

TUBERCULOSIS OUTBREAK ASSOCIATED WITH A MOSQUE: CHALLENGES OF LARGE SCALE CONTACT TRACING

S Duthie (susan.duthie@net.net)¹, C Black^{1,2}, G Douglas¹, A D Jackson³, D Webster¹

1. Health Protection, NHS Grampian, Aberdeen, United Kingdom

2. University of Aberdeen, Aberdeen, United Kingdom

3. Health Protection Scotland, Glasgow, United Kingdom

In this report, we describe the investigation and management of an outbreak of TB associated with a mosque in Scotland, and consider the implications of large-scale TB contact tracing. In 2005, an Algerian man living in the north-east of Scotland was found to be sputum smear-positive for TB. Initial investigation identified three (18.8%) close contacts with active disease. Due to the high rate of transmission, contact tracing was extended to casual contacts of the index case at a mosque. No sub-group at highest risk of exposure could be defined at the mosque. Screening of mosque attendees identified two cases (0.53%), with a further two identified by review of existing cases and enhanced surveillance. Two additional cases were linked to the outbreak by genetic profile. Response to the screening exercise was initially poor, but after modification of the communication strategy, 438 people were offered screening with 86% attending. The investigation and management of a TB outbreak is challenging and requires a complex message about risk to be communicated. In a mosque setting, there were additional complexities that, to the best of our knowledge, have not been reported previously. It was crucial, in designing the communication strategy, to identify key individuals within the community to assist with tailoring the message to address risk perception and to help to deliver the message. Despite this, approximately 50% of those considered to have the highest exposure (adult males regularly attending Friday lunchtime prayer meetings) did not come forward for screening. The screening of casual contacts in this setting was complex and time-consuming with a low detection rate.

Introduction

In 2005, an Algerian man, living in the north-east of Scotland was found to be sputum smear-positive for tuberculosis (TB). He had lived in three houses in Aberdeen and was a member of the Aberdeen mosque. Initial investigation identified three (18.8%) close contacts to have active TB disease. Therefore, NHS Grampian undertook a large contact tracing exercise in early 2006, focusing on the mosque community. In this report, we describe the outbreak investigation and management, and consider the implications of large-scale TB contact tracing. As far as we are aware, this is the first reported exercise of its kind associated with a mosque.

Epidemiology of TB in Scotland

Since the mid 1980s, the incidence of TB has been increasing in many parts of the developed world [1]. In low-incidence European countries, it has long been assumed that reactivation of latent infections was responsible for causing the majority of disease [2]. However, molecular epidemiology studies have shown that the

contribution of recent transmission to the overall burden of disease is greater than previously thought [3-6]. The rising incidence of TB in England, Wales and Northern Ireland has been attributed to an increase in cases among those who have recently arrived from high-prevalence countries, with 72% of cases in 2005 occurring in people not born in the United Kingdom (UK) [7]. In contrast, case numbers in Scotland have been relatively stable, with approximately 400 new TB cases annually over the past decade and non-UK born cases representing only 30% of the total number of cases [8].

The outbreak we report here was unusual in Scotland, representing recent transmission of infection rather than reactivation of latent disease. Occurrence within a community where a high proportion of members were not born in the UK is an epidemiological pattern more akin to England and Wales than to Scotland.

Guidelines for the management of TB

At the time of this outbreak, the National Institute for Health and Clinical Excellence (NICE) guidelines were in draft form and the British Thoracic Society (BTS) guidelines (2000) formed the basis for the actions taken [9,10].

Investigation of index case

Setting

Grampian, in the north-east of Scotland, has a population of approximately 524,000 people spread over around 7,700 km². Approximately half the population live in Aberdeen. In Aberdeen, there is one mosque, although Muslim meetings also occur at other premises. In the 2001 census, 0.82% of people living in Aberdeen City reported that their current religion was Muslim, a figure similar to the Scottish national average of 0.84% [11].

Index case

The index case was identified in October 2005 after a prolonged illness lasting several months. It was estimated that his symptoms, including a productive cough, had begun around March 2005. A sputum sample was smear-positive for numerous acid- and alcohol-fast bacilli (AAFB) and was confirmed to be fully sensitive *Mycobacterium tuberculosis* by the Scottish Mycobacterium Reference Laboratory (Box 1).

