Tuberculosis and travel

Peter Ormerod

Tuberculosis is increasing worldwide with most countries having a high prevalence. Protection against tuberculosis, the risks of acquiring tuberculosis during air travel, and the evidence for clinical tuberculosis acquired on extended visits to such countries are all reviewed in this article.

The incidence of tuberculosis is increasing throughout the non-developed world, with all countries having over 40 cases/100 000 population, and many over 200/100 000, with the exceptions of the European Union countries, Canada, the United States, Australia and New Zealand (World Health Organization, 1998a). With increasing travel, particularly to long-haul destinations, persons from countries and subgroups with very low incidences of tuberculosis may well be exposed to tuberculosis in high-prevalence countries, and this potential risk increases with duration of stay.

PROTECTION AGAINST TUBERCULOSIS

Bacille Calmette-Guérin (BCG) vaccination should be given in the UK to neonates from ethnic minority groups, tuberculin-negative new immigrants from high-prevalence countries, tuberculin-negative household contacts of respiratory tuberculosis, and to previously unvaccinated 10–14 year olds in the Schools Programme.

The degree of protection given by BCG while resident in the UK has been shown to be between 65% (Packe and Innes, 1988) and 52% (Rodrigues et al, 1991) for neonatal BCG vaccination, between 70 and 80% lasting for a minimum of 15 years for the Schools Programme (Sutherland and Springett, 1989), and 80% for prior BCG of household contacts of respiratory tuberculosis (British Tuberculosis Association, 1978). The Departments of Health (1996) recommend, in the 'Green Book' on immunization against infectious disease, that BCG vaccination be given to those persons:

> **'visiting Asia, Africa, Central or South America for longer than 1 month',**

provided that they are previously unvaccinated, are tuberculin negative (Heaf grade 0–1) and have no contraindication to BCG vaccination. Reimmunization should only be carried out in subjects with a previous history of BCG vaccination if they have no characteristic scar and they are tuberculin negative.

The incidence of tuberculosis in Eastern Europe, Russia and the former Soviet republics is high and increasing rapidly in many of them. It would seem prudent therefore to extend the recommendation of BCG vaccination in appropriate persons to those visiting, for over 1 month, all countries in the world with the exception of the European Union, Canada, the United States, Australia and New Zealand.

RISKS OF ACQUIRING TUBERCULOSIS DURING AIR TRAVEL

Increasing numbers of people are using international air travel for business and tourism, but also for immigration and asylum-seeking. Outbreaks of various communicable diseases following exposure within commercial aircraft, such as measles, influenza, and staphylococcal food poisoning have been documented. In 1997, 1448 million passengers were carried by International Civil Aviation Organization members (IACO), and this is projected to rise to over 2 billion by the year 2005 (IACO, 1997).

Some countries, for example the United States, Australia and Canada, require tuberculosis screening before immigration and issue clearances valid for up to 1 year. Although persons with infectious tuberculosis are prevented from travelling until rendered non-infectious, persons can develop infectious tuberculosis between clearance and travel. Other countries, of which the UK, Switzerland and the United

Dr Peter Ormerod is Consultant Physician in Respiratory Medicine at Blackburn Royal Infirmary, Blackburn, Lancashire BB2 3LR, and Chairman of the Joint Tuberculosis Committee of the British Thoracic Society

Arab Emirates are examples, only screen for tuberculosis after immigration, thus infectious tuberculosis would only be identified after travel.

Between 1992 and 1994 Centers for Disease Control (CDC, 1995) in Atlanta conducted seven investigations into exposure to *Mycobacterium tuberculosis*, one involving a flight attendant and six involving passengers, all with active tuberculosis, to determine if disease had been transmitted (*Table 1*).

These investigations were conducted to address concerns that the closed aircraft cabin environment could enhance the airborne transmission of *M. tuberculosis*. In all of these investigations the index case was considered highly infectious, with extensive disease on chest X-ray, had spontaneously expectorated sputum which was heavily smear-positive; in one case there was additional laryngeal tuberculosis. Five of the cases had fully sensitive organisms but two had multidrug-resistant organisms reported.

