three hours, during which the ventilation system did not operate and the passengers did not receive outside air (*23*). Thus, ground delays without adequate ventilation must be kept as short as possible and in the case of delays over 30 minutes, the ventilation system should be in operation. According to a study by the United States Department of Transportation: "If the ventilation system is not operating, passengers should not stay aboard the plane for long time periods (i.e. greater than 30 minutes)" (*24*).

Fig. 1 Cabin airflow patterns



4. Cabin air quality

There is no evidence that recirculation of cabin air facilitates the transmission of infectious disease agents on board.

All large commercial jet aircraft built after the late 1980s, and a few adapted older aircraft, have a system to recirculate the cabin air. Between 10% and 50% of the cabin air is filtered, mixed with outside conditioned bleed air from the engine compressors and then reintroduced into the passenger cabin. Depending on the type of aircraft, air may be recirculated throughout the entire cabin or only within limited zones. All large commercial jet aircraft provide approximately 20 air exchanges per hour during cruising, with lower amounts during descent and while on the ground.

Airline crew, passengers and the media have expressed concern about the possible health risks to passengers and crew relating to air recirculation and air contaminants on aircraft. When recirculated, the cabin air passes through a set of filters before being mixed with outside conditioned air and re-entering the passenger cabin. At the cruising altitude, outside ambient air is virtually free of microorganisms. Generally, the first filter (or prefilter) of recirculated air traps the largest particles. Then, on most modern aircraft, the air passes through high-efficiency particulate air (HEPA) filters before re-entering the passenger cabin. The most efficient HEPA filters will capture 99.97% of particles between 0.1 and 0.3 µm and 100% of the other particles. The tubercle bacillus is approximately 0.2–0.5 µm wide and 2–5 µm in length. Properly-functioning and maintained HEPA filters therefore remove any *M. tuberculosis* organisms as well as other bacteria, fungi and viruses from the recirculated air, thereby eliminating the risk of exposure for passengers and crew from this source.

Few studies have examined microbial contaminants in aircraft cabin air. No evidence has been found that microbial contamination of cabin air entails a greater risk of disease transmission aboard a commercial aircraft than in any other public setting (*24–26*). Low concentrations of bacteria and fungi have been found at levels that are not thought to pose any

health risk (usually lower than those found in other public places or in private houses). This has been attributed to the sterility of the air entering the aircraft at cruising altitude, to the high ventilation rates and the laminar (non-turbulent) airflow pattern in the passenger cabin, and to the high-efficiency filters used for recirculated air.

Passengers on the aircraft are the most important source of any microbial aerosols in the cabin air. Droplet nuclei containing *M. tuberculosis* bacteria are aerosolized in the cabin air when a person with infectious TB coughs or speaks. Droplet nuclei will then follow the airflow in the passenger cabin. If there is no airflow, microorganisms may remain suspended in the air for an indefinite period. In most modern aircraft, however, when the ventilation system is operating, air is recirculated and filtered at a high rate, and any airborne particles would be rapidly removed. It has been shown that all measurements return to normal levels within three minutes of a sudden increase in bacterial concentration (e.g. after a cough or a sneeze) (*24*).

Investigations of possible transmission of *M. tuberculosis* on aircraft (*6–11*) found no evidence that it was facilitated by recirculation of the cabin air. In the only report of probable passenger-to-passenger transmission, *M. tuberculosis* infection was identified in only 4 of 257 passengers, all of whom were seated in the same cabin section of the aircraft as the index case. Since the aircraft used on this flight recirculated up to 50% of the air in the passenger cabin, this investigation supports the potential for transmission through close contact rather than by air recirculation. In reported investigations of measles transmission on aircraft, only passengers seated within a few rows of the ill passenger were infected (*27, 28*). However, a report on SARS transmission on aircraft (*29*) showed that cases occurred among passengers seated further apart and on flights lasting considerably less than 8 hours, but the possibility that passengers who developed SARS were infected before or after the flight could not be excluded.

5. Reducing the risk of exposure to *M. tuberculosis* on aircraft

5.1 Definition of infectious TB for air travel purposes

National public health authorities should inform international partners if either of the following definitions for infectious TB or potentially infectious TB is fulfilled. For action at national level, national public health authorities may modify these definitions based on more specific criteria in accordance with their national guidelines.

- **Infectious TB**. All cases of respiratory (pulmonary or laryngeal) TB which are sputum smear-positive and culture-positive (if culture is available).
- **Potentially infectious TB**. All cases of respiratory (pulmonary or laryngeal) TB which are sputum smear-negative and culture-positive (susceptible, MDR-TB or XDR-TB).
- **Non-infectious TB**. All cases of respiratory TB which have two consecutive negative sputum-smear and negative culture (if culture is available) results.

Patients with MDR-TB or XDR-TB are considered non-infectious if there is evidence of a clinical response to treatment and two consecutive negative sputum-culture results* have been obtained.

* After at least 6 weeks of incubation.

Action recommended for each category

1. For cases of infectious TB: it is recommended to start contact-investigation procedures, taking into consideration national contact-investigation policies.
2. For cases of potentially infectious TB: additional information should be requested to conduct a risk assessment and determine whether a contact investigation should be considered.
3. For non-infectious TB cases: no further action is required.

5.2 Precautions before travel

People with infectious or potentially infectious TB should not travel by commercial air transportation on a flight of any duration.

People known to have infectious or potentially infectious TB should be advised not to travel on commercial aircraft until there is no longer a risk of transmitting infection to others, i.e. until they become non-infectious. If, under exceptional circumstances, travel on a short flight is essential while a person is still infectious, commercial carriers or other public transportation should not be used. Alternative private transportation (e.g. ground ambulance transportation, air ambulance, private carrier) should be considered. If the use of commercial carriers is unavoidable (e.g. transfer to a tertiary care facility), a specific travel protocol should be agreed upon in advance between the public health authorities and airline(s) involved in the countries of departure, arrival and any transit points, and strictly applied.

Symptoms of pulmonary TB are not specific (e.g. cough) and people with TB are often infectious long before the disease is diagnosed. Therefore, the majority of aircraft passengers with undiagnosed infectious TB are unlikely to be identified as infectious before boarding. Since it is difficult to determine whether a person may be medically unfit to travel, passengers with infectious TB are more likely to be identified after, rather than at the time of, a flight.

It is not justified to deny boarding systematically to all TB patients who are undergoing treatment. Most patients with drug-sensitive TB become non-infectious after two weeks of adequate treatment (*20*, *21*). The responsible public health authority/physician involved should carry out a risk assessment including duration of treatment, clinical response, potential infectivity, potential drug resistance, and duration of the proposed flight. Patients infected with MDR-TB or XDR-TB will require a longer period of adequate treatment and detailed follow-up, with satisfactory clinical response to treatment, and sputum-culture conversion to negative before being confirmed as non-infectious and allowed to travel.

Physicians should inform all patients with infectious or potentially infectious TB that they pose a risk of infection for others, particularly those with whom they are in close contact for prolonged periods of time. Physicians should advise patients that they must not travel by any public air transportation, or by other public transportation, as long as they are considered infectious or potentially infectious according to the above criteria.

Patients being investigated for potentially infectious TB should follow

the physician's advice on whether to travel. Physicians should advise these patients not to plan to travel until the diagnosis and infectious status have been confirmed.