Screening of close contacts

The definition of a close contact (Box 2) was complicated by the index case having been resident at three separate addresses during his illness. The time period of concern also included the start of

Box 1

Details of cases of tuberculosis linked with the outbreak in a mosque, Aberdeen, 2005

Index Case

- adult male
- 7-8 month history of symptoms including productive cough, weight loss and night sweats
- Chest X-ray showed extensive bilateral changes
- Sputum smear-positive 8 October 2005
- Cultured as fully sensitive *Mycobacterium tuberculosis*
- High transmission risk period defined as July to October 2005
- Completed treatment May 2006; no adherence issues

Close Contacts – Linked Cases

Linked Case 1

- Child (intermittent household contact over risk period)
- Grade 3 Heaf test, no previous BCG vaccination
- Chest X-ray changes, weight loss, night sweats, slight unproductive cough
- Considered clinically to be non-infectious
- No samples for culture obtained
- Completed treatment May 2006; directly observed treatment

Linked Case 2

- Child (occasional contact at mosque)
- Grade 4 Heaf test, no previous BCG vaccination
- Chest X-ray changes, weight loss, night sweats, slight unproductive cough
- Considered clinically to be non-infectious
- No samples for culture obtained
- Completed treatment May 2006 no adherence issues

Linked Case 3

- Adult male (intermittent household contact over risk period)
- Chest X-ray changes, weight loss, night sweats, no cough
- Considered clinically to be non-infectious
- Bronchoalveolar lavage – smear-negative, culture-positive, fully sensitive *M. tuberculosis*
- Culture specimen genetically identical to index case
- Completed treatment August 2006; no adherence issues

Review of Grampian Cases and enhanced surveillance

Linked Case 4

- Adult male (mosque attendee with no known direct contact)
- Grade 1 Heaf test
- Chest X-ray changes, abnormal computer tomography chest scan
- Considered clinically to be non-infectious
- Diagnosed on bronchoalveolar lavage – smear-negative culture positive for fully sensitive *M. tuberculosis*
- Culture specimen genetically identical to index case
- Completed treatment June 2006; no adherence issues

Linked case 5

- Adult male (mosque attendee with no known direct contact)
- New arrival in United Kingdom (UK), September 2005 – no BCG vaccination
- Mantoux 18 mm, minor chest X-ray changes
- Considered clinically to be non-infectious
- No samples for culture obtained
- Incomplete treatment; lost to follow up (left UK) July 2006

Screening detected cases

Linked Case 6

- Child (mosque attendee with no known direct contact)
- Mantoux 12 mm, no previous BCG vaccination
- No changes on chest X-ray or symptoms suggestive of tuberculosis
- Completed three-month course of chemoprophylaxis

Linked Case 7

- Adult male (mosque attendee with no known direct contact)
- Mantoux >15 mm and blistered, minor chest X-ray changes
- Weight loss, night sweats, cervical lymph nodes swollen
- Sputum sent for culture and found to contain fully sensitive *M. tuberculosis*
- Lymph node aspirated and sent for culture; found to be fully sensitive *M. tuberculosis*
- Culture specimens genetically identical to index case
- Completed treatment October 2006; no adherence issues

Late cases

Linked Case 8

- Adult female from England, no known links to mosque or Aberdeen
- Culture specimens genetically identical to index case
- No additional information available

Linked Case 9 (Grampian)

- Adult male household contact intermittently over at risk period
- Screened as a close contact but no chest X-ray changes
- Presented in 2007 with productive cough, no changes on chest X-ray
- Sputum sent for culture and found to contain fully sensitive *M. tuberculosis*
- Culture specimens genetically identical to index case
- Completed treatment September 2007; no adherence issues

Ramadan and, as a result, the index case had spent substantial periods of time in close contact of people beyond his residence. Sixteen people were classed as close contacts, although their degree of contact was variable.

From the screening of the 16 close contacts, three cases of TB were identified (18.8%); one adult and two children (see Box 1: linked cases 1, 2 and 3). Screening of the contacts of the three linked cases resulted in a further three people being tested (two children and one adult); all were negative for TB disease.

Conclusion of initial investigation

To find such a high rate of spread among close contacts (18.8%) was unusual. BTS 2000 guidelines advised that casual contact tracing should be considered if the index case was highly infectious, indicated by transmission to more than 10% of close contacts [10]. Therefore an outbreak was declared and an outbreak control team assembled to consider further investigation and control measures.