Aircraft ventilation

The ventilation system of a jet aircraft works best during flight, airflow being decreased during take-off and landing. On the ground, with the engines off, cabin ventilation is supplied by either:

1. A ground air-conditioning system
2. A ground pneumatic source providing air to operate the aircrafts environmental control system
3. The auxiliary power unit of the aircraft.

Unless such provision is made during ground delays, there can be little or no air movement or ventilation. Once the engines have started, air to the cabin sections is supplied with bleed air from the engines. Outside air enters the aircraft engine compressor section where it is heated to 200°C and compressed to 28 kg/m^2. This air then enters the aircraft passing to environmental control sections which cool and condition the air before entry to all sections of the cabin from overhead distribution outlets above the windows or in the middle of the ceiling. Airflow is laminar (side to side) with air flowing downward in a circular pattern to outflow grills in the sidewalls at floor level. Air enters and leaves the cabin at roughly the same seat row, airflow in the forward or rear directions is minimal, the movement of cabin staff and passengers having little impact.

Older aircraft (built before the late 1980s) did not recirculate air, some have been adapted to do so. All newer commercial jets do recirculate air, with between 10 and 50% of cabin air being filtered, mixed with fresh bleed air, and returned to the passenger cabin.

Recirculation can be achieved though one central plenum to the whole plane, or by zonal plena to the same zone. The rate of recirculation is approximately 20 air-changes/hour in flight and seven changes during descent and on the ground. High efficiency particulate air (HEPA) filters, which capture material as small as 0.3 microns are used in recirculation circuits. Since *M. tuberculosis* is between 0.5 and 1.0 microns, tubercle bacilli should be removed from cabin air during the recirculation process. The potential risk from a person with infectious tuberculosis in an aircraft with recirculation should therefore be limited to droplet spread to a small number of seats in the immediate vicinity of the infected passenger before recirculation takes place.

The investigations into the seven incidents (*Table 1*) produced evidence in only two of these incidents that transmission of tuberculosis infec-

TABLE 1.
Summary of flight investigations

Reference	Index case	Flight duration	Number completing screening	Outcome
Driver et al (1994)	Flight attendant	Multiple	212 crew	30% exposed crew tuberculin positive
			59 passengers (frequent flyers)	5% non-exposed crew tuberculin positive
				No evidence of transmission to passengers
McFarland et al (1993)	Passenger	9 hours	79 passengers and crew	No evidence of transmission
CDC (1995)	Passenger	1.5 hours	22 passengers	No evidence of transmission
Miller et al (1996)	Passenger	8.5 hours	142 passengers	No evidence of transmission
CDC (1995)	Passenger	Longest 9 hours	85 passengers	No evidence of transmission
Kenyon et al (1996)	Passenger	Longest 8.7 hours	257 passengers	Six tuberculin conversions in non-BCG'd
				Probable transmission
Moore et al (1996)	Passenger	1.25 hours	100 passengers	No evidence of transmission

BCG = bacille Calmette-Guérin; CDC = Centers for Disease Control

tion had occurred, i.e. tuberculin skin test conversion that could not be otherwise explained. No case of clinical tuberculosis has yet been shown to be related to these incidents. In one incident (Driver et al, 1994), the infection was from the infected flight attendant to other crew members, but transmission was limited to those with over 12 hours' exposure. In the second episode (Kenyon et al, 1996), transmission was demonstrated to only a small number of passengers within three seats of the infected persons, and only on one flight lasting for longer than 8 hours.

Air travel does not seem to carry greater risk of infection with exposure to potentially infectious tuberculosis than other modes of transport. All aspects of tuberculosis risk and air travel have recently been reviewed by the World Health Organization which has produced guidelines for control and prevention (World Health Organization, 1998b).

CLINICAL TUBERCULOSIS ACQUIRED ABROAD

No regular national statistics are kept to indicate the level of clinical tuberculosis acquired abroad. In national tuberculosis notification surveys of England and Wales, the most recent of which was published in 1997 (Kumar et al, 1997), ethnic origin and sites of disease were recorded as was the date of first entry for the non-UK born.