The physician and/or public health authority must give clear advice or instruction on whether travel may or may not be undertaken. Patients intending to travel against this advice should be reported to the appropriate public health authority for any necessary action to be taken, potentially together with the airline, in accordance with national legislation.

5.3 Precautions during travel

If during a flight a passenger is suspected of having infectious TB, because he or she informs the cabin crew or experiences severe symptoms such as haemoptysis, the cabin crew should try to relocate the passenger in an area without close contact with other passengers if space is available. One cabin-crew member should be designated to look after the ill passenger, preferably the crew member who has already been dealing with him/her. The ill passenger should be given a surgical face mask to prevent the dissemination of infectious droplets.[1] If no mask is available or if the mask cannot be tolerated, the passenger should be given an adequate supply of paper tissues (or towels if necessary) and instructed to cover the nose and mouth at least when speaking, coughing or sneezing, and to dispose of the tissues appropriately.

Cabin crew should follow standard universal precautions when handling potentially infectious material (e.g. wear gloves, place disposables in a biohazard bag (if available) or in a sealed plastic bag, etc.) (*30*). The cabin-crew member designated to look after the possible index case may wear a surgical mask to protect against inhalation of infectious droplets, especially if the ill person cannot tolerate a mask. Cabin crew should receive routine training on the use of surgical masks. The IATA guidelines for suspected communicable disease in-flight, which have been approved by WHO, should always be followed by all airlines (*31*).

ICAO standards require the pilot in command to inform the air-traffic control provider that the aircraft may be carrying such a case; the IHR have similar requirements (see *Annex 1*). When advised, the air-traffic controller will transmit a message to the destination airport control tower, for

[1] Surgical masks retain and prevent the passage of infectious droplets but do not prevent the passage of aerosol suspensions of bacteria. They are therefore most effective when worn by the person who is the infectious source.

onward transmission to the local public health authority. Timely communication provides an opportunity for the authority to prepare for arrival of the aircraft. It is important for States to develop a local procedure for reliably informing the health authority when notified of the imminent arrival of the aircraft concerned. (Other provisions of the IHR may also apply.)

6. Contact investigation following potential exposure to *M. tuberculosis*

6.1 Criteria for deciding whether to initiate a contact investigation

The treating physician should undertake a clinical evaluation in all cases of severe communicable disease of public health concern, including a detailed history of recent travel (i.e. within three months) including travel by air, destination(s) and duration of travel.

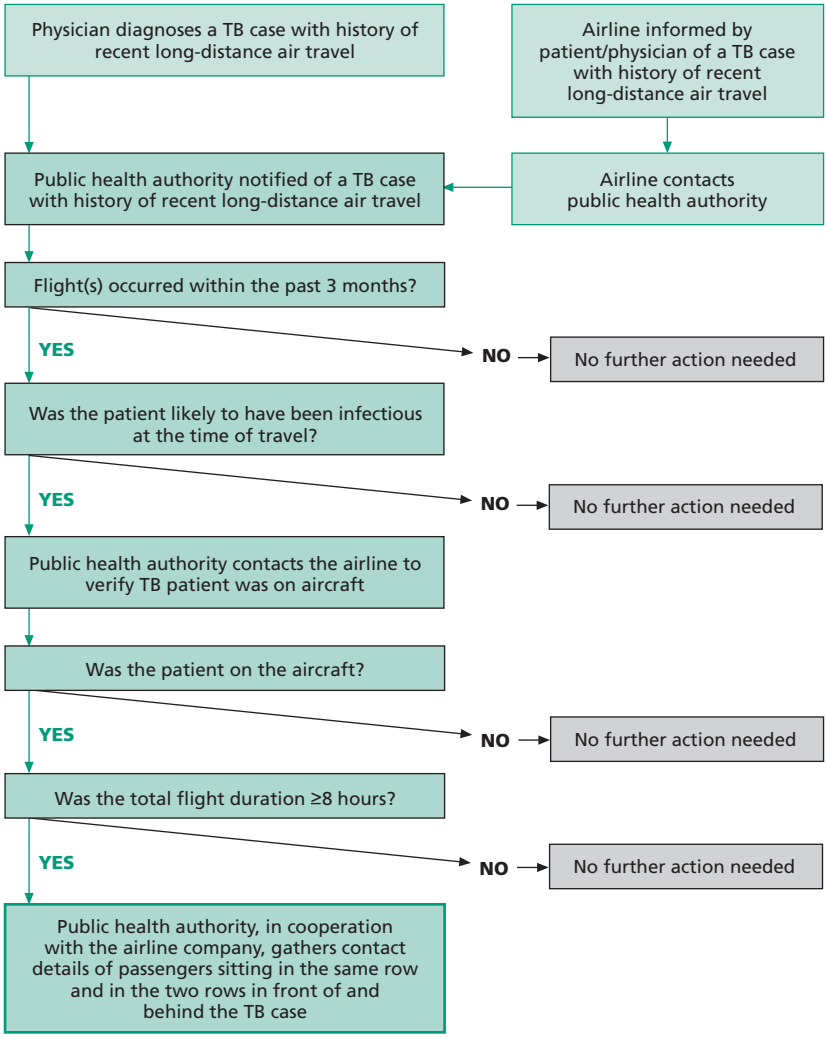
Physicians should immediately inform the public health authority after assessing a recent (i.e. within three months) history of air travel in a patient with confirmed pulmonary or laryngeal TB, in addition to submitting the required notification for a TB case.

Following receipt of the physician's report, the public health authority should conduct a risk assessment to determine whether a contact investigation is needed. The public health authority should evaluate the risk of *M. tuberculosis* transmission and decide whether it is necessary to inform travellers who may have been in close contact with the index case of the potential exposure. For this purpose, the following risk assessment criteria should be used:

- infectiousness of the person with TB at the time of travel:
  - sputum-smear examination;
  - presence of cavitations on chest X-ray;
  - documented transmission to close contacts;
  - presence of symptoms (e.g. cough, haemoptysis) at the time of the flight;
- duration of exposure;
- context:
  - identification of susceptible individuals as potential contacts;
  - proximity of other travellers to the index patient;
  - consequences of transmission (MDR-TB and XDR-TB);
- time elapsed between the flight(s) and the notification of the case.

Fig. 2 summarizes the steps to be followed by public health authorities in determining whether travellers should be informed of their possible exposure to infectious TB on commercial flights.

Fig. 2 Assessing whether contact-tracing is needed



In both infectious and potentially infectious cases as defined in section 5.1, the national public health authority in the country where the case was reported should inform counterpart authorities of the other countries involved (at least the countries where the flight departed and landed) if the flight duration was 8 hours or longer. This should be done whether or not any further action is required by national regulations in the country where the case was reported.

6.1.1 Infectiousness of the index case

Determination of infectiousness. Tracing travellers and informing them of potential exposure to *M. tuberculosis* is recommended only if the person with TB is likely to have been infectious or potentially infectious at the time of the flight(s). The infectiousness of the index case is to be assessed by the relevant public health authority. A person should be considered infectious at the time of the flight(s) when he or she meets the conditions identified in chapter 5. Priority should be given to conducting contact investigations for index cases that meet the criteria for being infectious. Consideration may also be given to conducting contact investigations for index cases that meet the criteria for being potentially infectious based on: (1) national contact investigation policies; and (2) assessment of the likelihood of transmission using the criteria listed in section 6.1.