The outbreak control team identified two settings where significant casual contact with the case could have occurred:

The index case's work place, a small food outlet (however, all contacts through work had already been screened as part of the close contacts);

The mosque where the index case had attended Friday lunchtime and Friday evening prayer meetings throughout his illness.

Outbreak investigation and management

Review of recent TB cases and enhanced surveillance

The outbreak control team decided that a review of recently diagnosed cases, along with enhanced surveillance, of any new cases was appropriate to identify potential association with the index case. Association was considered if there was evidence that the case could have been attending the mosque at the same time as the index case. Through this process, two cases of TB were linked to this outbreak: two adult males (Box 1: linked cases 4 and 5), diagnosed with TB in December 2005 and January 2006.

Initial microbiological investigation

Where bacteriological specimens were available, genotype testing was requested to establish potential linkage to the index case. The Scottish Mycobacterial Reference Laboratory undertook molecular typing and comparison of genetic profiles using Mycobacterial Interspersed Repetitive Unit-Variable Number Tandem Repeat (MIRU-VNTR), a method introduced in Scotland in August 2005 [12].

Of the three cases detected as part of the close contact investigation only one (linked case 3) had culture-positive specimens available for genotyping. This specimen had a genetically identical profile to the index case.

Box 2

Definition of a close contact (British Thoracic Society guidelines 2000 [10])

Close Contacts:

Someone from the same household (sharing a kitchen), very close associates, or frequent household visitors.

BCG = Bacillus Calmette Guérin

Of the two cases detected as potentially linked to the outbreak from the review of all recent Grampian TB cases, bacteriological specimens were available for genotyping for one case, and this specimen was also found to be genetically identical to the index case. A third possibly linked case, a 33 year-old male with a lymph node biopsy positive for TB, was found to have a different genotype from the index case.

Environmental investigation

Members of the health protection team (a TB specialist nurse and a colleague) visited the Aberdeen mosque accompanied by the Imam outwith prayer meeting times. For Friday lunchtime prayer meetings, attended by adult males only, the series of rooms that made up the mosque were reported to be full and found to be poorly ventilated. The Friday evening meetings, though substantially less well attended, also included women and children. Children were considered to be more susceptible to infection due to their potentially immature immune systems [13].

Attempts were made to identify a subgroup considered to have had greatest exposure or to be particularly susceptible to infection. However, there was no list of contact details for the mosque attendees nor was there a regular pattern as to where within the mosque the attendees prayed. It was, therefore, impossible to identify any "high-risk" sub-group within the mosque using the traditional "ripples from a stone in the pond" approach recommended in the BTS guidelines [10].

Risk assessment of potential to spread to casual contacts and definition of casual contacts

The outbreak control team identified a risk of spread to casual contacts through attendance at the mosque at the same time as the index case. The key factors in reaching that decision were:

- Evidence of high rate of infection among the close contacts (with genotype as evidence of link),
- Long period of symptomatic disease in the index case prior to diagnosis as demonstrated by numerous AAFBs in the sputum samples,
- Evidence linking other Grampian cases with the index case for whom the only opportunity for common exposure appeared to be through attendance at the Friday lunchtime mosque meetings (with genotype as evidence of link),
- Relatively overcrowded conditions and poor ventilation at the mosque,
- Presence of children, with their less mature immune systems, among the contacts.

The outbreak control team therefore established a definition of casual contacts (Box 3) and made the decision that a larger scale contact tracing exercise should be undertaken.

Box 3

Definition of casual contacts of the index case in the tuberculosis outbreak in a mosque, Aberdeen, 2005

Casual Contact:

"Anyone who regularly attended mosque prayer meetings on Friday lunchtimes or Friday evenings between the beginning of July 2005 and the end of October 2005." ('regularly' defined as attending at least three times during the defined time period)

Large scale contact tracing exercise of casual contacts attending the mosque

Organisation and methods

Communication with the mosque community was via the Imam. Religious beliefs dictated that only male Muslims could attend the Friday lunchtime prayer meetings. As a result, no one from the (all female) health protection team could attend. It was necessary to rely on the Imam communicating our complex message to the mosque attendees requesting casual contacts to come forward for screening. Figure 1 summarises the communication process.

