Case reports

Transmission of tuberculosis infection in a commercial office

We report a cluster of cases of tuberculosis in a commercial office in Victoria, possibly transmitted because of a delay in diagnosing, quarantining and treating a patient with an active case of the disease.

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Clinical record

A 34-year-old, white, married man, previously well, presented to his general practitioner with a 4-week history of influenza-like symptoms, including fevers, night sweats, 5 kg weight loss in under a month and a persistent non-productive cough. He was initially diagnosed with bronchitis and commenced on therapy with a β-agonist inhaler and oral antibiotics.

After 2 weeks, this patient, the index case, experienced his first episode of haemoptysis. He attended work the following day and arranged to see another GP who advised him to remain away from work. This second GP had been trained overseas in a country with a high burden of tuberculosis (TB); he requested sputum microscopy for acid-fast bacilli (AFB) and a chest x-ray, despite there being no significant risk factor for TB. After 48 hours, the patient presented to hospital for isolation and treatment as his chest x-ray showed right upper-lobe consolidation and his sputum was positive for TB on AFB smear (result, 3+). Quadruple antituberculous therapy was commenced and the Victorian Department of Health (DH) was notified.

DH staff traced and screened close household contacts, extended family and friends and workplace contacts. A chest x-ray, tuberculin skin test (TST) and/or interferon-γ release assay (IGRA; by QuantiFERON-TB Gold test) was performed on all contacts of the index case in accordance with DH guidelines. Also in accordance with DH guidelines:

- household contacts were screened both at baseline and 8–12 weeks after break-of-contact (BOC);
- other contacts were screened at 8–12 weeks after BOC only;
- a positive contact was defined as having a TST conversion from no induration at baseline to ⩾ 10 mm induration, or a TST result ⩾ 10 mm induration at BOC and/or a positive result on IGRA; and
- mycobacterial interspersed repetitive unit variable number tandem repeat (MIRU-VNTR) genotyping was performed on all *Mycobacterium tuberculosis (M. tb)* isolates.

The sputum sample from the patient with the index case was positive for TB by polymerase chain reaction (PCR), and was also culture-positive for *M. tb* after 3 weeks. The isolate was fully sensitive to first-line antituberculous medications.

A total of 108 contacts were identified and screened — three household contacts, 16 extended family members and friends, and 89 workplace contacts (Box). TSTs carried out within 4 days of the patient's diagnosis on the three family members living with him in the same house (his pregnant wife, 4-year-old son and 6-month-old daughter) were all negative at baseline. However, at 7 weeks, the 4-year-old boy showed conversion on repeat TST, with the induration measuring 15 mm. A chest x-ray showed bilateral hilar adenopathy, right middle-lobe consolidation and left upper-lobe nodules. *M. tb* was isolated by gastric aspirate. The isolate was fully sensitive to first-line antituberculous drugs and had the same genotype as the index case. The patient's wife had a repeat TST at 3 months that also converted, with the induration measuring 17 mm. Her chest x-ray remained normal. She deferred prophylaxis because of her pregnancy, but has since completed 9 months of treatment for latent TB infection (LTBI).

Sixteen extended family members and friends underwent screening at between 8 and 12 weeks from BOC with TST and/or IGRA, and three tested positive. All three had a history of BCG vaccination or other risk factors for TB (Box) and so were not considered likely to have been infected through contact with the index case.

The patient with the index case of TB was working as chief of staff in a large commercial business office, and his 89 co-workers were tested at 8–12 weeks from BOC. Screening was extended on two occasions to take in the whole ground floor, reception and mezzanine level, and to include staff who transited the area on a regular basis. Of the 89 workplace contacts, 50 (56%) were male, 78 (88%) were Australian born and 39% had previously had a BCG vaccination. No workplace contacts had a previous known exposure to active TB, but three reported previous residence in a country with a high burden of TB.

Overall, 23 workplace contacts (25.8%) tested positive on TST and/or IGRA (Box). No active cases of TB were identified among workplace contacts. Twelve co-workers with a positive result on TST and/or IGRA had other possible risk factors or were excluded as having probable workplace-acquired infections because the question about previous risk factors was not answered. This left 10 of the 89 workplace contacts (11.2%) with a positive result on TST or IGRA who had no risk factors other than their workplace exposure. All contacts who tested positive were referred for consideration of LTBI treatment. Of the 18 patients with known follow-up, 12 received treatment and

Results of investigations on contacts of the patient with the index case of tuberculosis