6.1.2 Duration of exposure

Informing close contacts is indicated if the total flight duration was 8 hours or longer.

If a public health authority concludes that the index case was infectious or potentially infectious (as defined in section 5.1) at the time of travel, contact should be made promptly with the airline medical service (or designated official) in order to confirm that the person with TB was on the flight(s) in question and to determine the total duration of each flight.

The duration of exposure is estimated on the basis of the total duration of the flight, including ground delays after boarding, flight time and ground delays after landing. The public health authority should construct a complete history of the flight(s) including the approximate duration of all ground delays. Evidence for *M. tuberculosis* transmission has been found only when the duration of exposure was 8 hours or longer (*6*, *10*). Therefore, only those travellers in close contact with and exposed to the index case for at least 8 hours should be informed. If the TB patient travelled

on more than one airline, the public health authority should contact each airline on which the passenger travelled on a flight of 8 hours or longer total flight duration.

If the total flight duration (including all ground delays) was 8 hours or longer, the public health authority should send an official letter to the airline company requesting passenger contact information. A sample letter is provided in *Annex 2*.

6.1.3 Time elapsed between the flight(s) and the notification of the case

Contact investigation should usually be limited to flights that took place during the three months before notification of the TB case to the public health authority.

There may be substantial delays between diagnosis of TB, recognition that the person with infectious TB had travelled on commercial flight(s) and notification to the public health authority. The reliability of the contact information will be related to the time interval between the flight and the diagnosis of TB.

Given the difficulties of (i) assessing infectiousness at the time of the flight, (ii) interpreting TST results to determine recent versus remote infection, and (iii) obtaining sufficiently accurate passenger travel and seating details, three months is considered the maximum time after travel that would usually warrant public health intervention, including contacting the airlines and subsequent contact-tracing. Public health investigations of incidents reported more than three months after the time of travel require, in addition to the risk assessment, a prior assessment of the availability of contact information.

6.1.4 Proximity of other passengers and crew to the index case

Passenger-to-passenger transmission of *M. tuberculosis* has been documented only among close contacts seated in the same section as the index case.

Informing those passengers seated in the same row as the index case and those seated in the two rows (from one side of the aircraft to the other because of ventilation patterns) in front of and behind is usually sufficient. Informing passengers seated in rows which are separated by a solid bulkhead from the row where the index case was seated is not indicated.

To date, there have been no known cases of cabin crew having been

infected by a passenger with infectious TB during an airline flight. Furthermore, due to the usual nature and limited duration of contact between cabin crew and individual passengers, crew members would not normally be considered close contacts of an index case. However, in special circumstances, such as a cabin-crew member designated to look after an ill passenger who is subsequently found to have infectious or potentially infectious TB, public health authorities may consider the cabin-crew member(s) to be close contacts.

If the infectious source is one of the cabin crew, passengers are not considered to be close contacts, due to the usual nature and limited duration of contact between cabin crew and passengers. Passengers are also not considered to be close contacts if the index case is a member of the flight-deck personnel (e.g. pilot, co-pilot, flight engineer, training officer) because there is usually no contact between passengers and flight-deck personnel. However, in such cases the contact-tracing risk assessment should include all work colleagues who were potentially exposed, including in-flight, during layovers and in ground roles.

6.2 Recommended roles and responsibilities when exposure to infection is suspected

- The first public health authority to receive a report on an incident involving possible exposure to infectious or potentially infectious TB during air travel (usually, but not always, in the country where the index case was diagnosed), should inform counterpart public health authorities in all countries where the flight(s) departed and landed, in accordance with these guidelines.
- The public health authorities in the latter countries should then inform the public health authorities of the countries of residence of the identified contacts, in accordance with these guidelines.
- In the countries of residence of the contacts, the public health authorities should follow national policy for TB contact investigation.

Public health authorities and airline companies should collaborate to assess whether exposure may have occurred.

Public health authorities and the airline medical service (or designated official) should work together to determine whether an exposure to infectious or potentially infectious TB could have occurred (according to the case definitions in section 5.1) and, if so, which travellers should be informed.

Airlines should collaborate closely with public health authorities in providing as quickly as possible all available information requested for contact-tracing. All possible close contacts should receive appropriate information promptly from the public health authority. (Alternatively, other established local arrangements for informing contacts may be followed.)

The first public health authority to be informed of the index case is that of the country where the diagnosis was made.

The public health authority of the country where the diagnosis was made (usually the destination country) should carry out the risk assessment based on the specific conditions of the index case (see section 6.1) and, if required, initiate the investigation process.

The national (or local, if appropriate) public health authority of the country which initiates the process should inform the public health authorities of all countries involved (i.e. countries where the flight/flights have departed and landed), to agree on their respective roles and responsibilities, which include: (i) obtaining details of the index case; (ii) informing other involved countries; and (iii) the request to the airline(s) for the passenger manifest. Personally-identifiable health information may be subject to requirements that it be held confidential or used strictly for public health purposes in accordance with national or international law (including the IHR). In addition, in some circumstances, such cases may have to be reported to WHO under the IHR (see *Annex 1*).

Effective communication links between national public health authorities are necessary to ensure an efficient coordinated response. In complex situations, for instance involving several countries, international bodies such as WHO, EC, ECDC or others may be requested to facilitate the process if deemed necessary. The updated list of national IHR focal points, and their contact information, is available to all national public health authorities.

The public health authority of the country that obtained the passenger list(s) should inform the counterpart health authorities in all countries where close contacts are resident through the existing procedures of communication. The relevant information for these contacts should be provided (contact details, nature of the exposure and flight details, clinical information to determine infectiousness or potential infectiousness of the index case, and drug-resistance pattern if available).

Public health authorities are usually informed by a physician about

a traveller in whom TB has been diagnosed before the airline has been informed. In instances where the airline is informed first, the airline should obtain basic contact details of the informant (patient, physician or other) to be passed on to the appropriate public health authority and advise the informant that the treating physician should communicate all information immediately to the public health authority. Before any further action is considered in such cases, public health authorities should confirm whether the person has pulmonary or laryngeal TB and carry out an assessment of the risk of infection to other travellers on the flight(s) concerned.

6.3 Informing close contacts

Public health authorities are responsible for identifying and informing close contacts of their potential exposure to *M. tuberculosis*.

Airline companies should cooperate with the relevant public health authorities to promptly supply all available information needed to contact passengers who are likely to have been exposed, so that the public health authorities can provide the contacts with appropriate information and guidance. (See related IHR requirements, *Annex 1*.)

For cabin crew considered to be close contacts (see section 6.2.4), an airline medical department may, with the agreement of the public health authority and in accordance with relevant laws, take responsibility for contacting and informing crew member(s) deemed to be at risk. It should be clearly established, by the public health authority and the airline, who will notify the potentially exposed crew. If the airline company prefers to notify its crew through established procedures, the airline should ensure that the crew member(s) receives and understands the relevant information for appropriate risk assessment including date and duration of the flight, and clinical details of the case related to infectiousness (smear status, culture status, symptoms and resistance pattern).

In exceptional instances, if public health authorities decide to issue a press release or communicate publicly through other media for the purpose of contact-tracing, the counterpart authorities in all other involved countries should be informed at the time of, or prior to, the public release of the information. This may also be required by WHO in accordance with the IHR, if any required reporting has not already been ongoing.