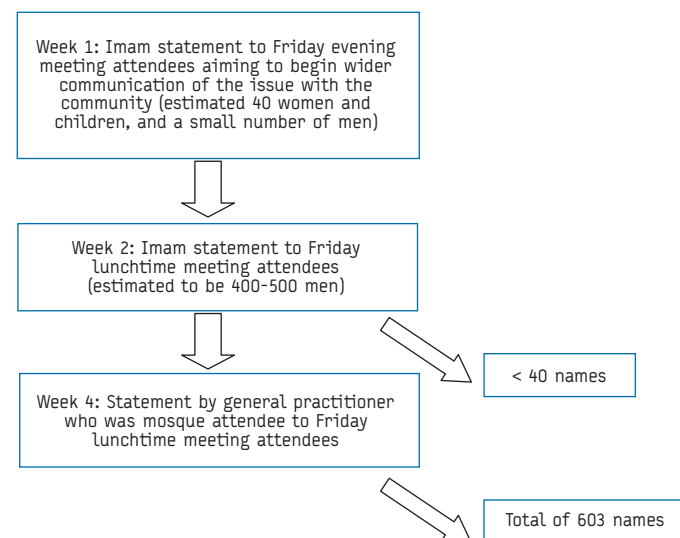
On the advice of the Imam that the mosque community would provide translation as required, standard information letters and leaflets in English were made available for collection. The information provided advice about TB and the risk of transmission, along with advice that anyone who met the definition of a casual contact should call a dedicated National Health Service (NHS) helpline to provide their personal details, so that invitations for screening appointments could be sent out.

The initial response was low, with less than 40 names received. A further meeting was held to discuss approaches to improve the response. The NHS Grampian Equity and Diversity Manager, through a network of contacts within the NHS, identified the chair of the mosque committee and a number of well-respected mosque attendees, including a local general practitioner (GP), to assist with communication. With the help of these individuals, a number of potential barriers were identified:

- Risk perception – the level of anxiety was thought to be low, with many considering TB to be easily treated and not a major cause for concern;
- Misunderstanding of risk – some people believed that if they did not currently have clinical symptoms of TB they could not have the disease, especially since some months had elapsed since the time of exposure;

FIGURE 1

Summary of the communication process with the mosque, Aberdeen, 2005



- Protection by Bacillus Calmette Guérin (BCG) vaccine – there was a misconception that previous BCG vaccination would guarantee life-long protection;
- Language barriers – complex messages, provided in English, may not have been translated or passed on effectively; where English was not the first language, having to contact a helpline number was believed to be daunting;
- Confidentiality – some people expressed anxiety about sharing of personal information.

To address these issues, the outbreak control team decided to re-iterate among all regular attendees the message about the importance of contact tracing and the need for them to come forward. The message was modified to address the potential barriers and was delivered by the male GP. In view of the potential difficulties calling the help-line, forms were also made available for attendees to complete and return to the health protection team in a freepost envelope.

Communication with the two universities in Aberdeen, which many international students attend, and local media attention raised general awareness. As the first people began to attend for screening, they were asked to encourage others to come forward.

These actions led to a greatly increased response.

Screening

All adults (aged 16 years and over) were offered a chest X-ray. Clinics were staffed by X-ray department staff as well as the TB specialist nurse or another member of the health protection team. People who came for a chest X-ray, were also asked to take part in a questionnaire survey of potential symptoms and risk factors.

One respiratory physician reviewed all chest X-rays, together with the relevant questionnaire survey findings. The radiology departments provided a second review of the chest X-ray films. If an abnormality was identified, appropriate follow-up was arranged. All children aged under 16 years were offered a Mantoux test and BCG vaccination as appropriate.

Screened participants, and their GPs, were informed of their test results.

Results of large scale casual contact screening

Although no formal register of mosque attendees was kept, estimates from various sources suggested that between 400 and 500 adult males (over 15 or 16 years of age) regularly attended Friday lunchtime meetings; a further 40 women and children were thought to regularly attend Friday evening sessions.

A total of 603 mosque attendees contacted the health protection team but, after discussion with a member of the team, only 438 who had had sufficient contact with the index case to qualify as casual contacts were screened; 336 (76.7%) of these 438 were male and 102 (23.3%) were female (Figure 2).

258 adult males (aged 16 years or over) were identified for screening (59% of the total identified for screening). This represented approximately half the number of attendees estimated of the Friday lunchtime prayer meetings.

180 women and children under the age of 16 years were offered appointments for screening; this number was 4.5 times that of

the estimated number of attendees to the Friday evening prayer meeting.