Visits to high-prevalence countries within 2 years of notification are now being recorded under the new enhanced surveillance system by the Public Health Laboratory Service Communicable Disease Surveillance Centre, which began in January 1999. Over 50% of cases of tuberculosis in England and Wales are now in non-white ethnic groups (Kumar et al, 1997). In the Indian subcontinent (ISC) ethnic group there are some data to suggest infection during return visits.

From a high-prevalence district (Newham, Greater London) it was shown, in the 1980s, that 20% of new clinical cases of tuberculosis occurred within 5 years of a return visit to the ISC (McCarthy, 1984). Some chest physicians working in high-prevalence districts believe that this still occurs. The author certainly sees patients each year who return from the ISC following extended visits with clinical tuberculosis (Omerod, 1999), and is also aware of at least two cases of multidrug-resistant tuberculosis acquired abroad within the last 18 months. **HM**

Conflict of interest: none

British Tuberculosis Association (1978) A study of a standardised contact procedure in tuberculosis. *Tubercle* **59:** 245–59

Centers for Disease Control (1996) Exposure of passengers and flight crew to *Mycobacterium tuberculosis* on commercial aircraft, 1992–95. *MMWR* **44:** 137–40

Departments of Health (1996) Joint Committee on Vaccination and Immunisation. HMSO, London

Driver CR, Valway SE, Morgan WM, Onorato IM, Castro KG (1994) Transmission of *M. tuberculosis* associated with air-travel. *JAMA* **272:** 1031–5

IACO (1997) *Annual Report of the Council.* IACO Document 9700. IACO, Montreal

Kenyon TA, Valway SE, Ihle WW, Onorato IM (1996) Transmission of multi-drug resistant *Mycobacterium tuberculosis* during a long airplane flight. *N Engl J Med* **334:** 933–8

Kumar D, Watson JM, Charlett A et al (1997) Tuberculosis in England and Wales in 1993: results of a national survey. *Thorax* **52:** 1060–7

McCarthy OR (1984) Asian immigrant tuberculosis - the effect of visiting Asia. *Br J Dis Chest* **78:** 248–53

McFarland JW, Hickman C, Osterholm MT, MacDonald KL (1993) Exposure to *Mycobacterium tuberculosis* during air travel. *Lancet* **342:** 112–3

Miller MA, Valway SE, Onorato IM (1996) Tuberculosis risk after exposure on airplanes. *Tubercle Lung Dis* **77:** 414–9

Moore M, Fleming KS, Sands L (1996) A passenger with pulmonary/laryngeal tuberculosis: no evidence of transmission on two short flights. *Aviation Space Environ Med* **67:** 1097–100

Omerod LP, Green RM, Gray S (1999) Are there still effects on the tuberculosis of visiting the Indian subcontinent: a longitudinal study 1978-97. *Thorax* **54(Suppl 3):** A50

Packe GE, Innes JA (1988) Protective effect of BCG vaccination in infant Asians: a case control study. *Arch Dis Child* **63:** 277–81

Rodrigues LC, Gill ON, Smith PG (1991) BCG vaccination in the first year of life protects children of Indian subcontinent ethnic origin against tuberculosis in England. *J Epidemiol Commun Health* **45:** 78–80

Sutherland I, Springett VH (1989) The effects of the scheme for BCG vaccination of schoolchildren in England and Wales and the consequences of discontinuing the scheme at various dates. *J Epidemiol Commun Health* **43:** 15–24

World Health Organisation (1998a) *Global Tuberculosis Programme.* Global TB Control. WHO, Geneva: WHO/TB/98-237

World Health Organisation (1998b) *Tuberculosis and Air Travel: Guidelines for Control and Prevention.* WHO, Geneva; WHO/TB/98-256

KEY POINTS

- Previously unvaccinated persons visiting high prevalence countries for longer than 1 month should receive bacille Calmette-Guérin (BCG) vaccination.
- There is limited evidence for tuberculosis infection during long-haul flights.
- Clinical tuberculosis acquired in high prevalence countries does exist but as yet there are no national data to quantify the size of the problem.