6.4 Practical issues for contact investigation after potential exposure to *M. tuberculosis*

Adequate and timely contact investigation after potential exposure to *M. tuberculosis* may be impeded by practical constraints.

Constraints particularly involve the length of time between travel, diagnosis and reporting, and the accuracy and availability of airline records. Published studies have highlighted the practical difficulties and substantial resources involved in conducting contact investigations in such cases (*12*, *13*).

Investigations of possible *M. tuberculosis* transmission on board commercial aircraft are usually initiated several weeks to months after the flight. Passengers are therefore often difficult to locate. Airlines are not required to retain passenger records after the flight and, with the exception of passengers enrolled in "frequent flyer" programmes, airline companies do not maintain records of passengers' addresses, telephone numbers or emergency contact information. Although a telephone number is often requested by the airline at the time of booking, this is not a requirement and the accuracy of the information provided is not known. Passenger contact information maintained in airline records is inadequate for contact-tracing purposes in a high proportion of cases.

Immigration (landing) cards are completed by passengers and crew arriving in some countries and residence addresses are required. Depending on the country, one form may be completed for passengers from the same household rather than separate forms for each individual passenger. In addition, because forms are handwritten, it is often not possible to read the passenger's name and the address information is frequently incomplete, inaccurate or missing. Thus, the usefulness of these forms for follow-up purposes may be limited, and often contact identification cannot be accomplished. However, regardless of the limitations, immigration landing cards may be used as a source of information to support contact-tracing.

In some instances, country of citizenship and passport number are the only contact passenger information available from the airline. Some countries have established internal arrangements for obtaining contact information for passengers from their passport numbers. Any available information on affected passengers should therefore be sent to the appropriate public health authority for follow-up of contacts.

Efforts are under way nationally and internationally to improve the col-

lection of passenger contact information for use in contact investigations. As an interim measure, locator cards have been developed by IATA for consideration by public health authorities; these cards contain the name, seat number and emergency contact information of selected passengers on board in the event that someone on the same flight with a suspected communicable disease is subsequently diagnosed with infectious TB or another communicable disease of public health significance.

Ultimately, the timely notification of passengers and crew relies on efficient and accurate communication between national public health authorities, airline companies and other public agencies.

The list of national IHR focal points is available to States; the list of competent authorities for contact investigations should be available and updated at the national level.

6.5 Procedures for follow-up of contacts

National guidelines for TB contact investigation should be followed in countries where they are available. Contact investigations may not be part of national policy (e.g. in high-burden countries with limited resources) and the decision to initiate a contact investigation should be considered in the context of the national policies or guidelines.

For countries without guidelines for TB contact investigations, the steps outlined in *Annex 3* may be considered.

7. Legal and regulatory issues

7.1 International Health Regulations (2005)

The International Health Regulations 2005 (IHR) (*32*) are legally binding upon 194 States worldwide (including all WHO Member States) and have as their purpose and scope "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international travel and trade". The Regulations include several provisions[1] that may apply to the detection and control of TB on board aircraft, including confidentiality and requirements for the dissemination of personal information, and the notification or other reporting of such cases to WHO, as outlined in *Annex 1*.

Airline companies are obliged to comply with the applicable requirements in the IHR and the laws of the countries in which they operate. It is the responsibility of airlines to be familiar with the specific laws and regulations concerning communicable diseases applying to passengers and goods at points of entry for each destination country. Similarly, when transporting infectious agents or passengers with communicable diseases, airline companies need to comply with the laws on safety procedures and on the release of passenger information of each country to which they fly, as well as the IHR regarding such information and other issues.

To avoid delays in the communication process, whenever possible airline companies should endeavour to provide the requested information on passenger and crew in a timely manner and on an expedited basis, in accordance with applicable laws. Airlines may, in order to comply with national legislation, require the requesting public health authority to complete a form that allows release by the airline of confidential personal data on the grounds of overriding public interest.

[1] For reference purposes and to facilitate implementation, this document at times summarizes or paraphrases the official text of the IHR. The official text of the IHR, including the authentic texts in the six official languages of WHO (Arabic, Chinese, English, French, Russian and Spanish) may be found at www.who.int/ihr.

7.2 Selected activities of WHO under the IHR concerning TB-related events

- ***Notification/reporting to WHO***. If a country[1] notifies or otherwise reports to, or consults with, WHO on an event under the IHR, WHO will consult with the national public health authorities of that country regarding assessment of the event and the potential need for a public health response.
- ***Verification***. If WHO receives information from sources other than official notifications or consultations on an event that may constitute a PHEIC, WHO will seek verification from the country (including communications informing its national IHR focal point) in whose territory the event is allegedly occurring (articles 9.2; 10.1–2). Depending on the circumstances, the public health information to be provided by the country as part of notification or verification may possibly include contact information (Article 6.2).
- ***Collaboration***. If WHO receives information about an event that may constitute a PHEIC, WHO will offer to collaborate in assessing the potential for international spread or for interference with international traffic (risk assessment), and the adequacy of the control measures (Article 10.3).
- ***Technical guidance and assistance***. If the event involves a public health risk, WHO will, if requested by national authorities, collaborate by providing technical guidance and assistance and by assessing the effectiveness of control measures in place, including mobilization of international teams for on-site assistance as necessary (Article 13.3). On request, and to the extent possible, WHO will collaborate in the provision or facilitation of technical cooperation and logistic support (Article 44.2.b).
- ***Information exchange***. Subject to potential confidentiality requirements, WHO will send to all national authorities and relevant intergovernmental organizations public health information it has received under the IHR which is necessary to enable countries to respond to the public health risk. This dissemination is generally done through the secure WHO IHR Event Information web site for national IHR focal points. Confidentiality does not prevent this dissemination to all other national IHR focal points if serious disease is already spreading across international border(s), or as otherwise permitted in Article 11.2.

[1] This section refers to "countries"; under the IHR (2005) these are referred to as "States Parties".

- Contact investigation. WHO will provide guidance on contact investigation upon request. If the event is determined by the WHO Director-General to be a PHEIC, the WHO Director-General may make a formal IHR "temporary recommendation" concerning contact-tracing (articles 15–18).

7.3 Privacy/confidentiality of personal health information

Health-related information about individuals is a key part of the process of contact investigation. However, health information or data that relates to an identified or identifiable person (such as international travellers) is subject to particular restrictions for countries under Article 45 of the IHR as to how it may be used, stored, disseminated or collected – although it may be disclosed and used where essential for particular public health purposes, provided specific requirements are followed. In addition, the laws of many States, and some international laws, also protect or restrict the use of this information, with varying provision for use as necessary in the public health context.

In accordance with these laws, confidentiality must be ensured when public health authorities need to release the name of a passenger with TB to an airline in order to confirm that the passenger was on a particular flight. This information should be communicated securely and confidentially to the airline's medical service or its designated contact person.

Confidentiality is also a concern for airline companies when health authorities request the release of passenger and crew lists. Airlines are required to cooperate with public health authorities, consistent with the IHR and the laws of the countries in which they operate. It is the responsibility of the public health authorities to carry out patient notification and contact-tracing. They are competent to do so and are supported by the law as applicable if any enforcement is needed.