Of the 438 individuals identified as casual contacts and eligible for screening, 378 attended the screening (86%). Of the 60 who were offered appointments but did not attend, 57% were adult males.

Screening findings

Two individuals with TB (one latent, one active) were identified among the 378 who attended screening (a rate of 0.53%) (see Box 1: linked cases 6 and 7).

The screening identified a further three adults with chest X-ray abnormalities, and one with possible clinical symptoms. All required additional follow-up before TB was excluded.

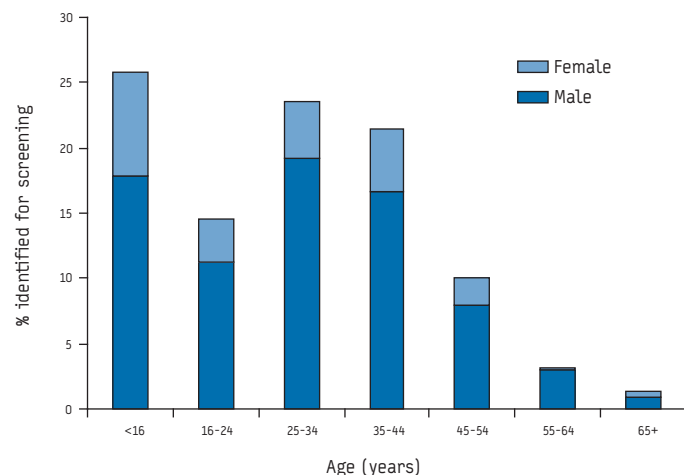
Additional molecular genotyping information

A UK-wide database of MIRU-VNTR profiles, developed by the UK TB Diagnostic and Molecular Epidemiology (DAME) Group, was searched to identify whether the 15 digit profile associated with this outbreak had been detected previously in the UK. It was the first time this particular fully sensitive MIRU-VNTR profile had been observed in the UK. There is no known link of this strain with Algeria nor is there any known pre-deposition for acquiring it. Since the outbreak, this MIRU-VNTR profile has been detected in a UK-born person in England in May 2006, and a further case in a previous household contact in February 2007 (see Box 1: linked cases 8 and 9; personal communication: Dr Ian Laurenson, Oct 2008).

Discussion

We have described the experience of undertaking a large-scale contact tracing exercise for an outbreak of TB associated with a mosque. Literature searches failed to identify any other such exercises associated with a mosque community, although similar experiences had been reported in other community settings [14-18].

FIGURE 2
Age and sex distribution of people identified as casual contacts for screening, tuberculosis outbreak, Aberdeen mosque, 2005



In total, our screening identified five cases of active disease (1.3% of those screened) with a further four cases identified by other means. The detection rate from screening of casual contacts was low, at 0.53%. A review of outbreaks of TB in the UK involving screening of more than 100 contacts reported an estimated mean detection rate of 0.37% [19], raising questions about the effectiveness of large scale screening of contacts [20].

The national Collaborating Centre for Chronic Conditions report, funded by NICE for the development of guidelines on the control and prevention of TB in the UK, suggested the following definition of a significant casual contact:

“Contacts with a cumulative total exposure to a smear-positive case of TB exceeding eight hours within a restricted area equivalent to a domestic room are equivalent to domestic contacts” [9].

Faced with a high incidence of active disease found in close contacts, there was an imperative to identify any potentially significant casual contacts. Reviewing the type of contact between the index case and attendees at the mosque, it was considered that at least some of the attendees would have met the NICE criteria. In this instance, no definable subgroup of contacts from the mosque who definitely met the criteria could be identified to enable the traditional “stone in the pond” approach. In addition, the degree of contact with the index case, reported by the linked cases, was variable and did not indicate a minimum level of exposure that could be used to focus screening. To further restrict our definition of a casual contact would have substantially increased the complexity of the message delivered. We were therefore faced with the difficult decision of whether to screen all attendees or no attendees.

We experienced some specific challenges in managing the outbreak that related to the mosque setting. Delivering our message was difficult because, for religious reasons, it was not possible for a member of the health protection team to directly address mosque attendees at a mosque meeting. Identifying all appropriate communication avenues as well as key individuals, who would be seen as respected and influential by their community, to deliver the message, was crucial.