Characteristics	All contacts	Household close contacts*	Extended family and friends†	Workplace contacts
Total number identified and screened	108	3	16	89
TST only	77 (71.3%)	3 (100%)	12 (75.0%)	62 (69.7%)
TST and IGRA	31 (28.7%)	0 (0)	1 (6.3%)	20 (22.5%)
IGRA only	10 (9.3%)	0 (0)	3 (18.8%)	7 (7.9%)
Number testing positive for TB on TST and/or IGRA	28 (25.9%)	2 (66.7%)	3 (18.8%)	23 (25.8%)
Past history of BCG vaccination	9/28 (32.1%)‡	0/2 (0)	0/3 (0)[3]	9/23 (39.1%)‡
No past history of BCG vaccination	16/28 (57.1%)[3]	2/2 (100%)	2/3 (66.7%)[3]	12/23 (52.2%)‡
Risk factors for those who tested positive				
Prolonged residence in a country with a high burden of TB§				
➢ Yes	1/28 (3.6%)	0/2 (0)	1/3 (33.3%)	0/23 (0)
➢ No	17/28 (60.7%)	2/2 (100%)	1/3 (33.3%)	14/23 (60.9%)
➢ Unknown	10/28 (35.7%)	0/2 (0)	1/3 (33.3%)	9/23 (39.1%)
Born overseas in country with a high burden of TB	3/28 (10.7%)	0/2 (0)	0/3 (0)	3/23 (13.0%)
Past exposure to TB	1/28 (3.6%)	0/2 (0)	1/3 (33.3%)	0/23 (0)
Contacts testing positive with no previous BCG vaccination or other risk factors for TB				
As a proportion of the total who tested positive	12/28 (42.9%)	2/2 (100%)	0/3 (0)	10/23 (43.5%)
As a proportion of the total screened	12/108 (11.1%)	2/3 (66.7%)	0/16 (0)	10/89 (11.2%)

IGRA = interferon-γ release assay. TB = tuberculosis. TST = tuberculin skin test.
* Immediate family in the same household (wife and two children). † Friends and extended family members not in the same household (brother, father, cousins, parents-in-law and family friends). ‡ Numbers and percentages do not add up to total because of missing data. § Defined as a residence of 3 or more months, cumulative; this could not be assessed accurately for 11 contacts owing to lack of data on countries visited or time spent overseas. ◆

six were managed with symptom monitoring or chest x-ray surveillance.

The workplace had an open-plan design with low-profile cubicle dividers and closed air conditioning. The practice of "hot-desking" (where most staff are not allocated a permanent desk) involved about 75%–80% of the staff in the main office area. The patient with the index case of TB had a permanent desk.

MIRU-VNTR typing (15-digit spoligotype, followed by 24-locus MIRU-VNTR) confirmed that the *M. tb* isolates from the patient with the index case and his child were indistinguishable. Comparison with other MIRU-VNTR profiles of *M. tb* strains isolated from Victorian patients with TB since 2003 showed that the strain matched that of a patient who was culture-positive in 2009. These three isolates are the only ones in the database of about 2500 *M. tb* strains from Victoria that share this profile. At the time of genotyping, there had been no known contact between the patients with the 2011 (our patient) and 2009 cases of TB. However, subsequent contact tracing showed that the two patients did have known social contact.

Discussion

Tuberculosis is one of the world's leading infectious causes of death because of lack of access to effective treatment and increasing drug resistance.[1] The incidence of TB in Australia is low, with an annual incidence of five to six cases per 100000 population. However, TB continues to pose significant challenges because of migration from countries with a high burden of TB and reactivation of the disease in the older people. Adding to the challenge are reported delays in people seeking health care and diagnosis of TB in low-incidence settings where there is a low index of suspicion of TB among both people who may be infected and health professionals.[2]

Controlling TB remains paramount, and key priorities include early detection and treatment of disease and contact investigations to interrupt further transmission.[3] Contact investigation involves screening and evaluating the risk factors for TB transmission, which includes the infectiousness of the source case, proximity of contacts, environmental determinants, delays in diagnosis and social and behavioural risk factors.[3] In settings with access to good diagnostics facilities, contact tracing can be facilitated by modern molecular typing to determine where index cases probably acquired their infections.

Here, we report on possible transmission of TB from an infected patient with no initially identified risk factors to others in a commercial office in Victoria, Australia, where contributing factors included a significant delay in presentation and diagnosis and a contained working environment.

A review of workplace contact investigations in five state TB-control programs in the United States found that 29% of contacts (range, 16%–51%) tested positive by TST.[4] We found that 26% of workplace contacts in our case screened positive. However, in the absence of a baseline TST to show conversion, it is difficult to ascertain if this reflected recent exposure or previous BCG vaccination or past exposure to TB. We found 11% with no other risk factors for TB, supporting our contention that workplace transmission had occurred in this group.

Transmission of TB among non-household social contacts has been documented in settings such as workplaces, health clinics and churches.[5,6] In our case, there were several factors in the workplace design that may have contributed to transmission including a closed air-condi-

tioning system, modern open-plan office design with low profile design of cubicle dividers that allows workers to see and communicate directly with their colleagues without standing, and the practice of "hot desking". We identified two people who tested positive who had used the same desk, which was in the cluster of desks that included the desk of the index case. Neither of these individuals had any other previous risk factors for a positive TST.

We also observed a delay in diagnosis of the index case during which the infected patient had at least 6 weeks of contact with the other staff. Delays in diagnosis have been shown to be associated with greater transmission of infection[7] as they increase the exposure period and can result in progression to advanced disease that is more likely to transmit infection.[8]

Our case study does highlight the issue of low awareness of TB among community and health care workers that has been previously described in other lower incidence settings, with lack of awareness especially the case among GPs who are usually the first point of contact with the health system for infected patients.[9]

We emphasise that children younger than 5 years who have been identified as contacts of people with infectious TB should receive a full course of treatment for LTBI when active TB has been ruled out regardless of TST results. This intervention is especially critical for infants and toddlers younger than 3 years, but is recommended for all children younger than 5 years.[10]

Increasing public and health care worker awareness of tuberculosis may help to reduce transmission and should be considered as an important public health priority in Australia.

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