7.4 Denying boarding

The captain of the aircraft has the legal right to deny boarding if one of the two following conditions are met: (1) there is a national law on this matter; (2) the airline has this provision included in its terms and conditions of carriage.

Although the captain of an aircraft can deny boarding to a person if there is a valid concern that he/she is a threat to the health and/or safety

of other passengers and crew, in practice this may be difficult to apply. If a passenger is obviously very ill and with signs and/or symptoms suggesting a communicable disease, a medical consultation may be obtained before boarding. National laws vary significantly in different countries and air crew may be hesitant to deny boarding when privacy concerns may protect the individual passenger and discrimination charges may be an issue. However, many countries have laws or regulations to prevent people known to have infectious TB from boarding commercial aircraft.

Boarding should be denied to individuals with an infectious or potentially infectious form of TB. When a physician is aware that a person with an infectious or potentially infectious form of TB is planning to travel on a commercial carrier, he/she should inform the public health authority who in turn should inform the airline concerned. To avoid false reports of a malicious nature, airlines should require a written notification from the public health authorities.

If a person is placed on a "deny boarding" list for public health reasons, the airline should include an explanation of the reason why boarding is denied and what action the airline staff should take in case of attempted boarding. Anyone placed on a list that prohibits boarding should be removed from it as soon as they are no longer infectious or at risk of flying. The public health authority should inform the airline when the person is no longer infectious so that he/she can be promptly removed from the "deny boarding" list.

8. Airline employee health

The risk of TB among cabin crew members is similar to that of the general population. Mandatory routine or periodic screening is not indicated for cabin crew.

Available data about transmission of *M. tuberculosis* on aircraft do not suggest an increased risk for cabin crew resulting from their work, and thus routine and periodic tuberculin screening of all flight crew is not indicated.

Crew members are not generally considered to be close contacts of an infected passenger due to the nature and limited contact between individual passengers and crew. Exceptionally, if a cabin-crew member is assigned during a flight to look after an ill passenger who is subsequently diagnosed with infectious or potentially infectious TB, this crew member may be considered to be a close contact on the basis of the risk assessment.

When the infectious source is a crew member (cabin or flight crew), an assessment of individual work assignments should be made. All other crew with a cumulative exposure of 8 hours or longer during the period when the crew member with TB was potentially infectious should be informed of their exposure and advised to seek medical evaluation. Crew members would be considered close contacts if they were exposed to the infectious source while working, travelling and socializing together. The risk assessment should also consider whether any other work colleagues would also meet the criteria for close contact.

If evaluation of crew members with a cumulative exposure of less than 8 hours is required due to exceptional circumstances, the public health authority investigating contacts of the case will, in cooperation with the airline occupational health department where this exists, advise the relevant crew members.

Cabin crew should receive training about potential exposure to communicable diseases during flights. Cabin crew should also be trained in first aid and in the use of universal precautions when there may be exposure

to body fluids (*29*). Airlines should ensure that gloves, surgical masks and biohazard bags are readily available. Airline cleaning staff should be prepared for appropriate cleaning of the aircraft after potentially contagious passengers have disembarked.

9. Role of WHO in prevention and control of tuberculosis associated with air travel

WHO, in cooperation with competent intergovernmental organizations and other partners, seeks to facilitate the prevention and control of TB during air travel, including through the following activities, in response to requests from WHO Member States:

1. Provision of technical guidance on the conduct of contact investigations and the appropriate interventions.
2. Provision of advice, based on current international policies, on the prevention and treatment of TB and follow-up interventions for close contacts.
3. Assistance in identifying and facilitating contact with appropriate authorities in countries where contact-tracing is advised for travellers following potential exposure to TB during a commercial flight.
4. Facilitation, in the case of incidents involving health authorities in several countries, of cooperation between countries and coordination of the international response to the event.
5. Provision of information and guidance to national health authorities regarding the application of relevant IHR provisions, including contact with the national IHR focal point, assessment of events and appropriate interventions.

10. Recommendations

While the following recommendations are provided for guidance and are not legally binding upon States, it is important to note that depending on the particular national context, the same subjects or issues may also be covered by national or international laws or regulations which are legally binding.

In addition, these recommendations should be distinguished from official "temporary recommendations" during a public health emergency of international concern or "standing recommendations" for routine application which may be issued under the International Health Regulations (2005) as noted in *Annex 1*. Such IHR recommendations have particular legal consequences as indicated in the Regulations, and are adopted and issued according to specified procedures.

For travellers

Pretravel

1. People with infectious or potentially infectious TB should postpone all travel by commercial air transportation[1] of any flight duration until they become non-infectious.

For physicians

Pretravel

2. Physicians should inform all infectious and potentially infectious TB patients that they must not travel by air on any commercial flight of any duration until they are sputum smear-negative on at least two occasions (additional steps are required for MDR-TB and XDR-TB, see recommendation 3).
3. Physicians should inform all MDR-TB and XDR-TB patients that they must not travel by any commercial flight – under any circumstances or

[1] Excluding specially-designated aircraft – air ambulance.

on a flight of any duration – until they are proven to be non-infectious (i.e. two consecutive negative sputum-culture results).

4. Physicians should immediately inform the relevant public health authority when they are aware that an infectious or potentially infectious TB patient intends to travel against medical advice.
5. Physicians should immediately inform the relevant public health authority when they are aware that an infectious or potentially infectious TB patient may have exceptional circumstances requiring commercial air travel.

Post-travel

6. Physicians should immediately inform the public health authority when an infectious or potentially infectious TB patient has a history of commercial air travel within the previous three months.

For public health authorities (see also requirements under the IHR)

Pretravel

7. Public health authorities aware that a person with infectious or potentially infectious TB is planning to travel via a commercial air carrier should inform the concerned airline and request that boarding be denied.
8. If an infectious or potentially infectious TB patient has exceptional circumstances that may require commercial air travel, public health authorities should ensure that the airline(s) involved and the national public health authorities at departure, arrival and any transit points have approved the commercial air travel and the procedures for travel.

Post-travel

9. The public health authority (see section 6.1) should promptly contact the airline when an infectious or potentially infectious TB patient is known to have travelled on a commercial flight that may have been of 8 hours duration or longer within the preceding three months in order to obtain the information required for the initial risk assessment (i.e. confirm that the passenger was on the flight and the total flight duration).
10. The public health authority of the country of diagnosis should carry out a risk assessment based on the specific conditions of the case.

If the index case is considered to be infectious or potentially infectious, the public health authorities of all countries involved should be informed (i.e. all countries where the flight(s) departed and landed).

11. If a contact investigation involves more than one country, national public health authorities of the involved countries should agree on their respective roles and responsibilities (including who will request the passenger manifests from airlines). International bodies such as WHO, the EC, ECDC or others may provide assistance if requested.
12. The national public health authority that obtained the passenger information from the airline should contact counterpart public health authorities in the appropriate countries and provide them with the relevant information on the source case and the available contact information of all travellers identified as potentially exposed (i.e. those passengers seated in the same row and in the two rows in front of and behind the index case) in their jurisdiction. (See chapter 7 on legal confidentiality and permitted dissemination of such information.)
13. Public health authorities may follow national policies and guidelines regarding TB contact investigation involving potentially exposed travellers in their jurisdiction (see also *Annex 3* for a suggested approach), in accordance with requirements under the IHR.
14. Public health authorities should be in communication with their national IHR focal point concerning any event that may involve the IHR, including events for which international contact-tracing may be initiated, for assessment of any action that may be required under the IHR and support in facilitating communication.
15. National and international public health authorities are encouraged to collaborate on a TB and air travel research agenda.