Substantial work was generated for the health protection team because of a lack of clarity in communicating the definition of a casual contact. 603 individuals gave their names and details as casual contacts but closer interview identified that 165 of them had had no, or only minimal, contact with the index case at the mosque. Often the details of entire households were given when only one or two of the male members of the house regularly attended the mosque. Had we been clearer, we might have been able to reduce the number of individuals that were worried or answered the invitation for screening unnecessarily.

Attempts to operate by standard local radiology procedures in the X-ray department identified some language and cultural challenges. For Muslim women, changing into gowns before the X-ray examination was problematic. Cubicles for changing were located in mixed sex waiting areas, so women changed into gowns and then put their outer garments back on over the gowns while waiting for their X-ray. This increased the required appointment time substantially but was unavoidable as many of the women preferred to have their husbands present during interview and X-ray.

The contact tracing exercise was based on the then current BTS guidelines (2000) for the management and control of TB [10]. This guidance recommended that those under 16 years of age should have a tuberculin skin test, irrespective of BCG status, with a follow up chest X-ray for those who had a positive result. This meant that both latent and active TB cases could be identified. Those over 16 years, with a previous BCG vaccination, were recommended to have a chest X-ray, which would only detect those with active TB disease. Linked case 9 was not identified at initial screening because latent TB was not detected. Even when presenting with symptoms approximately 15 months after exposure to the index case, chest X-ray was normal.

However, had the latest NICE guidance (2006) been followed, all those under 35 years would have been offered a tuberculin skin test and, where positive, followed up by interferon gamma blood test and chest X-ray as necessary [9]. The case finding rate, especially for latent TB, might then have been higher. That said, it would still have been impossible to ascertain and report on who had developed latent TB due to recent infection at the mosque. Many of those who were screened were born in countries with a high prevalence of TB (>40 per 100,000) and, therefore, prior latent TB infection could not have been ruled out.

By using the BTS guidelines (2000) for screening adults with a single chest X-ray, we required attendance at only one appointment. We experienced a failure to attend rate of 14%, and a number of attendees required multiple appointments before they finally did attend. Anecdotal evidence suggested that offering screening that required more than one attendance may have led to a higher default rate. Freudenstein *et al.* reported their experience of a large casual contact tracing exercise in a UK village community where screening offered Heaf testing and reading, followed by chest X-ray as required. 20% of the casual contacts failed to complete the screening process [21].

While extensive casual contact tracing was undertaken in this outbreak, we know that a substantial number of individuals who were exposed did not come forward for screening. Standard communication about TB is aimed at reducing anxiety. The message focuses on emphasising the low risk of transmission and treatable nature of TB. It seems that some individuals in the mosque community may have interpreted our initial message as meaning there was no need to come forward for screening. A more direct message, delivered by medical members of the mosque community, and a change in the written information provided, instigated a more active response. However, we continued to have difficulty convincing adult males, who potentially had the highest exposure, to come forward for screening. And yet more children and women attended for screening than were estimated to be at risk. Risk perception contributed to this discrepancy, as it appeared that this community perceived the highest risk to be to women and children, but less concern was given to the risks faced by adult men. Ethnicity and religious beliefs have been reported to influence risk perception of other health issues [22-25].

In summary, enhanced surveillance and, where possible, the use of molecular genetic techniques to link TB cases to the outbreak was, in our experience, useful in defining the extent of the outbreak [26]. The screening of a large number of casual contacts was a complex and time consuming exercise with a low detection rate.

The following insights were gained in the course of this investigation:

- Screening casual, multi-ethnic contacts in a mosque posed particular challenges;
- Communication of the risk of need for screening must be tailored to meet the specific needs of the community;
- Those at highest risk of TB infection in this setting, adult males, were least likely to attend for screening;
- The detection rate among screened casual contacts was low;
- We describe the first UK case with this particular pan-sensitive TB strain.

Policy implications

Where the identity of those individuals who form a group of causal contacts cannot be established and the group are asked to self-assess against given criteria and then volunteer for screening, the uptake of screening and the case yield are low.

Acknowledgements

We are grateful to Dr Ian Laurenson, Director, Scottish Mycobacteria Reference Laboratory, Edinburgh, Scotland, UK for his support during the outbreak investigation and additional information provide regarding molecular typing.

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This article was published on 18 December 2008.

Citation style for this article: Duthie S, Black C, Douglas G, Jackson AD, Webster D. Tuberculosis outbreak associated with a mosque: challenges of large scale contact tracing. *Euro Surveill*. 2008;13(51):pii=19069. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19069>