For airline companies

Pretravel

16. Airline companies should deny boarding to any person who is known to have infectious or potentially infectious TB as informed by the relevant public health authority.
17. Airline companies should, in the case of ground delays that last for 30 minutes or longer with passengers on board, ensure that the ventilation system is in operation.
18. Airline companies should ensure that all their aircraft which recirculate the cabin air are fitted with a filtration system. New aircraft should be

fitted with 99.97% efficiency HEPA filters, or an alternative of at least this level of efficiency. The filtration system should be maintained in accordance with the recommendations of the filter manufacturer.

19. Airline companies should ensure that cabin crew receive adequate training on potential exposure to communicable diseases, in first aid, and in applying universal precautions when there may be exposure to body fluids.
20. Airline companies should ensure that there are adequate emergency medical supplies aboard all aircraft (including gloves, surgical masks, biohazard disposal bags and disinfectant).

Post-travel

21. Airline companies should cooperate with national public health authorities in providing as quickly as possible all available contact information requested for contact-tracing of travellers, in accordance with applicable legal requirements including the IHR (see *Annex 1*).

Appendix 1

Literature search strategy

The search strategy aimed to identify published reports of cases of tuberculosis in air travellers and possible transmission of TB infection to passengers or crew.

A search strategy was developed by a librarian at the World Health Organization. Keywords and MeSH terms were employed to catch as many citations as possible. PubMed was searched on 27 November 2007 and limited to years 2000 to 2008 without language restriction; see *Table 1* for details of the search strategy.

A total of 48 citations were found using the search strategy, of which 19 were deemed of interest for the guidelines. No articles reporting conclusive evidence of transmission of TB infection during air travel were identified. Only one article provided evidence, which was inconclusive, suggesting a possible risk of transmission of TB infection following exposure to an infectious case during air travel. No report of TB disease resulting from exposure during air travel was identified.

Table 1 Details of literature search strategy

#1 Search "Aero-transport" OR "Aviation" [Mesh] OR "airplane*" OR "aero-transport*" OR "air transport*" OR "aeroplane*" OR "aeroport*" OR "airport" OR "air port*" OR "aero-port*" OR "aviation" OR "cabin" OR "aero-medical" OR "air force" OR "Aerospace Medicine" [MESH] OR Aviation [mesh] OR "airline*" OR "in-flight*" OR "inflight*" OR "helicopter*" OR "air travel*" OR "air passenger*" OR crew OR "flight attendant*" OR "steward* " OR "flying personne 40480
#2 Search (Tuberculosis OR "Antitubercular Agents" or "Tuberculin Test" [Mesh]) 183572
#3 Search (#2) AND (#1) 143
#4 Search "transportation of patients" [Mesh] AND air AND (Tuberculosis OR "Antitubercular Agents" or "Tuberculin Test" [Mesh]) 4
#5 Search (travel [mesh] AND air AND (Tuberculosis OR "Antitubercular Agents" or "Tuberculin Test" [Mesh]) 18
#6 Search ((#3) OR (#4)) OR (#5) 145
#7 Search (#6) Limits: Entrez Date from 2000 to 2008 48

Annex 1

International Health Regulations (2005) Selected provisions

For reference purposes and to facilitate implementation, this section at times summarizes or paraphrases the official text of the IHR. The official text of the IHR, including the authentic texts in the six official languages of WHO (Arabic, Chinese, English, French, Russian and Spanish) may be found at www.who.int/ihr.

Basic provisions of the IHR

Purpose and scope

The International Health Regulations 2005 (IHR) were adopted by the World Health Assembly in May 2005[1] and entered into force in June 2007. They are legally binding upon 194 IHR States Parties, including all WHO Member States. The IHR establish fundamental global legal requirements for all countries on international coordination in the detection and investigation of, and response to, public health risks (and related subjects), including some arising in the context of transmission of TB on aircraft.

The purpose and scope of the IHR (Article 2) are to prevent, control and respond to risks of international disease spread "in ways that are commensurate with … public health risks, and which avoid unnecessary interference with international traffic and trade". The disease-related scope of the IHR is extremely broad (essentially an "all risks" approach), covering not only communicable diseases but also risks arising from chemical or radionuclear sources as well as other biological public health risks.

Key rights, obligations and other provisions

To address public health risks, the IHR include several basic rights and obligations for States Parties, many of which may apply in the context of TB, including:

- *Reporting/notification/verification by States Parties to WHO*. Notification to WHO is required for all cases of: (i) certain specified diseases; and (ii) all events involving at least two of the following four criteria,

[1] http://www.who.int/gb/ebwha/pdf_files/WHA58/WHA58_3-en.pdf.3.

regardless of the particular disease or risk: seriousness of public health impact; unusual or unexpected nature; risk of international spread; and risk of interference with international trade. Notification of TB-related events would fall under the second category. Other provisions require additional reporting to WHO or verification of public health events upon request to WHO.

- *Public health capacity*. Obligations of States Parties to develop national core public health capacities for detection, assessment, control and reporting of public health events, and at some international ports, airports and ground crossings.
- *Travellers*. Obligations to provide proper treatment of international travellers by States Parties, including some human rights and other protections, such as protection of personal health data, prior informed consent for examinations and procedures, and other provisions.
- *Measures*. Authorizations and limits on health/sanitary measures that may be applied by States Parties to international travellers, conveyances (e.g. aircraft, ships), cargo and goods.
- *Certificate/document requirements* on sanitary requirements for international air and sea traffic.

The IHR also provide for determination by the WHO Director-General, in extraordinary public health situations, of public health emergencies of international concern (PHEIC) under the IHR, according to specified criteria and procedures. While such predictions of the future are necessarily speculative, even within the broadened scope of the revised IHR, such PHEICs are currently expected to be relatively rare. The likelihood that an event involving TB in international air travel may at some point be determined to be a PHEIC by the Director-General is difficult to predict; the possibility cannot be excluded.

In some situations, cases of TB relating to international travel may be notifiable to WHO, depending on factors such as infectiousness, duration and proximity of contact with others, and involvement of MDR or XDR-TB, in accordance with Annex 2 of the IHR. In addition, cases relating to international travel may be otherwise reportable to WHO or verifiable under other IHR provisions.

Applicability of the IHR – No PHEIC required

The IHR do not require an event to have occurred which has been determined to constitute a PHEIC (or which is a potential PHEIC or notifiable) for many provisions in the Regulations to be applicable. Events that will be

assessed under the IHR and determined to be PHEICs are expected to be relatively rare, but certain provisions of the IHR will still apply. For example, international travellers (with certain stipulated exceptions) are entitled to most of the relevant protections for them in the IHR when measures (e.g. medical examinations, quarantine, isolation, etc.) are applied for public health purposes – whether a serious public health risk has been identified or not.

The States Parties' obligations to develop and/or maintain key public health capacities for surveillance or response apply, regardless of whether a specific event is occurring. Similarly, the option for States Parties to request information from airline pilots or companies (see below) is also generally available as indicated under the IHR (although some may require particular public health justification). Additional procedures will be involved in the context of a PHEIC, such as the issuance by the Director-General of WHO of official IHR "temporary recommendations".

Provisions relevant to transmission of tuberculosis on aircraft

TB cases or events involving air travel may come within a number of different subjects addressed by the IHR, including: (1) State obligations to notify, report to WHO or verify TB cases or events; (2) State and WHO activities involving assessment of and response to TB cases or events; (3) provisions specifying health measures that States may (or may not) apply relating to international travellers (e.g. examinations, contact investigation, isolation/quarantine, protection of personal health information) and aircraft/airlines (e.g. provision of contact and other public health information).

Informational requirements from travellers, and aircraft pilots and operators

States Parties may require, for public health purposes:

- on arrival or on departure that travellers provide information on their itinerary for potential contacts with infection/contamination, and their destination so that they may be contacted (Article 23.1.a.i–ii); and
- that conveyance operators facilitate the provision of available relevant public health information to national authorities. Depending on the circumstances, such information may potentially include passenger manifests and seating plans, which may be needed for contact-tracing and follow-up after an infectious person has travelled by air (Annex 4.A.1.d).

Pilots in command of aircraft or their agents are obliged to report to airport control any cases of illness indicative of infectious disease or a public health risk on board as early as possible (if known) before arrival at the airport of destination. This information must be relayed immediately to the authorities competent for the airport (Article 28.4).

Pilots or their agents must supply any information required by the State Party concerning health conditions on board during an international voyage and any health measures applied to the aircraft (Article 38.2). They must also complete and deliver the Health part of the Aircraft General Declaration to the authority competent for the airport (unless not required by the State Party) which requires the *name and seat number* (or function) of persons on board who may be suffering from a communicable disease[1] (Article 38.1; Annex 9).

Notification/reporting/verification of disease

As noted, States Parties may have an obligation to notify or otherwise report to WHO or verify cases or events involving TB and air travel depending on the context. These obligations apply whether or not the event constitutes a PHEIC, as a key purpose of the provisions is early detection and international assessment of all events that may potentially develop to the level of a PHEIC (articles 6; 9.2; 10.1–2).

Treatment of personal data

States Parties are obliged to collect and handle health information containing personal identifiers in a confidential manner. However, States Parties may disclose and process personal data when it is essential for the purposes of assessing and managing a public health risk, subject to particular requirements (Article 45.1–2).

[1] The "Declaration of Health" in the Aircraft General Declaration requires indication of (in part): "Name and seat number or function of persons on board with illnesses other than airsickness or the effects of accidents, who may be suffering from a communicable disease (a fever – temperature 38 °C/100 °F or greater – associated with one or more of the following signs or symptoms: appearing obviously unwell; persistent coughing; impaired breathing; persistent diarrhoea; persistent vomiting; skin rash; bruising or bleeding without previous injury; or confusion of recent onset, increasing the likelihood that the person is suffering a communicable disease) as well as such cases of illness disembarked during a previous stop. See http://www.icao.int/icao/en/med/AvInfluenza_declaration_en.pdf.

Health measures applied to travellers

Medical examination

Subject to the other provisions in the IHR and any relevant international treaties to which the State may also be a party, States Parties may require, for public health purposes, travellers on arrival or on departure to undergo a non-invasive medical examination, as defined in the IHR (Article 23.1.a.iii). This may include a sputum test (collected externally). Specific requirements must be fulfilled to justify any invasive examination. See below concerning prior informed consent.

Suspect or affected travellers

A State Party may apply "additional" health measures on the basis of evidence of a public health risk, in particular with regard to suspect or affected travellers, including the least invasive and intrusive examination that would achieve the particular public health objective. Any such additional measures (which would include quarantine or isolation) must be based on scientific principles, the available scientific evidence of a risk to human health, and any specific guidance or advice from WHO (articles 23.2; 43.2). In the context of the IHR, an "affected" traveller is a traveller who is infected or contaminated or who carries sources of infection or contamination, so as to constitute a public health risk. A "suspect" traveller is a traveller considered to have been exposed, or possibly exposed, to a public health risk and who could be a possible source of spread of disease (Article 1).

Travellers seeking temporary or permanent residence

Subject to certain requirements, the Regulations do not preclude States Parties from requiring medical examination, vaccination or other prophylaxis, or proof of vaccination or other prophylaxis, as a condition of entry for travellers seeking temporary or permanent residence (Article 31.1.b).

Informed consent

Subject to certain exceptions and requirements, no medical examination, vaccination, prophylaxis or other health measures may be carried out without the traveller's prior express informed consent (Article 23.3–4). However, if the traveller fails to consent to medical examination, vaccination or other prophylaxis which is permitted under the IHR, or refuses to provide the specific information or documents authorized under the IHR (noted below), the State Party may deny entry to the traveller provided certain

additional requirements are fulfilled (e.g. transparency, nondiscrimination, appropriate treatment of travellers). If there is evidence of an imminent public health risk, a State Party may, in accordance with its law and other requirements in the IHR, and to the extent necessary to control the risk, advise or compel the traveller to undergo the least intrusive and invasive medical examination that would achieve the public health objective, or vaccination or other prophylaxis, or additional established health measures that prevent or control the spread of disease, including isolation, quarantine or public health observation (Article 31.2).

Treatment of travellers

States Parties shall treat travellers with courtesy, and with respect for their dignity, human rights and fundamental freedoms, and minimize any discomfort or distress associated with health measures implemented under the IHR. This includes taking into consideration gender, sociocultural, ethnic or religious concerns. In addition, for travellers who are quarantined, isolated or subject to medical examination or other procedures for public health purposes, the State must provide adequate food, water, accommodation, clothing, medical treatment and other requirements (Article 32).

Charges for health measures regarding travellers

With some limited exceptions, the IHR either restrict or prohibit charging travellers for most health measures applied to them on public health grounds, including a ban on charges for medical examinations, isolation and quarantine expenses, certificates specifying measures applied or measures applied to baggage; vaccinations and prophylaxis on arrival may be charged for under certain circumstances. However, States Parties may charge for other health measures including those that are primarily for the benefit of the traveller according to certain rules established in the IHR. Charges that are permitted may not exceed the actual cost of providing them and may not discriminate based on nationality, domicile or residence of the traveller (Article 40).

Timeliness, transparency and nondiscrimination

Whether health or sanitary measures under the IHR are applied to persons, conveyances or goods, they must be "initiated and completed without delay, and applied in a transparent and nondiscriminatory manner" (Article 42).

WHO recommendations under the IHR

In addition to providing relevant public health advice in the course of its activities generally, the Director-General will make a formal ***temporary recommendation*** under the IHR if the Director-General determines that a PHEIC is occurring, or in other circumstances potentially a ***standing recommendation*** for ongoing public health risks for routine or periodic application, including at international points of entry, for the application of appropriate health measures by States Parties, including measures applicable to international transport and risks of disease transmission in air travel. These IHR recommendations may include, for example, implementation of tracing of contacts of suspects or affected persons, isolation and treatment where necessary of affected persons; quarantine or other measures for suspects; placing suspects under public health observation. Prior to issuance of both temporary and standing recommendations, specific procedures must be followed (articles 15–18).

Annex 2

Sample letter from a national public health authority to an airline company requesting information for contact identification after possible exposure to *M. tuberculosis*

N.B. This official letter should normally be sent only after the public health authority has confirmed with the airline company that a TB patient likely to have been infectious or potentially infectious was on board within the past three months and that the flight plus ground delays lasted 8 hours or longer.

Although this sample letter includes potential text for such a letter, it is up to the authority sending the letter to ensure that all text and statements are true and accurate in the particular context.

Date .....

Address of relevant airline company authority

Dear colleague,

We have recently been informed of a case of tuberculosis (TB) with a recent history of air travel. This patient is considered to have been infectious or potentially infectious at the time of the flight.

We are informed that the patient, **[Mr/Ms .....]**, flew from **[town/airport of departure]** to **[town/airport of landing]** on **[date]** on your flight **[flight details – flight number and/or seat number if available – as precise as possible]**.

This flight itinerary was confirmed by your airline. It was also confirmed that the flight in question plus ground delays lasted 8 hours or longer. There is some evidence that transmission of *M. tuberculosis* may occur during flights 8 hours or longer, from an infectious source (passenger or crew member) to other passengers or crew members.

Thus, **all passengers seated in the same row and those seated in the two rows in front of and the two rows behind the index patient** (unless separated by a solid bulkhead) should be considered close contacts and potentially exposed to TB.

Please kindly provide us with the contact information for all of these individuals (names, addresses of origin and destination, telephone numbers, nationality, passport number and other relevant information allowing the passenger to be traced). We will use this information in accordance with our national and international legal requirements, for the purpose of providing medical guidance to those concerned.

We draw your attention to the obligations of airline operators under the International Health Regulations (2005), and as stipulated in ICAO Annex 9 to the Convention on International Civil Aviation, which require conveyance operators to facilitate provision of relevant public health information requested by a State that is Party to the IHR. (The IHR require the provision of relevant information and ICAO requires compliance with the IHR.)

Thank you for your cooperation.

Yours sincerely,

[Name, address, telephone/fax number of public health authority]

cc: Airline medical authority
National IHR focal point
National TB unit
Applicable WHO IHR contact point (if required under the IHR)

Annex 3

Proposed procedure for contact investigation following exposure to tuberculosis from an infectious source during air travel

National guidelines for TB contact investigation should be followed where these are available. For countries that do not have such national guidelines, the following steps and procedures are proposed for consideration.

Evaluation of exposed persons should be undertaken as rapidly as possible following recognition of the exposure. However, in practice the initial assessment of close contacts may often begin only many weeks, or even several months, after the exposure.

1. **Medical evaluation**. For each of the identified contacts a careful medical history, including history of travel and previous contact with tuberculosis, is required as well as a thorough symptoms review and physical examination.

2. **Tuberculin skin testing (TST)**. TST is recommended for the purposes of contact investigation. Each of the identified contacts requires an initial TST to identify present or past *M. tuberculosis* infection unless there is a documented history of a previous positive TST result or history of tuberculosis. TST is recommended regardless of whether the contact has received BCG vaccination in the past. The test will be carried out and the result interpreted according to national health policy and guidelines for TST.

   TST should be performed as soon as possible after the flight. It is preferable to do an initial TST within 3 weeks of the flight in order to obtain a baseline measurement, since TST sensitization usually occurs between 3 and 8 weeks after exposure. If it is not possible to obtain an initial TST result within 3 weeks of exposure (flight), only one TST should be performed at least 8 weeks following exposure. Risk factors for prior latent TB infection should be considered when interpreting all TST results during contact investigations.

   Use of in vitro immunological assays (IGRAs) to identify *M. tuberculosis* infection may be considered if available, and in accordance with national policy.

3. **Contacts at higher potential risk**. Contacts with a higher potential risk of developing active TB disease following infection require rapid identification and medical evaluation, including chest radiograph and follow-up, regardless of the initial TST result or history of previous positive TST or previous tuberculosis. These include contacts with significant comorbidity, those who are immunocompromised as a result of HIV infection or another cause, and all children under 5 years of age.

4. **Previous exposure**. Contacts who have a documented prior positive TST or documented previous tuberculosis, and who are not known or likely to be immunocompromised, do not require a TST and do not normally require further evaluation unless they have, or develop, symptoms suggestive of tuberculosis.

5. **Positive TST within 3 weeks**. If the TST was carried out within 3 weeks after the exposure, a positive result is considered to result from previous exposure to tuberculosis and not from infection transmitted by the index case. Such contacts require medical evaluation and exclusion of active tuberculosis. A further TST is not indicated. If there is no evidence of active tuberculosis, the contact should be evaluated for treatment of latent TB infection (preventive therapy) if this is in accordance with national policy.

6. **Negative TST within 3 weeks**. If the TST test was carried out within 3 weeks after the exposure and the result is negative, the test should be repeated at least 8 weeks after exposure to the index case. If the second TST is negative and the individual is well, no further follow-up is indicated.

7. **Positive TST after 3 weeks**. If the first TST is carried out at more than 3 weeks after exposure, a positive result might be due to either (i) prior infection, (ii) BCG vaccination, (iii) boosting, or (iv) the recent transmission. Such contacts require a medical evaluation and possible further investigation for active or latent TB.

8. **TST conversion**. Contacts with a negative initial TST that converts and becomes positive after a second test are considered to have been infected by the index case, unless the exposure history or epidemiology suggests that another source is more likely. Such cases require prompt and careful medical evaluation to identify possible active tuberculosis.

8.1 **TST conversion with TB**. If the contact with TST conversion has evidence of active TB disease, sputum samples should be taken for microscopy, and wherever possible culture and drug susceptibility testing (DST), as well as any other samples that are clinically indicated. If the culture is positive, molecular genotyping, where feasible, may be used to determine whether it matches the genotype of the index case.

8.2 **TST conversion without TB**. Contacts with TST conversion and no evidence of active TB disease are considered to have latent TB infection. If preventive therapy is included in national health policy, it should be considered in those who have been infected by drug-sensitive cases. Converters who do not receive preventive therapy should be advised to report any interim symptoms or signs of TB disease to a health-care provider without delay.

9. **Contacts infected by an MDR or XDR-TB index case**. Preventive therapy is of limited or no value for most persons who have been infected by an MDR-TB or XDR-TB index case, as no drug regimens have been shown to prevent progression from infection to disease. Infected contacts should be provided with full information and long-term medical evaluation to exclude active tuberculosis, for example at 6, 12 and 24 months after the flight. They should be educated about the symptoms that might be caused by tuberculosis and advised to seek medical help promptly if any such symptoms develop. They should be provided with written information about the possible exposure to drug-resistant tuberculosis to present to any clinician they consult in the future. Longer-term follow-up in cases of contact with XDR-TB should be considered if resources permit.

10. **Contacts who develop TB**. If any contact develops active TB disease, treatment should be started following national guidelines. In cases where DST results are awaited, and if no other more likely source of infection is identified, treatment based on the resistance pattern of the index case should be started.

11. **Recording and retention of data**. Data should be recorded by clinicians and public health authorities at all stages of the contact investigation and retained to allow subsequent evaluation of the process.

Further information

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WORLD HEALTH ORGANIZATION
STOP TB DEPARTMENT
20, AVENUE APPIA
1211 GENEVA 27, SWITZERLAND
Fax: +41 22 791 4285

Web site: www.who.int/tb
E-mail: tbdocs@who.int

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